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Draft Work Plan
Monitored Natural Attenuation Groundwater Sampling at SWMU 7/8

Naval Activity Puerto Rico
Ceiba, Puerto Rico

Revision No. 00

Contract No. N62470-08-D-1006
Task Order No. JM04

Submitted to:

U.S. Naval Facilities
Engineering Command
Southeast

Prepared by:

1000 Abernathy Road
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July 2010

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Prepared by:

July 2010

Prepared/Approved By:

Tom Beisel, Project Manager — July 30, 2010
Date

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Date

Client Acceptance:

U.S. Navy Responsible Authority — Date

Certification Page for Monitored Natural Attenuation Groundwater Sampling Work Plan (Revision No. 00) SWMUs 7 and 8

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: _____

Name: Mark E. Davidson

Title: BRAC Environmental Coordinator

Date: _____

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– Testing Plan and Log
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Acronyms and Abbreviations

AGVIQ-CH2M HILL	AGVIQ-CH2M HILL Constructors, Inc. Joint Venture
AHA	activity hazard analysis
AOC	Administrative Order on Consent
ASTM	American Society for Testing and Materials
Baker	Baker Environmental, Inc.
BTEX	benzene, toluene, ethylbenzene, and xylene
CFR	*Code of Federal Regulations*
CMS	corrective measures study
CAO	corrective action objective
CO	Contracting Officer
COC	chemical of concern
CTO	Contract Task Order
DO	dissolved oxygen
DOT	U.S. Department of Transportation
DRO	diesel range organics
DTP	depth to product
DTW	depth to water
EPA	U.S. Environmental Protection Agency
ERG	Emergency Response Guide
ft/ft	foot per foot
gpm	gallon per minute
GRO	gasoline range organics
ID	inner diameter
IRCDQM	Installation Restoration Chemical Data Quality Manual
LDR	land disposal restriction
LNAPL	light nonaqueous phase liquid
ml	milliliter
MNA	monitored natural attenuation
MS/MSD	matrix spike/matrix spike duplicate
NAPR	Naval Activity Puerto Rico
NAVFAC SE	Naval Facilities Engineering Command Southeast
NELAC	National Environmental Laboratory Accreditation Conference
ORP	oxidation-reduction potential
PAH	polynuclear aromatic hydrocarbon
P.E.	Professional Engineer
PPE	personal protective equipment
ppm	parts per million
PREQB	Puerto Rico Environmental Quality Board
PWR	partially weathered rock
QA	quality assurance
QC	quality control
QCR	quality control report

RAC	Response Action Contract
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
OIC	NAPR Officer in Charge
SAP	sampling and analysis plan
SMWU	solid waste management unit
SOP	standard operating procedure
SVOC	semivolatile organic compound
SWPPP	storm water pollution prevention plan
T&D	transportation and disposal
TPH	total petroleum hydrocarbon
TOC	total organic carbon
TSDF	treatment, storage, and disposal facility
TWFF	Tow Way Fuel Farm
UFP-SAP	Uniform Federal Policy–Sampling and Analysis Plan
UST	underground storage tank
VOA	volatile organic analytic
VOC	volatile organic compound

1.0 Introduction

AGVIQ-CH2M HILL Constructors, Inc. Joint Venture (AGVIQ-CH2M HILL) was contracted by the Department of the Navy (Navy), Naval Facilities Engineering Command Southeast (NAVFAC SE), to prepare this Work Plan for the sampling of groundwater in monitoring wells at solid waste management units (SWMUs) 7 and 8 located at the Tow Way Fuel Farm (TWFF), Naval Activity Puerto Rico (NAPR) in Ceiba, Puerto Rico. The work will be performed under Contract Number N62470-08-D-1006 and Contract Task Order (CTO) JM04. The work consists of collecting groundwater samples from 27 monitoring wells at SWMUs 7/8 to measure the natural attenuation parameters, and evaluate whether monitored natural attenuation (MNA) is a viable remedial action to reduce dissolved hydrocarbon concentrations in groundwater.

This Work Plan is organized as follows:

- **Section 1.0 Introduction** includes the site description and project objectives.
- **Section 2.0 Project Execution Plan** details the scope of work to be performed, project schedule, and project communications plan.
- **Section 3.0 Sampling and Analysis Plan.** This section details the sampling procedures that will be followed during execution of the work scope described in Section 2.0. Topics, such as sampling methodology, sample collection frequency, laboratory analytical methods, and quality assurance (QA)/quality control (QC) sampling, are discussed. The test methodology presented in Section 3.0 conforms to the standards promulgated by the Puerto Rico Environmental Quality Board (PREQB) and the U.S. Environmental Protection Agency (EPA).
- **Section 4.0 Waste Management Plan** discusses the characterization, disposal, onsite management, and transportation of wastes generated during the sampling.
- **Section 5.0 Environmental Protection Plan** contains site-specific environmental provisions for all work completed at SMWUs 7/8.
- **Section 6.0 Quality Control Plan** includes the testing requirements for work described in this Work Plan. The site-specific project organization for this CTO is also included in this section.
- **Section 7.0 References** contains a list of the works cited in this Work Plan.
- **Appendix A** contains the Uniform Federal Policy–Sampling and Analysis Plan (UFP-SAP).
- **Appendix B** contains QC attachments, including the Contractor Daily Production Report, Contractor Daily Quality Control Report, Preparatory Phase Report, and Testing Plan and Log.
- **Appendix C** contains the appointment letters for the QC manager.

1.1 Site Description and Investigation History

1.1.1 Site History

The Navy Activity Puerto Rico (NAPR) occupies over 8,600 acres at the northeastern-most portion of Puerto Rico along the Vieques Passage (Figure 1-1). The northern entrance to NAPR is about 35 miles east, along the coastal road (Route 3) from San Juan. The facility was commissioned in 1943 as a Naval Operations Base but was re-designated in 1957 as a Naval Station.

The TWFF is located on a hillside along Forrestal Drive north of Ensenada Honda (Figure 1-2). The fuel farm was constructed prior to 1957 and originally consisted of 9 bomb-proof underground storage tanks (USTs) (Figure 1-3). The tanks were used for the storage of marine diesel fuel, jet fuel (JP-5), and Bunker C fuel. Closure of Tanks 56A and 56B was completed in November 1996 by Reliable Mechanical, Inc. Two 10,000-gallon steel tanks and 329 tons of contaminated soil were bio-remediated and disposed of as nonregulated waste. On March 31, 2004, Base operations, including the storage and distribution of fuel, were discontinued. The seven remaining USTs (82, 83, 84, 85, 1080, 1082, and 1088) were drained and are empty. During the facility's operational history, numerous releases have occurred from the USTs, resulting in the release to the environment of almost 1 million gallons of petroleum hydrocarbons. The locations of known fuel releases are shown on Figure 1-4, and existing well locations are shown on Figure 1-5. Recent groundwater elevation measurements (April 9, 2010) and groundwater flow direction are displayed in Figure 1-6.

1.1.2 Regulatory History

EPA Region 2 is the primary agency that regulates environmental activities at the NAPR, and site work is performed under the 29 January 2007 Resource Conservation and Recovery Act (RCRA) Administrative Order on Consent (AOC)-7003. In addition, the PREQB provides regulatory input. The EPA has assigned the following SWMU designations to the TWFF:

- SWMU 7 – Encompasses environmental impacts from releases that emanated from the nine USTs (currently seven) located on a hillside along Forrestal Road north of Ensenada Honda.
- SWMU 8 – Encompasses TWFF sludge disposal; however, previous investigations were unable to locate evidence of the pits, and the EPA combined SMWU 8 with SWMU 7.

1.1.3 Summary of Previous Work

Between 1982 and the present, numerous investigations and remedial tests were performed to assess the extent of petroleum hydrocarbons in the soil and groundwater beneath the TWFF. The results of the work culminated in completion of a Corrective Measures Study (CMS) report prepared by Baker Environmental, Inc. (Baker, 2005). The CMS included a discussion of contaminant extent in soil and groundwater, light nonaqueous phase liquid (LNAPL) distribution, the hydraulic and physical properties of the soil and groundwater, pilot test results, and the studies performed to formulate remedial strategies for cleanup of the soil and groundwater to risk-based corrective action objectives (CAOs). The use of

LNAPL-only recovery pumps was proposed for the removal of LNAPLs, and MNA was proposed to reduce concentrations of select volatile organic compounds (VOCs) to the CAOs. Soil excavation of the upper 2-feet of soil within the fuel farm area was proposed to remove select polycyclic aromatic hydrocarbon compounds and arsenic that exceeded the risk-based CAOs. The EPA approved the CMS on February 9, 2006.

In 2008, the Navy retained AGVIQ-CH2M HILL to implement the remedial strategies presented in the CMS. However, the Navy requested that AGVIQ-CH2M HILL evaluate ways to optimize the remedial strategies described in the CMS. AGVIQ-CH2M HILL's optimization strategy is as follows:

- The collection of additional soil samples from the proposed area of excavation to verify whether polynuclear aromatic hydrocarbons (PAHs) and arsenic were present in soil above the CAOs, and if so evaluate the volume of soil requiring removal prior to mobilizing excavation equipment.
- Advance test pits in the lowland portion of the site to assess whether LNAPLs are present south of Forrestal Drive.
- Install LNAPL recovery wells to evaluate the extent of LNAPL and construct the wells with sufficient amounts of screen to straddle the water table and allow for seasonal fluctuations in the water table.
- Evaluate multiple LNAPL recovery technologies to identify the most technologically sound and cost-effective method to recover LNAPL and reduce the thickness of LNAPL in wells to CAO of 1/8 inch (0.01 foot).
- For the dissolved hydrocarbon plume, MNA was proposed for reducing concentrations of 1,2,4-trimethylbenzene, benzene, and ethylbenzene to applicable CAOs because previous test data collected by Baker suggested that biological degradation of hydrocarbons was occurring.

Therefore, the focus of this Work Plan is to describe the sampling requirements and procedures that will be used to collect the data necessary to calculate the attenuation rate of the chemicals of concern (COCs) and to evaluate changes in dissolved hydrocarbon concentrations resulting from reductions in source mass through LNAPL removal and from biological degradation.

1.2 Chemicals of Concern

The COCs for groundwater, as indicated in the revised CMS report, are presented in Table 1-1 (Baker Environmental Inc. [Baker], 2005).

TABLE 1-1
COCs for Groundwater

COC	Maximum Observed	Most Recently Observed Maximum
1,2,4-Trimethylbenzene	4,600	4,600
Benzene	26,000[c]	19,000D[c]
Ethylbenzene	95,702[a]	18,000[b]

Notes:
COC—chemical of concern
µg/L—micrograms per liter

[a]located at UGW1, concentration measured 3/1991
[b]located at 470MW3, concentration measured 1/2002
[c]located at 470MW1, concentration measured 4/1998 and 1/2002

1.3 Groundwater Remedial Action Objective

The remedial action objective for groundwater is to reduce concentrations of compounds 1,2,4-trimethylbenzene, benzene, and ethylbenzene to their respective CAOs through MNA. The use of MNA was presented in the revised CMS report (Baker, 2005) that was approved by the EPA on February 9, 2008. The CMS indicated that if after 2 years of monitoring, the chemicals of concern (COCs) exceed the CAOs, the Navy will reevaluate alternate remedial technologies to enhance contaminant degradation and/or to use a risk-based approach to calculate alternate CAOs that are protective of human health and the environment.

1.4 Task Background

In 2008, CH2M HILL was awarded the contract to implement the remedial strategy proposed in the CMS. This Work Plan focuses on the collection of water quality data that will be used to monitor changes in COC concentrations as a result of LNAPL removal and natural attenuation.

1.5 Task Objectives

The objectives for the project activities under this Work Plan are as follows:

- Collect depth to water (DTW) and depth to product (DTP) measurements within all wells associated with SWMUs 7/8 and 55 to evaluate LNAPL distribution, LNAPL thickness, and groundwater flow direction.
- Collect groundwater samples to measure natural attenuation parameters in 27 monitoring wells in the dissolved contaminant plume associated with SWMUs 7/8.
- Evaluate the ability of the aquifer to naturally attenuate dissolved hydrocarbons to the CAOs.

Gauging and sampling events will consist of an initial baseline site characterization event followed by quarterly events for 2 years.

City

Major Road

Naval Station Roosevelt Roads Boundary

N

0 5 10 20 Miles

FIGURE 1-1
NAPR Location in Puerto Rico
Naval Station Roosevelt Roads, Puerto Rico

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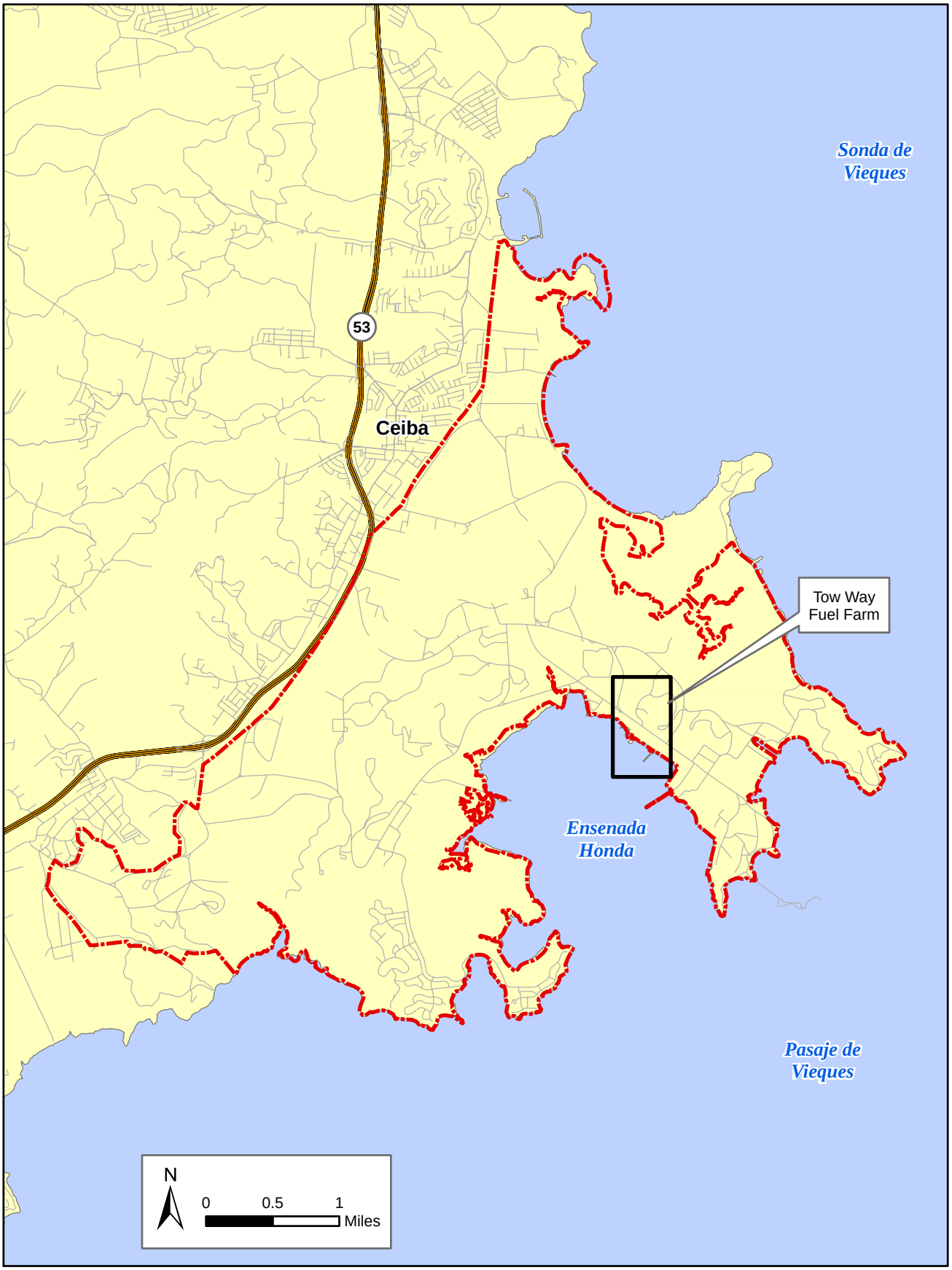
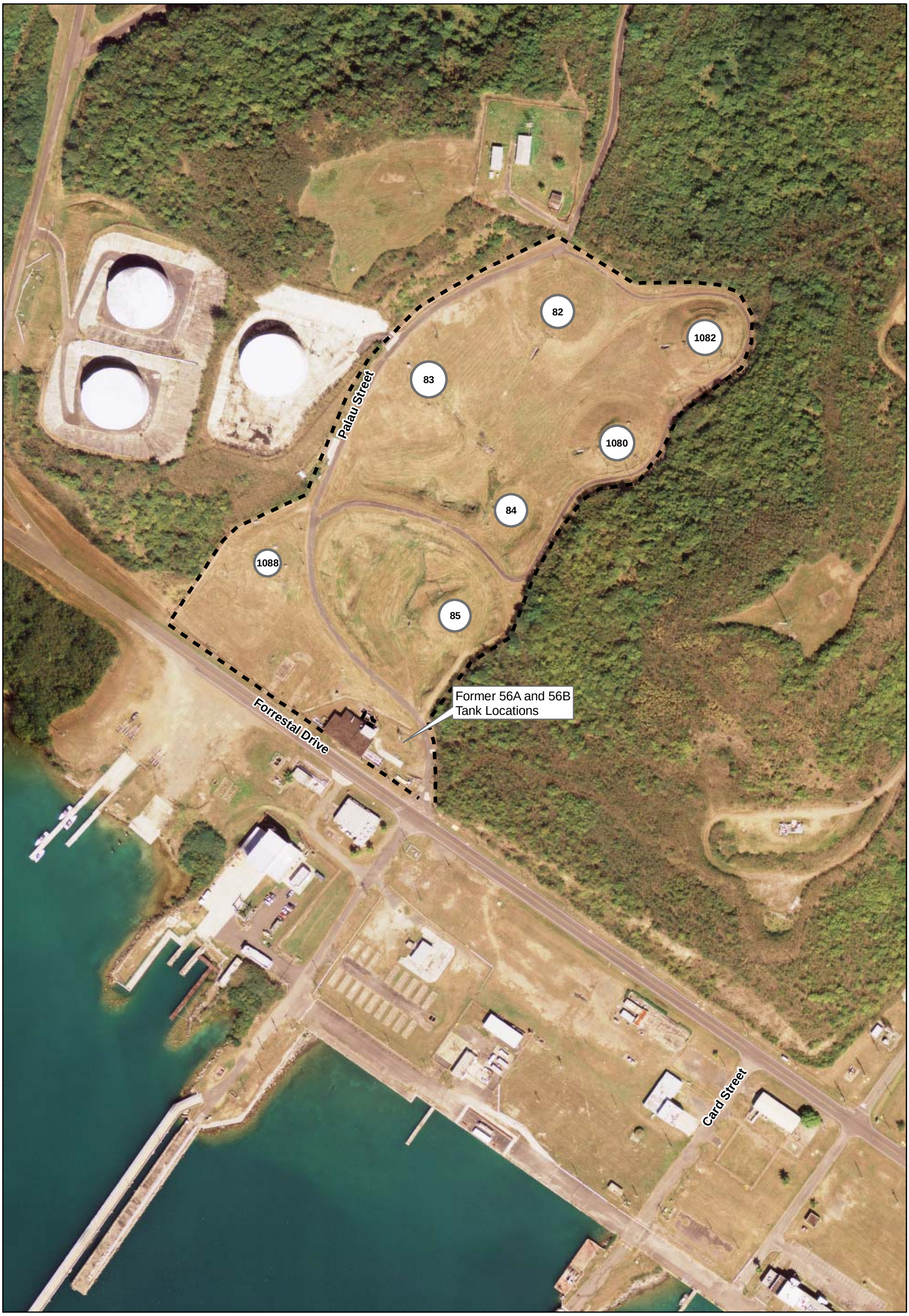


Road

Expressway

Naval Station Roosevelt Roads Boundary

FIGURE 1-2
Tow Way Fuel Farm Location
Naval Station Roosevelt Roads, Puerto Rico



Fence

Former Fuel Tank

N

0 100 200 Feet

1 inch = 200 feet

FIGURE 1-3
SWMU 7/8 Base Map
Tow Way Fuel Farm
Naval Station Roosevelt Roads, Puerto Rico

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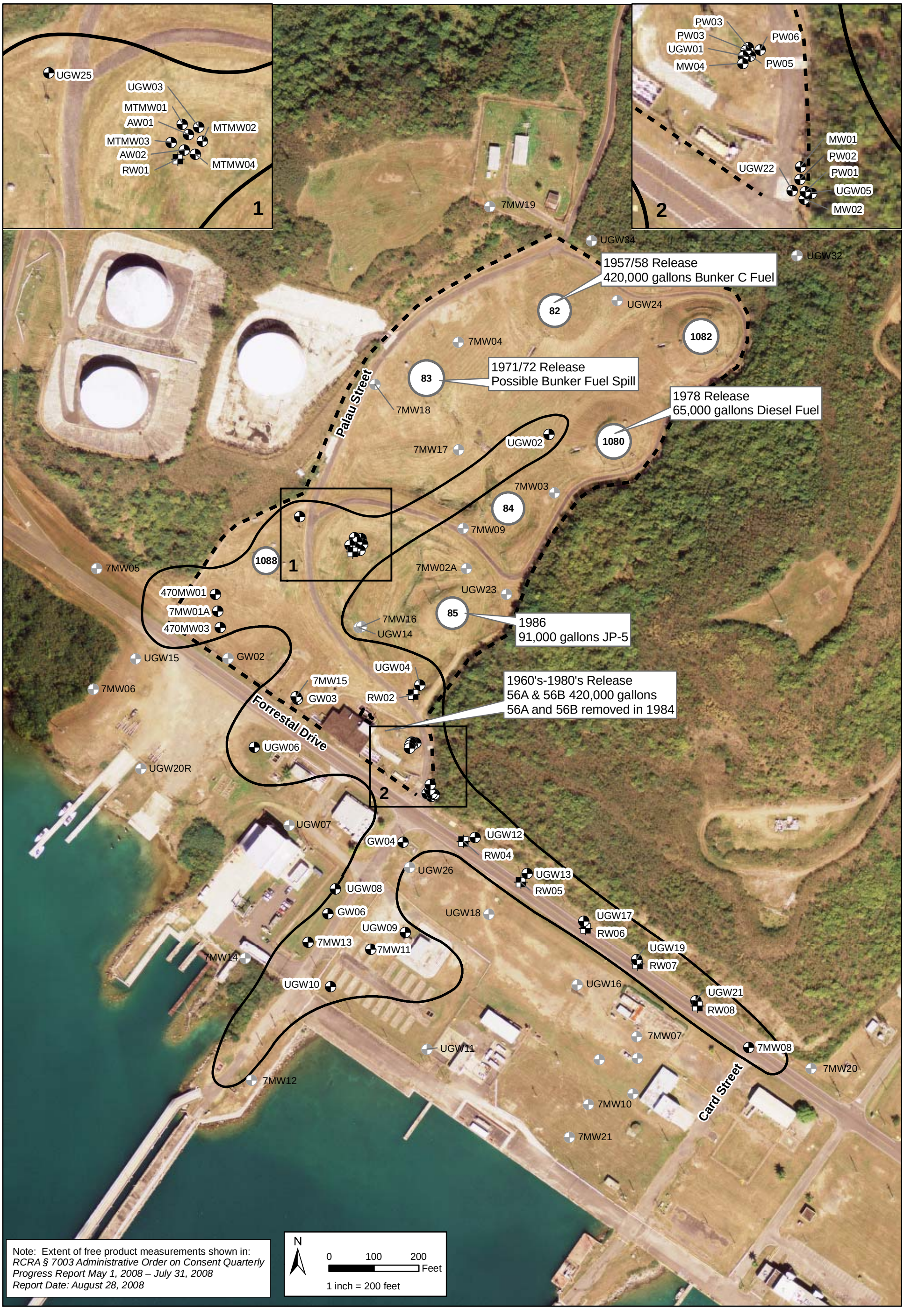

Wells

- Monitoring and Observation Well
- Recovery Well
- Historical Extent of Phase Separated Hydrocarbons (PSH)
- Fence
- Former Fuel Tank

UGW12	Well with measurable amount of free product.
UGW18	Well with no measurable amount of free product.

FIGURE 1-4
Historical Extent of Free Product
Tow Way Fuel Farm
Naval Station Roosevelt Roads, Puerto Rico

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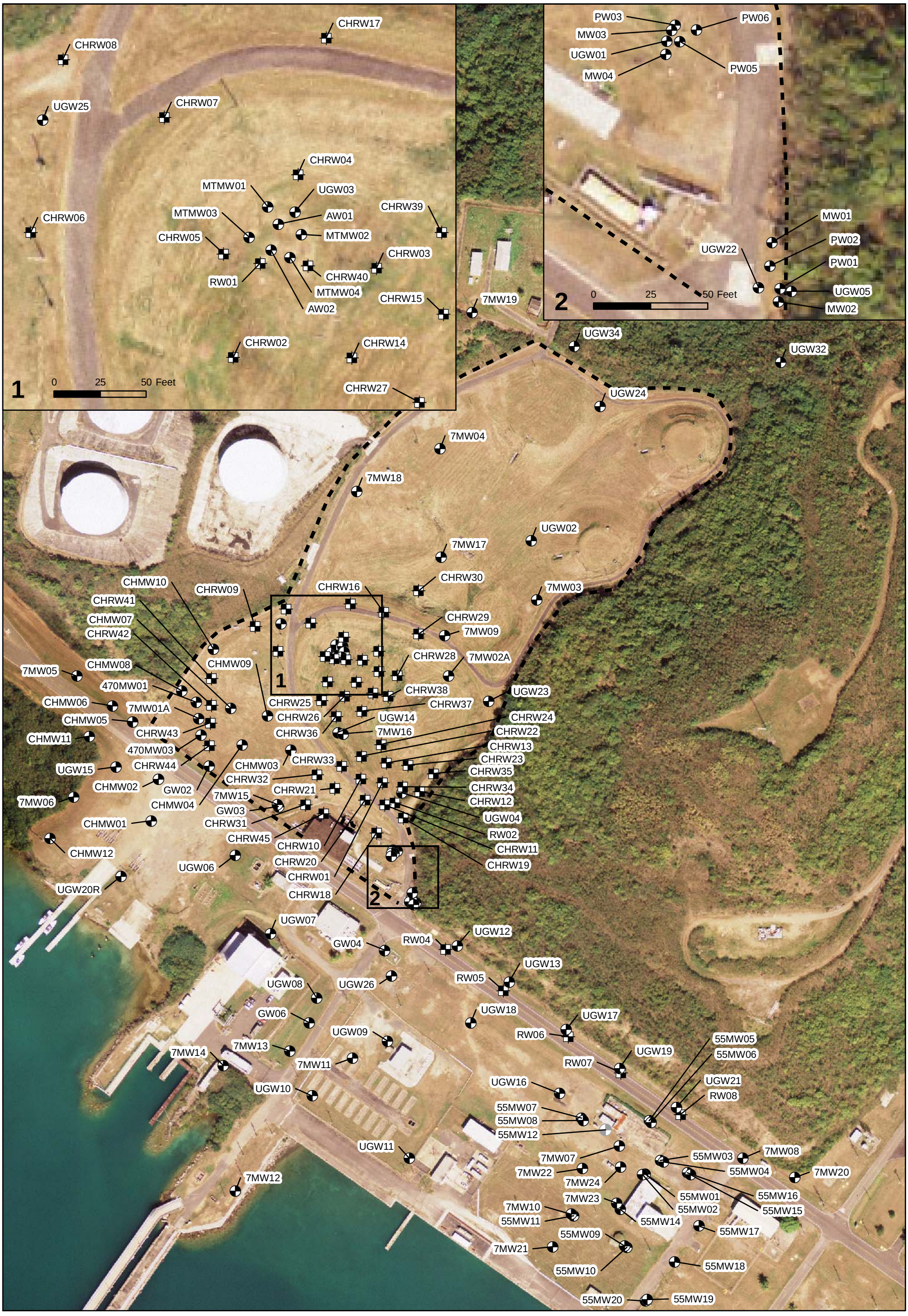

Wells

- Monitoring and Observation Well
- Monitoring Well (Not Surveyed)
- Recovery Well
- Fence

N

0 100 200 Feet

1 inch = 200 feet

FIGURE 1-5
Existing Well Locations
Tow Way Fuel Farm
Naval Station Roosevelt Roads, Puerto Rico

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Monitoring and Observation Well

Recovery Well

Groundwater Flow

Potentiometric Contour (Dashed Where Inferred)

Fence

Groundwater Elevation
in Feet NGVD29

N

0 100 200 Feet

1 inch = 200 feet

FIGURE 1-6
Groundwater Piezometric Surface (April 9, 2010)
Tow Way Fuel Farm
Naval Station Roosevelt Roads, Puerto Rico

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2.0 Project Execution Plan

The section describes the scope of work, project schedule, and communication plan that will be implemented during collection of water quality samples.

2.1 Scope of Work

The following activities are associated with the well gauging and groundwater sampling work that will be performed at SWMU 7/8:

- Plans and submittals preparation
- Mobilization and site preparation
- Dissolved contaminant plume groundwater investigation

2.1.1 Prepare Plans and Submittals

AGVIQ-CH2M HILL will prepare for the work by performing administrative, contractual, and logistic activities before mobilizing personnel and equipment to the site. The plans and submittals will address issues anticipated for performance of the work, including health and safety issues, permits, site access, supply and delivery of materials, subcontractor agreements, and insurance. Project deliverables, such as this Work Plan, the UFP-SAP, and schedules critical to the success of the project will be prepared and submitted to the Navy for approval and comment. Once the Navy has approved this Work Plan and the UFP-SAP, AGVIQ-CH2M HILL will mobilize personnel, equipment, and supplies to the project site.

- In addition, AGVIQ-CH2M HILL will prepare MNA reports consisting of an initial baseline report and eight quarterly monitoring reports, as well as an MNA evaluation report at the end of the 2-year sampling period.

2.1.2 Mobilization and Site Preparation

Project field personnel and equipment will mobilize to the work area. As part of this task, AGVIQ-CH2M HILL personnel will mobilize all equipment necessary to complete well gauging and groundwater sampling work. Equipment will include but will not be limited to an oil/water interface probe, water level meter, low-flow sampling pump, tubing, a water quality meter, Hach® ferrous iron test kit, sample jars, coolers, Ziploc® bags, logbook, and miscellaneous sampling supplies. The equipment will be stored in the same office/storage areas that were previously used by AGVIQ-CH2M HILL. Access to the facility and to SWMUs 7/8 will be undertaken in the same manner as done for the previous site work.

2.1.3 Dissolved Contaminant Plume Groundwater Investigation

The primary objective of the work is to collect groundwater samples to evaluate whether LNAPL removal coupled with MNA results in the reduction of the COCs to the CAOs within a 2-year monitoring period. To accomplish this task, a baseline sampling event will be performed to collect the data necessary to calculate the attenuation rates for COCs. Following the baseline event, water quality samples will be collected quarterly for 2 years to evaluate changes in dissolved VOC concentrations as a result of LNAPL removal and MNA.

In addition, comprehensive gauging events will be performed during each sampling event to monitor seasonal changes in LNAPL distribution and water levels. The following sections describe the scope of work that will be performed as part of the groundwater monitoring and sampling events. These tasks include the site-wide gauging of wells and collection of water quality samples for chemical analysis.

The groundwater sampling task will include the completion of a baseline sampling event followed by eight quarterly sampling events. During each event, 27 wells (CHMW01, CHMW02, CHMW03, CHMW04, CHMW05, CHMW06, CHMW09, CHMW11, CHMW12, CHRW06, CHRW09, CHRW25, CHRW31, CHRW41, CHRW44, 7MW05, 7MW06, 7MW15, 7MW18, GW02, GW04, UGW06, UGW07, UGW15, UGW20R, UGW32, and UGW34) will be sampled using EPA Method 8260B for analysis of the COCs, 1,2,4-trimethylbenzene, benzene, and ethylbenzene. However, during the baseline and yearly events, samples will also be collected for the MNA parameters that include: total alkalinity (SM 2320-B), nitrate/nitrite (EPA Method 300.0), sulfate (EPA Method 300.0), sulfide (SM4500-S2-F), methane (RSK-175), and total organic carbon (TOC) (SM 5310-B). Table 2-1 presents the project sampling matrix. Groundwater samples collected from the monitoring and recovery wells will be sent to an EPA-approved laboratory for chemical analysis. Wells containing LNAPL will not be sampled. Well locations are shown on Figure 2-1.

TABLE 2-1
SWMU 7/8 Sampling Matrix - Groundwater

Sampling Location	Parameters
Baseline Sampling Event and Yearly Events (Quarterly Sampling Events 4, and 8): New Wells: CHMW01, CHMW02, CHMW03, CHMW04, CHMW05, CHMW06, CHMW09, CHMW11, CHMW12, CHRW06, CHRW09, CHRW25, CHRW31, CHRW41, CHRW44 Existing Wells: (background) UGW32, UGW34, and 7MW18 (interior and perimeter plume) 7MW05, 7MW06, 7MW15, GW02, GW04, UGW06, UGW07, UGW15, UGW20R	VOCs: (SW846 8260B) 1,2,4-trimethylbenzene benzene ethylbenzene MNA parameters: alkalinity (SM 2320-B) nitrate/nitrite (EPA Method 300.0) sulfate (EPA Method 300.0) sulfide (SM 4500-S2-F) TOC (SM 5310-B) methane (RSK-175) Field parameters: Turbidity Ferrous iron (Hach® Test Kit) DO ORP Temperature pH Conductivity

TABLE 2-1
SWMU 7/8 Sampling Matrix - Groundwater

Sampling Location	Parameters
Quarterly Sampling Events (Events 1 through 8): New Wells: CHMW01, CHMW02, CHMW03, CHMW04, CHMW05, CHMW06, CHMW09, CHMW11, CHMW12, CHRW06, CHRW09, CHRW25, CHRW31, CHRW41, CHRW44 Existing Wells: (background) UGW32, UGW34, and 7MW18 (interior and perimeter plume) 7MW05, 7MW06, 7MW15, 7MW18, GW02, GW04, UGW06, UGW07, UGW15, UGW20R	VOCs: (SW846 8260B) 1,2,4-trimethylbenzene benzene ethylbenzene Field parameters: Turbidity Ferrous iron (Hach® test kit) DO ORP Temperature pH Conductivity

2.1.4 Characterization, Containerization, and T&D of Contaminated Media

Disposal characterization sampling and laboratory analyses will be completed to determine the necessary handling and transportation and disposal (T&D) requirements. Purge water and fluids used to decontaminate the sampling equipment will be containerized in 600-gallon tanks. Details the sampling, containerization, transportation, and disposal of wastes generated during the groundwater sampling work are described in Sections 3 and 4 of this Work Plan and are also described in the attached UFP-SAP.

2.1.5 Report Preparation

Reporting for the project will include preparation of a baseline report and eight quarterly reports. The outline of each report is as follows:

Baseline Report

- Introduction
- Purpose and Scope
- Summary of Work Procedures
- Discussion of Results
- Hydrology and LNAPL Distribution
- Distribution of VOCs in Groundwater
- Evaluation of Dissolved Hydrocarbon Degradation Rates
- Conclusions and Recommendations

  Tables
  - Summary of Well Gauging Data
  - Summary of Analytical Results

  Figures
  - Site Map
  - Site Location Map
  - Groundwater Contour Map
  - LNAPL Thickness Map
  - Summary of Analytical Test Data (Flag Map)

Wells

- Monitoring and Observation Well
- Recovery Well
- Fence

N

0 100 200 Feet

1 inch = 200 feet

FIGURE 2-1
MNA Monitoring/Recovery Well Locations
Tow Way Fuel Farm
Naval Station Roosevelt Roads, Puerto Rico

CH2MHILL

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Appendices
- Well Gauging Forms and Field Notes
- Laboratory Data Sheets and Chain-of-Custody Records
- Attenuation Rate Calculations

Quarterly Reports (Reports 1 through 8)

- Purpose and Scope
- Summary of Work Procedures
- Discussion of Results
- Hydrology and LNAPL Distribution
- Distribution of VOCs in Groundwater
- Evaluation of Fluctuations in Dissolved Hydrocarbon Concentrations
- Conclusions and Recommendations

Tables
- Summary of Well Gauging Data
- Summary of Analytical Results

Figures
- Site Map
- Site Location Map
- Groundwater Contour Map
- LNAPL Thickness Map
- Summary of Analytical Test Data (Flag Map)
- Graphs Depicting Fluctuations in Dissolved Hydrocarbon Concentrations

Appendices
- Well Gauging Forms and Field Notes
- Laboratory Data Sheets and Chain-of-Custody Records

The eighth quarterly report will also include a comprehensive data evaluation for assessing whether the CAOs for groundwater have been achieved. If the COCs exceed the CAOs, the report will also include recommendations for additional work.

2.2 Project Schedule

The baseline groundwater sampling work is anticipated to begin in May 2010 following completion of the well installation work. Once the baseline event is completed, groundwater monitoring and sampling will be performed quarterly thereafter for a 2-year period. The anticipated start and completion date for each task for each event is summarized in Table 2-2.

TABLE 2-2
Project Schedule

Activity ID	Activity Name	Start	Finish
WBS	**JM04 P.R.B1 Baseline Site Characteristics**		
B1	Mobilization and Site Preparation	5/17/2010	5/17/2010
B2	Site-wide Groundwater Gauging Event	5/18/2010	5/18/2010
B3	Groundwater Sampling at Designated Wells	5/19/2010	5/27/2010
B4	Demobilization	5/27/2010	5/27/2010
B5	Laboratory Analysis/Data Validation	5/28/2010	7/9/2010
B6	Baseline Site Characterization Report	7/12/2010	7/30/2010
WBS	**JM04 P.R.Q1 Quarterly Sampling Event**		
Q11	Mobilization and Site Preparation	8/16/2010	8/16/2010
Q12	Site-wide Groundwater Gauging Event	8/17/2010	8/17/2010
Q13	Groundwater Sampling at Designated Wells	8/18/2010	8/26/2010
Q14	Demobilization	8/26/2010	8/26/2010
Q15	Laboratory Analysis/ Data Validation	8/27/2010	10/1/2010
Q16	Q1 Quarterly Sampling Report	10/4/2010	10/22/2010
WBS	**JM04 P.R.Q2 Quarterly Sampling Event**		
Q21	Mobilization and Site Preparation	11/8/2010	11/8/2010
Q22	Site-wide Groundwater Gauging Event	11/9/2010	11/9/2010
Q23	Groundwater Sampling at Designated Wells	11/10/2010	11/18/2010
Q24	Demobilization	11/18/2010	11/18/2010
Q25	Laboratory Analysis/Data Validation	11/19/2010	12/31/2010
Q26	Q2 Characterization Report	1/3/2011	1/21/2011
WBS	**JM04 P.R.Q3 Quarterly Sampling Event**		
Q31	Mobilization and Site Preparation	2/14/2011	2/14/2011
Q32	Site-wide Groundwater Gauging Event	2/15/2011	2/15/2011
Q33	Groundwater Sampling at Designated Wells	2/16/2011	2/24/2011
Q34	Demobilization	2/24/2011	2/24/2011
Q35	Laboratory Analysis/Data Validation	2/25/2011	4/8/2011
Q36	Q3 Quarterly Sampling Report	4/11/2011	4/29/2011
WBS	**JM04 P.R.Q4 Quarterly Sampling Event**		
Q41	Mobilization and Site Preparation	5/16/2011	5/16/2011
Q42	Site-wide Groundwater Gauging Event	5/17/2011	5/17/2011
Q43	Groundwater Sampling at Designated Wells	5/18/2011	5/26/2011
Q44	Demobilization	5/26/2011	5/26/2011
Q45	Laboratory Analysis/Data Validation	5/27/2011	7/8/2011
Q46	Q4 Quarterly Sampling Report	7/11/2011	7/29/2011
WBS	**JM04 P.R.Q5 Quarterly Sampling Event**		
Q51	Mobilization and Site Preparation	8/15/2011	8/15/2011
Q52	Site-wide Groundwater Gauging Event	8/16/2011	8/16/2011
Q53	Groundwater Sampling at Designated Wells	8/17/2011	8/25/2011
Q54	Demobilization	8/25/2011	8/25/2011
Q55	Laboratory Analysis/Data Validation	8/26/2011	10/7/2011
Q56	Q5 Quarterly Sampling Report	10/10/2011	10/28/2011
WBS	**JM04 P.R.Q6 Quarterly Sampling Event**		
Q61	Mobilization and Site Preparation	11/7/2011	11/7/2011
Q62	Site-wide Groundwater Gauging Event	11/8/2011	11/8/2011
Q63	Groundwater Sampling at Designated Wells	11/9/2011	11/17/2011
Q64	Demobilization	11/17/2011	11/17/2011
Q65	Laboratory Analysis/Data Validation	11/18/2011	12/30/2011
Q66	Q6 Quarterly Sampling Report	1/2/2012	1/20/2012
WBS	**JM04 P.R.Q7 Quarterly Sampling Event**		
Q71	Mobilization and Site Preparation	2/13/2012	2/13/2012
Q72	Site-wide Groundwater Gauging Event	2/14/2012	2/14/2012
Q73	Groundwater Sampling at Designated Wells	2/15/2012	2/23/2012
Q74	Demobilization	2/23/2012	2/23/2012
Q75	Laboratory Analysis/Data Validation	2/24/2012	4/6/2010
Q76	Q7 Quarterly Sampling Report	4/9/2010	4/27/2010

TABLE 2-2
Project Schedule

WBS	JM04 P.R.Q8 Quarterly Sampling Event		
Q81	Mobilization and Site Preparation	5/14/2012	5/14/2012
Q82	Site-wide Groundwater Gauging Event	5/15/2012	5/15/2012
Q83	Groundwater Sampling at Designated Wells	5/16/2012	5/24/2012
Q84	Demobilization	5/24/2012	5/24/2012
Q85	Laboratory Analysis/Data Validation	5/25/2012	7/6/2012
Q86	Q8 Quarterly Sampling Report	7/9/2012	7/27/2012

2.3 Communications Plan

The lines of communication for NAVFAC SE and AGVIQ-CH2M HILL personnel are presented in Section 6 (Quality Control Plan). Table 2-3 presents a directory of project personnel.

TABLE 2-3
Directory of Project Personnel

Name	Role	Company	Phone Number	E mail
Nancy Ballantyne	Waste Management	AGVIQ-CH2M HILL 9191 South Jamaica St Englewood, CO 80112	(720) 286-5561 (office) (303) 885-9954 (cell)	Nancy.ballantyne@ch2m.com
Tom Beisel	Project Manager	AGVIQ-CH2M HILL 1000 Abernathy Road Suite 1600 Atlanta, GA 30328	(678) 530-4033 (office) (678) 429-8273 (cell)	Tom.Beisel@ch2m.com
Carlos Brown	Local Onsite Team Member	AGVIQ-CH2M HILL 4610 West Road Court Virginia Beach, VA 23455	(787) 435-6086 (office) (787)885-9026 (home)	Sebi@isla.net
Bryan Burkingstock	Lead Project Hydrogeologist	AGVIQ-CH2M HILL 1000 Abernathy Road Suite 1600 Atlanta, GA 30328	(678) 530-4060 (office) (404) 414-2762 (cell)	Bryan.burkingstock@ch2m.com
Eric Burrell	Quality Control Officer	AGVIQ-CH2M HILL 1000 Abernathy Road Suite 1600 Atlanta, GA 30328	(678) 530-4061 (office) (678) 296-0920 (cell)	Eric.Burrell@ch2m.com
Tom Cherrix		AGVIQ-CH2M HILL 4610 West Road Court Virginia Beach, VA 23455	(757) 417-5506 (office)	Tcherrix@tikigag.com
Andrew O'Conor	Site QA/QC Lead	AGVIQ-CH2M HILL 1000 Abernathy Road Suite 1600 Atlanta, GA 30328	(843) 200-3825 (cell)	Andrew.oconor@ch2m.com
Thomas Kessler	Senior Consultant	AGVIQ-CH2M HILL 1000 Abernathy Road Suite 1600 Atlanta, GA 30328	(678) 530-4197 (office) (404) 216-5073 (cell)	Tom.kessler@ch2m.com
Camden Robinson	Project Chemist	AGVIQ-CH2M HILL 1000 Abernathy Road Suite 1600 Atlanta, GA 30328	(770) 439-8363 (office)	Camden.robinson@ch2m.com
Theresa Rojas	Contracts Administration Manager	AGVIQ-CH2M HILL 1000 Abernathy Road Suite 1600 Atlanta, GA 30328	(678) 530-4297 (office) (678) 642-7030 (cell)	Theresa.rojas@ch2m.com

TABLE 2-3
Directory of Project Personnel

Name	Role	Company	Phone Number	E mail
Pedro Ruiz	Onsite Navy Contact for Environmental Services	FedEx packages: Naval Activity Puerto Rico Att: Pedro Ruiz Bldg. 1205 Ceiba, PR 00735 Regular mail: Naval Activity Puerto Rico Attn: Pedro Ruiz PO BOX 1418 Ceiba, PR 00735	(787) 534-0933 ext 459 (office)	Ruizp@napr.navy.mil
Mike Karafa	Project Geologist	AGVIQ-CH2M HILL 1000 Abernathy Road Suite 1600 Atlanta, GA 30328	(678) 530-4194 (office) (770) 605-9820 (cell)	Mike.karafa@ch2m.com
Amber Guilfoyle	Project Geologist	AGVIQ-CH2M HILL 9311 San Pedro Avenue, Suite 800 San Antonio, TX 78216	(210) 321-6244 (office) (210) 275-5197 (cell)	Amber.guilfolye@ch2m.com

3.0 Sampling and Analysis Plan

This section describes the sampling procedures that will be followed during execution of the work scope described in Section 2.0. Analytical methods, data quality objectives, protocol for equipment decontamination, and procedures used for the collection of samples for waste characterization are discussed in this section (Section 3). This section of the Work Plan is a condensed version of the UFP-SAP, which is contained in Appendix A. Any changes to the activities described in this section, or any changes made to the UFP-SAP, must be documented as an addendum and must be approved by the Project Manager, Project Chemist, and the Navy.

3.1 Data Quality Levels for Measurement Data

The data quality levels for each sampling task are listed in Table 3-1. The sampling events, sampling and analytical requirements, and the required level of QC and data packages are listed in Table 3-2. The quantity, project action, accuracy, precision, and completeness limits by which the data will be evaluated will be provided by the selected laboratory and will be approved by CH2M HILL's Project Chemist. All analytical data will be submitted via hard copy and electronic files.

Samples will be collected in accordance with the EPA Region 4 *Environmental Investigative Standard Operating Procedures and Quality Assurance Manual* (EISOPQAM [EPA, 2001]) and in accordance with the sampling requirements stipulated by the PREQB. Where two documents conflict, the more stringent will apply.

The sampling team will be qualified under the *Navy Installation Restoration Chemical Data Quality Manual* (IRCDQM [Navy, 1999]) sampling requirements. A Navy-, U.S. Army Corps of Engineers-, or Air Force Center for Engineering and the Environment and PREQB-approved laboratory will be used for all sample analyses.

TABLE 3-1
Data Quality Levels
Tow Way Fuel Farm – SWMU 7/8, Ceiba, Puerto Rico

Sampling Activity	Data Quality Level Category
Groundwater Sampling (offsite laboratory analyses)	Definitive
Waste Characterization of Liquid Waste (offsite laboratory analyses)	Definitive

TABLE 3-2
Sampling and Analysis Summary
Tow Way Fuel Farm – SWMU 7/8, Ceiba, Puerto Rico

Sample Task	Sample Point	Matrix	Sampling Frequency	Sample No	Sampling Method	Sampling Equipment	TAT	Data Package Requirement	Required Analysis	Analytical Method	Holding Time	Sample Preservation	Containers
Groundwater Monitoring with MNA parameters	Monitoring Wells (15 new and 12 existing wells)	Water	Baseline Groundwater Sampling Event + Quarter 4 Event + Quarter 8 Event	27 + 3 DUP + 2 MS/MSD	Low Flow	Low flow submersible pump	14 days	CH2M HILL Level C	1,2,4-trimethylbenzene, benzene, and ethylbenzene	SW 846 8260B	14 days	HCl pH<2; Cool to 4°C	(2) 40-ml vials
									Methane	RSK175	14 days	Cool to 4°C	(2) 40-ml vials
									Sulfate	EPA 300.0	28 days	Cool to 4°C	(1) 250-ml plastic
									Sulfide	SW 4500-S2-F	7 days	Cool to 4°C, pH>9 w/NaOH	(1) 500-ml plastic
									Nitrate, Nitrite	EPA300.0	48 hours	Cool to 4°C	(1) 250-ml plastic
									Alkalinity	SW 2320-B	14 days	Cool to 4°C	(1) 500-ml plastic
									TOC	SM 5310-B	28 days	Cool to 4°C, pH<2 w/HCl or H_2SO_4	(2) 40-ml vials
	Equipment Rinseate Blank	Water	1 per day per decontami-nated equipment	Dependant on number of days samples collected	Prepared in field	Analyte-free water, nalgene plastic funnel	14 days	CH2M HILL Level C	1,2,4-trimethylbenzene, benzene, and ethylbenzene	SW 846 8260B	14 days	HCl pH< 2; Cool to 4°C	(2) 40-ml vials
									Methane	RSK175	14 days	Cool to 4°C	(2) 40-ml vials
									Sulfate	EPA 300.0	28 days	Cool to 4°C	(1) 250-ml plastic
									Sulfide	SW 4500-S2-F	7 days	Cool to 4°C, pH>9 w/NaOH	(1) 500-ml plastic
									Nitrate, Nitrite	EPA300.0	48 hours	Cool to 4°C	(1) 250-ml plastic
									Alkalinity	SW 2320-B	14 days	Cool to 4°C	(1) 500-ml plastic
									TOC	SM 5310-B	28 days	Cool to 4°C, pH<2 w/HCl or H_2SO_4	(2) 40-ml vials
	Trip Blank	Water	1 per cooler containing volatile samples	1	Prepared by Lab	(2) 40-ml vials	14 days	CH2M HILL Level C	1,2,4-trimethylbenzene, benzene, and ethylbenzene	SW 8458260B	14 days	HCl pH< 2; Cool to 4°C	(2) 40-ml vials
Groundwater	Monitoring	Water	Quarterly	27 + 3 DUP +	Low Flow	Low flow	14 days	CH2M HILL	1,2,4-	SW 8468260B	14 days	HCl pH< 2;	(3) 40-ml vials

TABLE 3-2
Sampling and Analysis Summary
Tow Way Fuel Farm – SWMU 7/8, Ceiba, Puerto Rico

Sample Task	Sample Point	Matrix	Sampling Frequency	Sample No	Sampling Method	Sampling Equipment	TAT	Data Package Requirement	Required Analysis	Analytical Method	Holding Time	Sample Preservation	Containers
Monitoring	Wells (15 New and 12 Existing Wells)		(Events 1-3 and 5 7)	2 MS/MSD		submersible pump		Level C	trimethylbenzene, benzene, and ethylbenzene			Cool to 4°C	
	Equipment Rinseate Blank	Water	1 per day per decontaminated equipment	Dependant on number of days samples collected	Prepared in Field	Analyte-free water, nalgene plastic funnel	14 days	CH2M HILL Level C	1,2,4-trimethylbenzene, benzene, and ethylbenzene	SW 8458260B	14 days	HCl pH< 2; Cool to 4°C	(3) 40-ml vials
	Trip Blank	Water	1 Per cooler containing volatile samples	1	Prepared by Lab	(2) 40-ml vials	14 days	CH2M HILL Level C	1,2,4-trimethylbenzene, benzene, and ethylbenzene	SW 8458260B	14 days	HCl pH< 2; Cool to 4°C	(2) 40-ml vials
Waste Characterization Sampling													
Disposal of Liquid Waste from well purging water, development	600-gallon tanks containing liquid waste	Water	One per container or as required by disposal facility	1	Grab	Bailer	7 days	CH2M HILL Level B	TCL Volatiles	SW 8468260B	14 days	HCl pH< 2; Cool to 4°C	(3) 40-ml vial
									TCL Semi-volatiles	SW 846 8270C	7 days ext; 40-days analysis	Cool to 4°C	(2) 1-L amber glass
									TCL Pesticides	SW 846 8081A	7 days ext; 40-days analysis	Cool to 4°C	(2) 1-L amber glass
									Herbicides	SW 846 8151A	7 days ext; 40-days analysis	Cool to 4°C	(2) 1-L amber glass
									PCBs	SW 846 8082	7 days ext; 40-days analysis	Cool to 4°C	(2) 1-L amber glass
									TAL Metals	SW 845 6010B/7470A	180 days; Hg = 28 days	HNO_3 pH< 2; Cool to 4°C	(1) 250-ml HDPE
									Ignitability	SW 846 1010/1020A	ASAP	Cool to 4°C	(1) 250-ml HDPE
									Corrosivity	SW 846 9045	ASAP		
									Reactive Cyanide	SW 846 9012A	ASAP	Cool to 4°C	250-ml HDPE
									Reactivity Cyanide	SW 846 Chap. 7	ASAP	Cool to 4°C	250-ml HDPE

ASAP – as soon as possible
DO – dissolved oxygen
BTEX – benzene, toluene, ethylbenzene, and xylenes
HDPE – high density polyethylene
MNA – monitored natural attenuation
MS/MSD – matrix spike/matrix spike duplicate
PCBs – polychlorinated biphenyls
TAL – Target Analyte List
TCL – Target Compound List
TCLP – Toxicity Compound Leaching Procedure
TOC – total organic carbon

3.2 Sampling Objectives

The sampling objectives for this project will be as follows:

- Collect 27 groundwater samples during each event (one baseline event and eight quarterly events for the analysis of 1,2,4-trimethylbenzene, benzene, and ethylbenzene) by EPA Method 8260B.
- Collect 27 groundwater samples during the baseline sampling event and the 4th and 8th quarterly events for the following MNA parameters: sulfate/sulfide, alkalinity, nitrate, nitrite, TOC, and methane. These data will be used to verify that conditions are favorable for natural attenuation and to calculate the biological degradation rate of the COCs.
- Collect water samples for waste characterization.

3.3 Well Gauging and Groundwater Sampling and Analyses

As described in Section 2.0, Project Execution Plan, samples will be collected from 27 monitoring and recovery wells, 15 newly installed wells, and 12 existing wells, and analyzed for 1,2,4-trimethylbenzene, benzene, and ethylbenzene during the nine sampling events (one baseline and eight quarterly) that are planned for the site. In addition, during the baseline event and 4th and 8th quarterly events, water samples from the 27 wells will also be analyzed for MNA parameters. During all events, well gauging will be performed to evaluate LNAPL thickness and distribution on the water table, evaluate fluctuations in water table elevations, and prepare groundwater contour maps. Wells that contain LNAPL will not be sampled. The procedures that will be followed are discussed below.

Site-wide Gauging of Wells

During each sampling event, AGVIQ-CH2M HILL personnel will gauge all site wells using an oil/water interface probe. Site-wide gauging will be performed the day before beginning groundwater sampling. Gauging data will be recorded in a site-specific, waterproof logbook The following guidelines adopted from American Society of Testing and Materials (ASTM) D4750 - *Standard Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well* will be used to gauge the wells:

1. Unlock and uncap the well and allow water levels to reach static levels for at least 15 minutes. If the cap has a vent hole, this step may be ignored.
2. Clean the water level indicator or oil/water interface probe with a Liquinox/water solution and rinse with distilled water.
3. Turn on the oil/water interface probe and test the battery to verify proper charge. Verify that the probe is working by wetting the end of the probe. Dry the probe prior to measuring LNAPL/groundwater depth.
4. Measure depth to LNAPL/groundwater as follows:
    a. Adjust the gain/sensitivity (while probe is dry) to the maximum sensitivity that does not activate the audible sensor.

b. Lower the probe into the well slowly until the audible sensor activates. A single tone indicates that LNAPL has been encountered. Multiple beeping tones indicate that groundwater has been encountered.

c. Raise and lower the probe slowly to precisely measure the top of the LNAPL and/or water surface.

d. Hold the tape (indicating depth) against the designated measuring point and read the DTW and/or DTP to the nearest 0.01 foot. Perform a second and third check to verify each reading. If LNAPL is encountered record the measurement to the nearest 0.01-foot and continue to lower the probe until multiple beeps are heard. Record this measurement as this indicates that groundwater has been encountered. The difference between the top and bottom measurements is the LNAPL thickness.

5. Record the DTW and/or DTP in the field logbook.

6. Recap and lock the well.

Important items to check include:

- If the well does not have a vent hole, vent the well before measurement.
- Use the same location on the well casing during each measurement event to ensure comparability of readings. If in doubt, measure on the northern side of the casing for all wells.
- Clean the water level indicator or oil/water interface probe with a Liquinox/water solution and rinse with distilled water before and after each well measurement.

Groundwater Sampling Procedures

The groundwater sampling task will include the completion of a baseline sampling event followed by eight quarterly sampling events. During each event, 27 wells (see Table 2-1 and Figure 2-1) will be sampled for the analysis of the COCs, 1,2,4-trimethylbenzene, benzene, and ethylbenzene using EPA Method 8260B. However, during the baseline event and 4th and 8th quarterly events, samples will also be collected for the MNA parameters that include: total alkalinity (SM 2320-B), nitrate, nitrite (EPA Method 300.0) sulfate (EPA Method 300.0), sulfide (SM 4500-S2-F), methane (RSK-175), and TOC (SM 5310-B). Groundwater samples collected from the monitoring and recovery wells will be sent to an EPA-approved laboratory for chemical analysis. Wells containing LNAPL will not be sampled. Groundwater samples will be collected following the EPA's procedures for low-flow groundwater sampling. The procedure outlined below is based on the EPA paper entitled *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures* (EPA, 1996).

1. Slowly lower the decontaminated pump or pump intake to the middle of water column within the screened interval to minimize excessive mixing of the stagnant water, and to minimize resuspension of solids that may have accumulated at the bottom of the well.

2. Once the pump is positioned in the well, an airtight flow-through cell (equipped with a YSI-type water quality meter) will be connected to the water discharge line.

3. A water level meter will then be lowered into the well to monitor changes in water level during pumping. Once purging begins, water level measurements will be monitored, and pumping rates will be adjusted so the rate is between 0.1 to 0.3 liter per minute to maintain minimal drawdown.

4. While purging, field parameters (dissolved oxygen [DO], pH, temperature, conductivity, turbidity, and oxidation-reduction potential [ORP]) will be measured every 3 to 5 minutes using a YSI-type meter and recorded until all parameters have stabilized for 3 consecutive readings. Once field parameter stabilization is achieved, sample tubing will be disconnected from the YSI-type meter and associated flow-through cell and the sample bottles filled. In addition, ferrous iron concentrations will be measured using a Hach® test kit.

5. Water samples will be collected by directing the groundwater discharge stream from the pump so that it runs down the inside of the sample bottle with a minimum amount of splashing. To minimize VOC loss, samples to be analyzed for VOCs followed by the analyses for methane, sulfate/sulfide, alkalinity, nitrate/nitrite, and TOC. The sample bottles for each analysis are as follows:

   – VOCs (1,2,4-trimethylbenzene, benzene, and ethylbenzene) by EPA Method 8260B: Three 40-milliliter (ml) volatile organic analytic (VOA) vials containing a hydrochloric acid (HCl) preservative. Fill bottles so no headspace exists within the bottles.

   – Sulfate/sulfide by EPA Method 300.0 and EPA Method 4500-S2-F, respectively: One 250-mL plastic bottle for sulfate and one 500-mL plastic bottle containing sodium hydroxide (NaOH) preservative for sulfide. Fill to the top of each bottle.

   – Alkalinity by EPA Method SM2320-B: One 500-mL plastic bottle containing no preservative. Fill to the top of the bottle.

   – Nitrate/nitrite by EPA Method 300.0: One 250-mL plastic bottle containing no preservative. Fill to the top of the bottle.

   – TOC by EPA Method 5310-B: Two 40-mL plastic bottles containing HCl or sulfuric acid (H_2SO_4) preservative. Fill to the top of the bottle.

   – Methane by Method RSK-175: Two 40-mL VOA vials containing HCl preservative. Fill to the top of the bottle.

6. Cap each bottle and affix label to the bottle. Label information will include laboratory, project name and number, sample identification, station identification, preservative, analysis, sampler's initials, sample date, and time. Place samples in appropriate containers and pack with ice in coolers.

Requirements for sample collection, preservation, and analysis are listed in Table 3-2. Samples will be delivered to the laboratory as soon as possible to allow the samples to be analyzed within the specified holding times. Requirements for QA/QC samples are listed in Table 3-2. A CH2M HILL Level C data package will require appropriate QC samples from the offsite laboratory. All analytical data will be submitted by both hard copy and electronic files.

3.4 Waste Characterization and Incidental Waste Stream Sampling and Analyses

3.4.1 Waste Characterization

Waste characterization samples will be collected to evaluate the handling and T&D requirements of accumulated purge water and decontamination water. Water characterization samples will be collected from the tanks prior to disposal. One sample will be collected from each 600-gallon tank. Water samples will be collected as follows and analyzed for the parameters listed in Table 3-2:

1. Using a bailer, collect a water sample from the tank.
2. Fill the sample containers for volatile analyses first (grab sample). The 40-mL vials will be filled so that there is no headspace in each vial.
3. Then fill the sample containers for the remaining analyses.
4. Label and package the samples for shipment to the laboratory.

A CH2M HILL Level B package will be required along with appropriate QC samples for the required waste characterization and incidental waste stream samples. All analytical data will be submitted by both hard copy and electronic files.

3.5 Equipment Decontamination

Sampling methods and equipment have been selected to minimize decontamination requirements and the possibility of cross-contamination. The following procedures will be used:

1. Clean sampling equipment with potable water and Liquinox or equivalent laboratory grade detergent using a brush, if necessary, to remove particulate matter and surface films.
2. Rinse equipment thoroughly with potable water.
3. Rinse equipment thoroughly with analyte-free water.
4. Rinse equipment thoroughly with isopropanol (pesticide-grade). Do not rinse polyvinyl chloride or plastic items with isopropanol.
5. Rinse equipment thoroughly with organic/analyte-free water.
6. Allow equipment to air dry completely.

3.6 Sample Documentation

- Sampling documentation will include the following:
- Numbered COC Forms
- Sample log book, that includes the following information:

- Weather conditions
- Name of laboratories and contacts to which the samples were sent, turnaround time (TAT) requested, and data results, when possible
- Termination of a sample point or parameter and reasons
- Unusual appearance or odor of a sample
- Measurements, volume of flow, temperature, conductivity, DO, ferrous iron, turbidity, ORP, and pH
- Additional samples and reasons for obtaining them
- Levels of protection used (with justification)
- Meetings and telephone conversations held with the NAVFAC SE, regulatory agencies, project manager, or supervisor
- Details concerning any samples split with another party
- Details of QC samples obtained
- Sample collection equipment and containers, including their serial or lot numbers. Details of QC samples obtained
- Field analytical equipment, and equipment used to make physical measurements will be identified
- Calculations, results, and calibration data for field sampling, field analytical, and field physical measurement equipment
- Property numbers of any sampling equipment used, if available
- Sampling station identification
- Date and Time of sample collection
- Description of the sample location
- Description of the sample
- Sampler(s)' name(s) and company
- How the sample was collected

- Sample Labels
- Custody Seals (minimum of two on each shipping container)

3.7 Field Quality Control

Field duplicate samples, equipment blanks, trip blanks, and matrix spike/matrix spike duplicates (MS/MSD) will be collected at the frequency specified in Table 3-2. Field QC samples are not required for disposal sampling.

3.8 Analytical Methods

Samples will be collected for analytical methods summarized in Table 3-2.

Preliminary and final analytical results will be faxed to Bethany Garvey in accordance with the TATs listed in Table 3-2. Final hard-copy data and electronic file will be delivered to Camden Robinson within 14 days of sample receipt. Contact information for Bethany Garvey and Camden Robinson is provided as follows:

Bethany Garvey
Laboratory Coordinator
AGVIQ-CH2M HILL
Northpark 400
1000 Abernathy Road, Suite 1600
Atlanta, GA 30328
(770) 604.9182 ext 54124
(678) 579.8176 (fax)
bethany.garvey@ch2m.com

Camden Robinson
Database Coordinator
AGVIQ-CH2M HILL
Northpark 400
1000 Abernathy Road, Suite 1600
Atlanta, GA 30328
(770) 439-8363 (office)
Camden.robinson@ch2m.com

4.0 Waste Management Plan

The Waste Management Plan describes the waste management requirements and procedures that will be used to manage wastes generated during the completion of the well gauging and groundwater sampling work. Waste accumulated during the work will include groundwater accumulated during well purging and decontamination fluids accumulated from equipment cleaning. Additional wastes will include:

- Used personal protective equipment (PPE)
- Used plastic tubing, sampling materials, and packing materials

4.1 Waste Characterization

Contaminated aqueous waste will be characterized according to requirements listed in Section 3 of this document and in accordance with the requirements listed in the attached UFP-SAP. Other wastes such as debris and office trash will be characterized using process knowledge. Waste characterization information for wastes that will be disposed of offsite will be documented on a waste profile form provided by the treatment or disposal facility as part of the waste acceptance process. AGVIQ-CH2M HILL will provide analytical data from waste characterization sampling to the designated offsite treatment and disposal facilities for review, if required. The profile will be completed by AGVIQ-CH2M HILL and will be submitted to the AGVIQ-CH2M HILL Waste Coordinator for approval prior to submission to the Navy for generator signature. Where generator certification and signature are required, Navy personnel will provide. The signed profile will then be submitted to the disposal facility for review and approval.

The profile typically requires following information, including, but not limited to, the following:

- Generator (Navy) information including name, address, contact, and phone number
- Site name including street/mailing address
- Process generating waste (soil removal)
- Source of contamination
- Historical use for area
- Waste composition (95 percent soil, 5 percent debris)
- Physical state of waste (solid, liquid, etc.)
- Applicable hazardous waste codes

A facility approved copy of the waste profile will be received prior to scheduling offsite transportation of the waste.

4.2 Waste Management

4.2.1 Waste Storage Time Limit

Hazardous wastes, if generated, will be removed from the site within 90 days from generation. Liquids from groundwater well purging and decontamination activities will be

contained in 600-gallon tanks. The water is expected to be non-hazardous petroleum contaminated water and will be removed from the site following the completion of each groundwater sampling event. AGVIQ-CH2M HILL will provide the waste characterization results to the Navy, and will coordinate the transportation, and disposal of the liquid waste contained in the 600-gallon tanks.

4.2.2 Labels

Waste containers will be labeled in accordance with the U.S. Department of Transportation (DOT) requirements (49 Code of Regulations [CFR] 172, 173, and 178). Labels will include the type of waste, the location from which the waste was generated, and accumulation start date. Containers and tanks used to store/accumulate waste (including groundwater) will include one of the following labels:

- "Analysis Pending" or "Waste Material" – Temporary or handwritten label affixed to drum or container until analytical results are received and reviewed. This label will include the accumulation start date.
- "Non-Hazardous Waste" – Pre-printed labels with the following information:
  - Accumulation start date
  - Generator name
  - EPA ID number
  - Waste-specific information (for example, contaminated soil)

Where applicable, the major hazards (for example, flammable, oxidizer, and carcinogen) will be included on the label.

4.2.3 General Waste Management Requirements

Liquid wastes will be contained in 600-gallon tanks for offsite disposal at an approved wastewater treatment and disposal facility.

Incompatible wastes (for example, flammable and corrosive wastes) will be segregated. Wastes of the same matrix, contamination, and the same source may be aggregated to facilitate storage and disposal.

Wastes will be accumulated in an area identified or approved by the Navy. If an accumulation area is not designated, AGVIQ-CH2M HILL will accumulate wastes in an area that is not accessible to the general public and that can be secured.

Waste accumulation areas will contain appropriate emergency response equipment. The site-specific Health and Safety Plan identifies the specific emergency response procedures and equipment**.** Spill control equipment (for example, sorbent pads) will be available in the waste accumulation areas and where liquids are transferred from one vessel to another.

The following guidelines relate to drums and small containers if used:

- Drums and small containers will be transported to the temporary accumulation areas on wood pallets and will be secured together with non-metallic banding.
- Drums will be inspected and inventoried upon arrival onsite for signs of contamination or deterioration.

- Adequate aisle space (30 inches) will be provided for containers such as 55-gallon drums to allow the unobstructed movement of personnel and equipment. A row of drums will be no more than two drums wide.
- Each drum will be provided with its own label, and labels will be visible.
- Drums will remain covered except when removing or adding waste to the drum. Covers will be properly secured at the end of each workday.
- Drums will be disposed of with the contents. If the contents are removed from the drums for offsite transportation and treatment or disposal, the drums will be decontaminated prior to re-use or before leaving the site.
- Drums containing liquids will be provided with secondary containment.

The following guidelines relate to tanks:

- Tanks will be inspected upon arrival onsite for signs of deterioration or contamination. Any tank arriving onsite with contents or in poor condition will be rejected.
- Tanks will be provided with covers and secondary containment.
- Only non-stationary (i.e., portable) tanks such as a cargo tank or other wheeled tank will be used to accumulate hazardous waste.
- Tanks will remain closed except when removing or adding waste to the drum. Covers will be properly secured at the end of each workday.
- Each tank will be provided with its own label, and labels will be visible.

4.2.4 Shipping Documentation

Prior to offsite disposal of any waste, a waste approval package for each waste stream will be prepared. This package will include a waste profile naming the U.S. Navy as the generator of the waste, analytical summary table(s) applicable to the waste, land disposal restriction (LDR) notification for any hazardous wastes, a completed waste manifest, and any other applicable information necessary for the Navy to complete its review of the disposal package and signature as the generator.

The signed profile will then be submitted to the designated offsite disposal facility for acceptance and approval. Once the approval letter is received from the designated facility, transportation can be scheduled.

Each load of waste material will be manifested prior to leaving the site. At a minimum, the manifest form will include the following information:

- Generator information including name, address, contact, and phone number, USEPA ID number
- Transporter information including name, address, contact and phone number, USEPA ID number
- Designated facility information including name, address, phone number, USEPA ID number

- Site name including street/mailing address
- U.S. DOT Proper Shipping Name (e.g., Hazardous Waste Solid, n.o.s., 9, UN 3077, PG III [D008])
- Type and number of container
- Quantity of waste (volumetric estimate)
- Task order or job number
- Profile number
- 24-hour emergency phone number

In addition, each shipment of waste will have a weight ticket. An LDR notification/ certification is required for hazardous wastes. This form requires the generator signature and submission to the designated facility.

The generator and the transporter must sign the manifest prior to the load of waste leaving the site. The original of the signed manifest will be returned to the address of the generator.

If the signed hazardous waste manifest from the designated facility is not received within 35 days, the generator must contact the transporter or the designated facility to determine the status of the waste. If the signed hazardous waste manifest has not been received within 45 days, the generator must issue an "Exception Report" to the PREQB.

4.2.5 Transportation

Each transportation vehicle and load of waste will be inspected before leaving the site and documented. The quantities of waste leaving the site should be recorded on a transportation and disposal log. A contractor licensed for commercial transportation will transport non-hazardous wastes. In the event that wastes are hazardous, the transporter will have a EPA ID number and will comply with transportation requirements outlined in 49 CFR 171-179 (DOT) and 40 CFR 263.11 and 263.31 (Hazardous Waste Transportation).

The transporter will be responsible for weighing loads at a certified scale. For each load of material, weight measurements will be obtained for each full and empty container, dump truck, or tanker truck. Disposal quantities will be based on the difference of weight measurements between the full and empty container, or dump truck. Weights will be recorded on the waste manifest.

The transporter will observe the following practices when hauling and transporting wastes offsite:

- Minimize impacts to general public traffic.
- Repair road damage caused by construction and/or hauling traffic.
- Clean up waste spilled in transit.
- Line and cover trucks/trailers used for hauling contaminated waste to prevent releases and contamination.
- Decontaminate vehicles prior to re-use for transporting loads other than contaminated waste.
- Seal trucks transporting liquids.

- All personnel involved in offsite disposal activities will follow safety and spill response procedures outlined in the Health and Safety Plan.
- No materials from other projects will be combined with materials from this site.

4.2.6 Disposal of Waste Streams

Offsite treatment or disposal facilities will use the waste profile and supporting documentation (e.g., analytical data) to determine whether they will accept a waste.

- Any waste that is classified as hazardous will be sent to an offsite, permitted RCRA Subtitle C treatment, storage, or disposal facility.
- Non-hazardous wastes will be disposed at an offsite RCRA Subtitle D facility permitted to receive such wastes. It is expected that the contaminated soil and debris will be classified as non-hazardous and disposed of at a Subtitle D facility.
- Liquid wastes may be disposed of onsite with written permission from the Base or disposed of offsite at a facility permitted to accept the waste.
- Uncontaminated construction debris may be sent to municipal landfills or landfills designated for construction/demolition debris.

The designated offsite facility will be responsible for providing a copy of the fully executed waste manifest and a certificate of treatment or disposal for each load of waste received.

4.2.7 Record Keeping

The following records and documents shall be maintained:

- Transportation and offsite disposal records, including:
  - Profiles and associated characterization data
  - Manifests, LDR notifications/certifications, bills of lading, and weight tickets
  - Designated offsite facility waste receipts, certificates of disposal/destruction
- Training records
- Inspection records

5.0 Environmental Protection Plan

This NAPR Environmental Protection Plan discusses specific requirements and procedures to prevent pollution and protect the environment during the groundwater sampling activities at SMWU 7/8.

5.1 Spill Prevention and Control

The provisions for spill prevention and control establish minimum site requirements. All spills will be reported to the NAPR Officer in Charge (OIC). Refer to the site-specific Health and Safety Plan for emergency response procedures and further reporting requirements.

5.1.1 Spill Prevention

Trucks used for transporting drums containing contaminated water/LNAPL will be loaded at a dedicated loading area, debris will be brushed from the tires and outside of the vehicle, and the vehicle will be inspected for proper operation. Any deficiencies noted will be corrected. A system of communication will be implemented to allow the truck drivers and site personnel to quickly communicate should a spill occur. Site personnel will respond to spills, remove all material spilled, sweep all residue from the area, and deliver the material to its destination. The site superintendent or his delegate will periodically follow the transport route to ensure that no material is spilling from the vehicles. Any spills and the actions taken to clean them will be reported to the OIC.

5.1.2 Spill Containment and Control

Spill control materials will be maintained in the support zone and at waste storage areas. Incidental spills will be contained with sorbent and disposed of properly. Spilled materials must be immediately contained and controlled. Spill response procedures include:

- Immediately warning any nearby workers and notify supervisor.
- Assessing the spill area to ensure that it is safe to respond.
- Evacuating the area if spill presents an emergency.
- Ensuring any nearby ignition sources are immediately eliminated, if necessary.
- Stopping the source of the spill.
- Establishing site control for the spill area.
- Containing and controlling spilled material through the use of sorbent booms, pads, or other material.
- Using proper PPE in responding to spills.

5.1.3 Spill Cleanup and Removal

All spilled material, contaminated sorbent, and contaminated media will be cleaned up and removed as soon as possible. Contaminated spill material will be drummed, labeled, and properly stored until material is disposed of. Contaminated spill material will be managed

as a waste as described in the Waste Management Plan and disposed of according to applicable, federal, state, and local requirements.

6.0 Quality Control Plan

This Quality Control Plan describes the quality administrators and their associated duties, as well as the project organization for the work to be completed at NAPR. Additionally, this plan discusses the construction inspections associated with remedial activities at SMWU 7/8. The QC attachments, such as the submittal register and testing plan and log, are provided in Appendix B.

The submittal register documents submittals in accordance with AGVIQ-CH2M HILL's Contract Management Plan (dated July 1998). AGVIQ-CH2M HILL, the Navy, or others will approve submittals as identified in the submittal register. Approved submittals will be distributed by AGVIQ-CH2M HILL to the appropriate Navy personnel (Contracting Officer [CO], OIC [in duplicate], etc.), the project site, and the project file.

The project organization chart (Figure 6-1) depicts the chain-of-command for this CTO and the individuals responsible for executing the work as indicated. Individual roles and responsibilities of CTO personnel are summarized in Table 6-1.

6.1 Project QC Manager

The Project QC Manager is Andrew O'Conor, and the Alternate Project QC Manager is Alicia Nobles. The appointment letters for these individuals are included in Appendix C.

6.2 Identification and Certification of Testing Laboratories

This section describes the environmental testing laboratory and its certifications, environmental sampling and analysis, and test control. The Testing Plan and Log is provided in Appendix B.

The environmental testing laboratory used for this project will function as a subcontractor or a lower-tier subcontractor. The analytical laboratory will be Empirical Laboratories, LLC located in Nashville, Tennessee.

Laboratories performing analytical analysis of environmental samples will demonstrate compliance with the U.S. Department of Defense Quality Systems Manual for Environmental Laboratories. The selected laboratory will possess an approved Quality Assurance Project Plan.

6.3 Construction Inspections

The Project QC Manager will perform final inspections of the materials and overall work activities. The inspections ensure that high quality work is performed in a safe and efficient manner while meeting the objectives and requirements of the plans and specifications.

FIGURE 6-1 - Project Organizational Chart

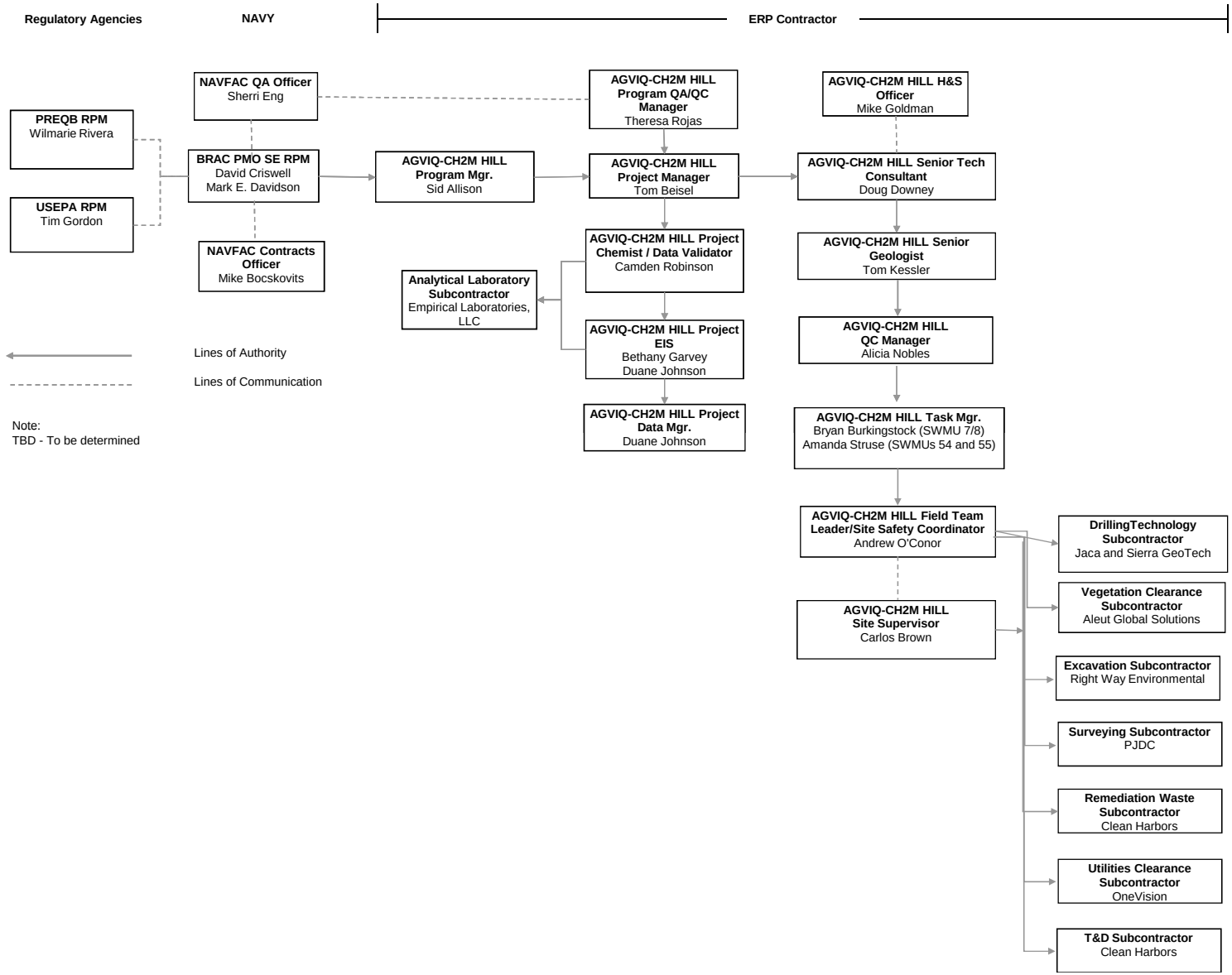

TABLE 6-1
Roles, Responsibilities, and Authorities of Key Project Personnel

Role	Responsibility	Authority
CTO Manager	• Communication with NAVFAC SE Remedial Project Manager and Navy Technical Representative • Management and technical direction of work • Overview subcontractor performance • Select CTO staff • Develop CTO Work Plan and supporting plans • Meet CTO performance objectives • Prepare status reports	• Approve subcontractor selection • Approve invoices to Southern Division • Approve CTO baseline schedule • Stop work at the site for any reason • Approve payment to vendors and suppliers • Approve payment to subcontractors
Site Superintendent	• Responsible for all site activities • Provide direction to subcontractors • Act for Project Manager • Provide daily status reports • Prepare CTO Work Plan • Conduct daily safety meetings • Review subcontractor qualifications • Stop work for unsafe conditions or practices • Monitor and oversee subcontractor compliance with scope of work • Review requests for changes in scope of work • Review technical qualifications of subcontractors • Prepare Field Change Requests	• Stop work for subcontractors • Approve corrective action for site work inspections • Approve materials and labor costs for site operations • Resolve subcontractor interface issues • Approve daily and weekly status reports • Approve Field Change Requests below ceiling amount •
Transportation and Disposal Coordinator	• Develop site specific procedures for transport and disposal practices • Plan and coordinate the transport and disposal of waste • Review subcontractor qualifications • Audit Transportation and Disposal (T&D) subcontractors compliance with contract requirements	• Approve subcontractors daily report of waste material removed from the site • Approve corrective action plans from T&D subcontractor
Project Assistant	• Maintain CTO files and correspondence • Coordinate CTO schedule and monitor deliverables • Maintain change management records • Maintain Action Tracking System log	• Submit Action Tracking System log • Assign correspondence log numbers

TABLE 6-1
Roles, Responsibilities, and Authorities of Key Project Personnel

Role	Responsibility	Authority
Project QC Manager/ QC Inspector(s)	• Monitor and report on subcontractor quality and quantities • Audit subcontractors offsite fabrication • Maintain Submittal Register • Participate in Continuous Improvement Team • Stop work for non-compliant operations • Maintain Lessons Learned Log	• Stop work for non-compliant operations • File daily quantities report • File Lessons Learned Log Sheet • Approve resumption of work for resolved quality issues
Site Health and Safety Specialist	• Monitor and report on subcontractor safety and health performance • Record and report safety statistics • Conduct needed site safety and health orientation • Maintain Environmental Log • Stop work for unsafe practices or conditions	• Stop work for unsafe practices or conditions • Approve subcontractor site specific health and safety plan • Set weekly safety objectives • Approve resumption of work for resolved safety issues
Subcontract Specialist	• Prepare bid packages • Purchase disposable materials • Maintain subcontract log	

6.4 Definable Features of Work

The project tasks for this CTO are grouped into definable features of work, which are work activities that are significant enough to warrant distinct plans and specifications. The definable features of work for this project are as follows:

- Mobilization and Site Preparation
- Dissolved Contaminant Plume Groundwater Investigation
- Waste Management
- Decontamination and Demobilization

The definable features of work will be inspected in accordance with the three phases of control: preparatory, initial, and follow-up. An overview of the inspection provisions is outlined in the subsections that follow.

6.4.1 Mobilization and Site Preparation

As part of mobilization, a pre-construction meeting will be held to review the overall project scope and schedule, communications, reporting, and preparations to begin work. The preparations check will verify the following provisions are in place to begin work activities: permits/approvals; utility clearances; demarcation of the work zones; staging of equipment and material; stormwater runoff and erosion control plan (if necessary); and devices

implemented as necessary. Additionally, equipment and materials will be checked to verify they are functional and in good working condition prior to starting the project.

Preparatory Phase

The preparatory phase will include a review of the relevant activity hazard analyses (AHAs), the project Work Plan, UFP-SAP, communications matrix, project schedule, submittal status, and confirmation of appropriate materials and equipment.

Initial Phase

Inspections will be made as necessary to ensure the sampling limits are defined and materials are staged in designated areas.

Follow-up Phase

The Project QC Manager will provide continuous oversight of the site preparation activities to verify that the work is completed in accordance with the requirements provided in this Work Plan. Deficiencies will be documented and corrected.

Table 6-2 lists the QC procedures that will be implemented during mobilization and site preparation.

TABLE 6-2
QC Procedures for Mobilization and Site Prep

Task	Procedures/Sampling Details
Pre-construction Meeting	• Verify designated locations of equipment layout, material and waste staging, and decontamination
Site Walk	• Verify site layout plan • Verify Environmental Conditions Report
Pre-construction Submittals	• Subcontractor plans and specifications (if applicable) • Subcontractor personnel qualification and certifications (if applicable)
Temporary Facilities	• Verify temporary facilities • Verify temporary utility hookups for conformance with the utility and the base requirements, as needed • Verify implementation of environmental protection measures, as needed

6.4.2 Dissolved Contaminant Plume Groundwater Investigation

Liquid waste characterization samples will be collected. Environmental samples will be collected in accordance with the as described in Section 3 of this Work Plan and in accordance with the UFP-SAP. Other controls will include, but are not limited to, sampling by qualified persons; maintaining a proper chain-of-custody of samples; proper handling, packing, and shipping of samples; and the use of certified laboratories.

Preparatory Phase

The preparatory phase for sample collection activities includes reviewing the relevant AHAs and the sampling procedures described in Section 3 of this Work Plan and in the UFP-SAP; verifying the acceptance of the selected laboratory; and confirming the appropriate equipment and materials are available to perform the sampling activities.

Initial Phase

Groundwater and waste characterization samples will be collected and analyzed at an approved laboratory in accordance with the protocols and methods outlined in Section 3 of this Work Plan and in accordance with the UFP-SAP, including proper chain-of-custody documentation.

Follow-up Phase

The Project QC Manager will observe sample collection activities and review the associated documentation records throughout each sampling event. Analytical reports from the approved laboratory will be reviewed for accuracy and quality. If required, data validation information from the laboratory will be reviewed to resolve discrepancies in the analytical data. AGVIQ-CH2M HILL quality assurance personnel will validate laboratory data and field sampling results.

Table 6-3 lists the QC procedures that will be implemented during field sampling activities.

TABLE 6-3
QC Procedures for Field Sampling

Task	Procedures/Construction Details
Field Sampling	• Verify laboratory and credentials • Verify appropriate sampling equipment • Verify appropriate facilities and testing equipment are available and comply with testing standards • Verify the field instruments are calibrated in accordance with manufacturers' recommendations • Verify recording forms, including all of the test documentation requirements, have been prepared and are accurate and complete • Inspect and collect samples in accordance with SOPs • Use internal version of chain-of-custody record, rather than laboratory's version • Coordinate sample shipment and delivery with laboratory coordinator; copy of completed chain-of-custody submitted to the PM on day of sampling • Verify equipment decontamination

6.4.3 Waste Management

Preparatory Phase

The preparatory phase for the transportation and disposal of waste streams includes reviewing the Waste Management Plan (see Section 4), reviewing the disposal facility's qualifications, confirming transportation schedule for hauling material offsite, and confirming that the appropriate equipment and materials are available to commence the work activity. Prior to any work, the relevant AHAs will be reviewed and discussed. All temporary storage containers will be inspected prior to acceptance onto the project and labeled.

Initial Phase

The initial phase includes inspecting the waste transport vehicles prior to acceptance on the job site. Information provided on the waste manifest must be verified as complete and accurate, including, but not limited to, the generator's name, address and signature; date; type of material being hauled; designated recycling or treatment facility; and volume

and/or weight of material. Any discrepancies on waste manifest documents will be corrected.

Follow-up Phase

The follow-up phase includes verifying that the designated disposal facility has accepted the waste material at the facility and has sent the required completed manifest to the generator or the generator's technical representative. A field logbook and an electronic log of all transportation and disposal shipments will be maintained. Waste storage containers will be routinely inspected for integrity. Waste storage areas, including areas with waste storage containers, will be visually inspected on a daily basis for releases or signs of corrosion, deterioration, or other conditions. These results of all inspections will be recorded.

Table 6-4 lists the quality controls that will be implemented for waste management.

TABLE 6-4
QC Procedures for Waste Management

Task	Inspection/Construction Control
Waste Management	• Verify designated locations of equipment layout, material and waste staging, and decontamination • Update waste tracking log and label waste containers • Inspect segregated wastes and label containers with content • Inspect waste containers for cleanliness, acceptable materials of construction, adequate storage volume
Transportation and Disposal	• Verify waste profile completion (obtain Navy Signature) • Transporter and disposal facility certificates • Verify waste storage area inspection

6.4.4 Decontamination and Demobilization

Personnel and equipment used to perform work will be decontaminated in accordance with the provisions of the site-specific Health and Safety Plan. Pre-final inspection of cleanliness will be performed by the site superintendent and the site health and safety specialist. Final equipment inspections will be performed and documented by the Project QC Manager or his/her designee.

Equipment and personnel will demobilize from the site following the completion of the work activities identified in this Work Plan. The Project QC Manager will verify that the objectives of the associated remedial activities have been met. A final inspection will be conducted to verify completion of all project activities. Any findings should be identified, tracked, resolved, and documented during a final site walk-through inspection.

Preparatory Phase

The preparatory phase will include a review of decontamination procedures, the site-specific Health and Safety Plan, the Waste Management Plan, and relevant AHAs.

Initial Phase

The site superintendent will perform inspections to confirm that the objectives of the decontamination activities have been met and that the rework items, if any, have been completed to the satisfaction of AGVIQ-CH2M HILL and the Navy.

Follow-up Phase

The Project QC Manager will provide continuous oversight of decontamination and demobilization to verify the work is completed in accordance with the requirements provided in this Work Plan. Deficiencies will be noted and corrected.

Table 6-5 lists the quality controls that will be implemented during decontamination and demobilization.

TABLE 6-5
QC Procedures for Decontamination & Demobilization

Task	Procedures/Construction Details
Decontamination and Demobilization	• Pre-final site inspection and develop punch-list items • Work areas to ensure all temporary facilities, equipment and materials are safely removed from the site • Work areas to ensure project housekeeping and cleaning • Decontamination of personnel and equipment • Completion inspection when work is substantially complete • Punch lists on outstanding items • Project housekeeping and final project cleaning • Final Inspections • Orderly Site Demobilization • Collation of Site Records & Documents • Final Reports and Deliverables • Complete Resolution of Punch-list items • Final Site Inspection • Orderly Site Demobilization

7.0 References

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Appendix A
UFP-SAP

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May 25, 2010

Mr. Mark Davidson
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Subject: **Amendments to the Final Sampling and Analysis Plan**
Solid Waste Management Units 7/8 at Naval Activity Puerto Rico
Ceiba, Puerto Rico

Dear Mr. Davidson and Mr. Tucker:

CH2M HILL is pleased to submit amendments to the *Final Sampling and Analysis Plan (SAP)* for Solid Waste Management Units (SWMUs) 7/8 for your review. Worksheets #11, 14, 16, 17, 18, and 20 have been revised. In order to facilitate your review, these worksheets are enclosed separately in "track changes" mode following this cover letter. In addition, enclosed is the entire Final SAP for SWMUs 7/8, including the revised worksheets. If you have any questions, please contact me at 678.530.4033 or email at Tom.Beisel@ch2m.com.

Sincerely,

CH2M HILL

Tom Beisel, P.G.
Project Manager

cc: David Criswell/BRAC PMO SE

SAP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements

1. **Who will use the data and what will the data be used for?**
   The Navy, EPA, PREQB, subcontractors, and AGVIQ-CH2M HILL will use the data collected during the groundwater sampling events to define horizontal extent of the COCs, determine if 1,2,4-trimethylbenzene, benzene, and ethylbenzene levels are above CAOs, evaluate the ability (assimilative capacity) of the aquifer to naturally attenuate dissolved hydrocarbons to CAOs, determine the current extent of product on the water table, and determine the direction of groundwater flow. The product distribution combined with historical data will also be used to optimize product recovery efforts.

   The data from the soil and aqueous waste characterization sampling will be used by AGVIQ-CH2M HILL to determine the disposal or treatment options for the soil waste generated during the monitoring well installation and aqueous waste generated from groundwater sampling activities.

2. **What are the Project Action Limits (PALs)?**
   The approved actions for the dissolved VOC plumes in groundwater are addressed under Alternative 1 in the revised final CMS (Baker, 2005). Under this alternative, groundwater samples will be collected and analyzed to determine if MNA is a viable remedial action. The groundwater CAOs are: 1,2,4-trimethylbenzene (3,300 µg/L), benzene (550 µg/L), and ethylbenzene (1,000 µg/L). PALs for the COCs are the CAO levels listed in Worksheets #10 and 15. The PALs for waste characterization are provided in Worksheet #15.

3. **What types of data are needed (matrix, target analytes, analytical groups, field screening, onsite analytical or offsite laboratory techniques, sampling techniques)?**
   Worksheets #10 and 17 contain detailed information on the types of data needed for this project. Worksheet #12 defines the matrices, analytical groups, and target analytes. As detailed in the revised final CMS, site-specific COCs have already been identified and only specific VOCs will be analyzed (Baker, 2005).

   Sample analyses for COCs will be conducted by an offsite laboratory in accordance with Worksheets #15, 19, 23, 24, 25, 28, and 30. Analyses for ferrous iron will be conducted onsite using a colorimeter. Measurements of turbidity, dissolved oxygen (DO), oxidation-reduction potential (ORP), temperature, pH, and conductivity will be conducted onsite using a multi-parameter, water quality meter.

   Groundwater sampling and related activities will be performed in accordance with the applicable standard operating procedures (SOPs) in Appendix B. Appendix B also presents the SOP for aqueous waste characterization sampling. Worksheet #14 presents well gauging procedures.

4. **How "good" do the data need to be in order to support the environmental decision?**
   All groundwater data will be validated against QA/QC criteria and measurement performance criteria listed in this SAP and certified by a Puerto Rican chemist, Ralph Abbondanza, Analytical Services, Inc. Level IV package and QC sampling are required. Data will be used to determine if MNA is a viable remedial action at SWMU 7/8 as stated in the revised final CMS (Baker, 2005). QC data requirements are detailed in Worksheet #20**.** The waste characterizations

data will be evaluated by the project chemist to ensure quantitation limits (QLs) are met and certificated by the Puerto Rican chemist as well. A Level III package is required.

Data need to be sufficient to meet the following:

Visual Observations – Visual observations will be used to determine the presence or absence of product. As such, the data are considered qualitative in that they do not need to provide an exact or quantified value.

Onsite Analytical Data – A Hach water testing kit with a colorimeter will be used to measure ferrous iron. In addition, a multi-parameter water quality meter will be used to measure turbidity, DO, ORP, temperature, pH, and conductivity during and after purging activities. Field parameters will be used to determine if well water during purging activities has stabilized. Stabilization for each field parameter is defined as follows: pH measurements ± 0.1 units, temperature measurements ±1 degree Celsius (°C), specific conductance measurements ± 10 percent, and ± 10 percent for turbidity.

Offsite Analytical Data – The data need to be "good" enough to evaluate results of groundwater sampling at SWMU 7/8, determine the effectiveness of MNA on the treatment of COCs in the groundwater, make decisions on how to treat or dispose of aqueous waste from the future excavation activities, and optimize the approach for product recovery. Ensuring data are "good" enough for this purpose is done via employing appropriate analytical protocol, validating the resulting data, including QA/QC samples to verify proper sampling and analysis protocol, and performing a DQE to assess the availability and usability of the data for the intended purpose. Each of these is further discussed below:

- Appropriate Analytical Protocol – See Worksheets #15, 19, 23, 24, 25, 28, and 30, and Item 5 below.

- Data Validation – Validation of data increases the level of confidence in a data set for a particular data use. The particular type and level of validation necessary to achieve acceptable confidence is subjective. In other words, the appropriate type and level of data validation is not an absolute. Rather, it is data use- and data user-specific. For the groundwater sampling events, analyses for potential contaminants will be certified by a Puerto Rican chemist, 90 percent of the data will be validated by an AGVIQ-CH2M HILL data validator, and 10 percent of the data will be validated by a third party validator (eDATApro) using guidance from the validation criteria outlined by the U.S. Department of Defense (DoD) Quality System Manual (QSM). The validation criteria and guidance documents are listed in Worksheet #36. These documents will help the validators create a thorough and systematic approach to the validation process. The data validator will also recalculate 100 percent of the results from the raw laboratory data, which may identify laboratory errors in identification or quantification, if present.

- QA/QC Samples – During the groundwater sampling events, QA/QC samples will be collected as a check on sampling and analytical protocol. Like data validation, the appropriate type and quantity of QA/QC samples is not an absolute. For the groundwater sampling events, field duplicates will be collected at a frequency of 1 per 10 field samples per matrix. Field duplicates help assess sample collection techniques and laboratory precision. Matrix spike (MS)/matrix spike duplicates (MSDs) are collected at a frequency of 1 pair per 20 field samples per matrix. The frequency is such that there is one MS/MSD pair per laboratory analytical batch. MS/MSD samples are often required by the analytical

method and/or data validation guidance. Equipment blanks are collected at a frequency of 1 per day per decontaminated equipment. Equipment blanks help assess equipment decontamination techniques and identify when contamination may have been carrying over from one sample location to another. It is important to maintain this equipment blank frequency because the equipment blank is collected after visiting the most contaminated location, and it is important to not associate too many locations with the potentially contaminated equipment blank. Trip blanks are collected at a frequency of one per cooler containing volatiles. Trip blanks accompany the empty sample containers while they are stored at the laboratory or shipped to the site, and while they are full and shipped back to the laboratory. Trip blanks are useful for assessing whether or not there is any contamination during periods of time when the samples are not directly supervised. No field blanks will be collected unless on a particular day of sampling, the ambient conditions suggest airborne particulates may contaminate the samples being collected.

– DQE – In order to support the environmental decision, each result must be *available* to and *usable* for the project team. All data sets will undergo a DQE prior to using the data to make site-specific determinations. The terms *data availability* and *data usability* and the DQE process in general are described in Worksheet #37.

5. **How much data should be collected (number of samples for each analytical group, matrix, and concentration)?**
A baseline site characterization event and eight quarterly sampling events will be conducted after the completion of well installation activities. Groundwater samples will be collected from 27 monitoring wells, as shown on Figure 10. Each sample will be analyzed for 1,2,4-trimethylbenzene, benzene, and ethylbenzene by SW846 8260B, and the following MNA parameters: sulfide (SM 4500-S2-F), alkalinity (SM 2320B), nitrate/nitrite/sulfate (EPA 300.0), TOC (SM 5310B), and methane (RSK-175). MNA parameters will be collected during the baseline sampling event and during the fourth and eighth quarterly events. Groundwater samples will not be collected in monitoring wells with measurable product. During purging activities and before sample collection, field measurements of turbidity, ferrous iron, DO, ORP, temperature, pH, and conductivity will also be recorded.

Detailed information on how much data will be collected is provided in Worksheets #10, 15, and 17. The number of QA/QC samples is detailed in Worksheet #20. One composite soil waste characterization sample will be collected for every ten drums after all the wells have been installed and analyzed for Toxicity Characteristic Leaching Procedure (TCLP) (see Worksheet #15 for specific compounds). At the conclusion of the baseline and each quarterly sampling event, one composite aqueous waste characterization sample will be collected from each tank and analyzed for RCRA compounds (see Worksheet #15 for specific compounds), reactivity (sulfide and cyanide), ignitability, and corrosivity as pH. All tanks will be located at the SWMU 7/8 lay down area. The number of QA/QC samples is detailed in Worksheet #20.

6. **Where, when, and how should the data be collected/generated?**
Figure 10 shows the tentative sampling locations for the groundwater sampling at SWMU 7/8. All site wells will be gauged prior to groundwater sampling. Well gauging and waste characterization sampling procedures are presented on Worksheet #14. All other SOPs are provided as Appendix B, and the sampling schedule is outlined in Worksheet #16. Well gauging and groundwater sample collection will occur for 2 years starting in the second quarter

of 2010 at SMWU 7/8. Waste characterization samples will be collected in the manner stated in question 5.

7. **Who will collect and generate the data? How will the data be reported?**
AGVIQ-CH2M HILL will gauge all the wells and collect the groundwater samples, aqueous and soil waste characterization samples. Analytical data will be generated by Empirical Laboratories, LLC. Two weeks following the certification of the laboratory data by a Puerto Rican chemist, and the validation of the laboratory data, AGVIQ-CH2M HILL will submit a letter-report to the PREQB to document the findings obtained during each groundwater sampling event. The report will include the following:

   - Tabulated environmental-media analytical data
   - Map(s) illustrating the horizontal extent of 1,2,4-trimethylbenzene, benzene, and ethylbenzene in groundwater

   The well gauging and groundwater data will then be presented to the stakeholders via technical memorandums completed subsequent to each groundwater sampling event to summarize results and provide recommendations as appropriate. The aqueous and soil waste characterization data will be presented to the Navy and the receiving facility to determine and ensure appropriate disposal of remediation waste.

8. **How will the data be archived?**
The electronic data will be loaded into the Navy Installation Restoration Information System (NIRIS) database. Raw data, as well as data summary tables, will be included in an initial baseline site characterization report, quarterly monitoring reports, and a MNA evaluation report at the end of the 2-year sampling period. Hardcopy data will be released to the Navy following completion of the project.

9. **List the project quality objectives in the form of if/then qualitative and quantitative statements.**
The regulatory-approved remedial action for SWMU 7/8, as described in the revised final CMS (Baker, 2005), includes the measuring natural attenuation parameters within the dissolved plume to determine if MNA is a viable remedial action for 1,2,4-trimethylbenzene, benzene, and ethylbenzene in groundwater. Data results of the groundwater sampling events will be reported in an initial baseline site characterization report, quarterly monitoring reports, and a MNA evaluation report at the end of the 2-year sampling period.

   The primary study question for this phase of work at SWMU 7/8 is: Is MNA a viable remedial action for 1,2,4-trimethylbenzene, benzene, and ethylbenzene in groundwater?

   Planned actions include:

   - If the baseline groundwater sampling data indicate concentrations for 1,2,4-trimethylbenzene, benzene, and ethylbenzene are no longer greater than the CAOs, then no further action will be taken.
   - If the groundwater sampling data indicate concentrations for 1,2,4-trimethylbenzene, benzene, and ethylbenzene are still greater than the CAOs, then groundwater sampling events will occur quarterly for a period of 2 years. However, it should be noted that the PREQB only requires that COC concentrations remain below the associated CAOs for four

consecutive quarters. Therefore, it is possible that the groundwater sampling events can occur for a period of less than 2 years.

- If after 2 years of collecting groundwater samples, the dissolved COCs for the groundwater exceed the associated CAOs, the Navy will re-evaluate alternate remedial technologies to enhance contaminant degradation and/or to use a risk-based approach to calculate alternate CAOs that are protective of human health and the environment.
- If during well gauging product is detected in any of the 27 monitoring wells, then the wells containing product will not be analyzed. If no product is detected in monitoring wells, then the wells will be sampled for VOCs and/or MNA parameters.
- If soil and aqueous waste sample results indicate that the material is hazardous, then material will be sent to a landfill that accepts hazardous waste. If material it not hazardous, then material will be sent to a landfill that accepts non-hazardous waste.

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SAP Worksheet #14—Summary of Project Tasks

General Protocol

Mobilization

Mobilization will include AGVIQ-CH2M HILL staff and subcontractors traveling to the island. Mobilization will include the completion of the following task:

- Approval of the SAP by the stakeholders
- Arrival of groundwater sampling equipment

Sampling Locations and Quantities

During the groundwater sampling events, 27 wells will be gauged and then groundwater samples will be collected at SWMU 7/8. The approximate proposed monitoring well locations are illustrated on Figure 10. One soil waste characterization sample per ten drums will be collected after all wells have been installed. An aqueous waste characterization sample will be collected after the baseline and quarterly sampling event. All drums will be stored at the SWMU 7/8 lay down area.

Sampling

A baseline site characterization event and eight quarterly sampling events will be conducted after the completion of well installation activities. Groundwater samples will be collected from 27 monitoring wells, as shown on Figure 10. Each sample will be analyzed for the following VOC compounds: 1,2,4-trimethylbenzene, benzene, and ethylbenzene (SW846 8260B). Analyses of groundwater for the following MNA parameters will be performed during the baseline, fourth, and eighth quarterly events: sulfide (SM 4500-S2-F), alkalinity (SM 2320B), nitrate/nitrite/sulfate (EPA 300.0), TOC (SM 5310B), and methane (RSK-175). Groundwater samples will not be collected in monitoring wells with measurable product. Wells will be sampled in order of least to most contamination.

During purging activities and before sample collection, field measurements of turbidity, ferrous iron (Hach water testing kit with colorimeter), DO, ORP, temperature, pH, and conductivity will also be recorded.

Worksheet #18 lists the sampling identifications (IDs) and the analysis that will be performed at each monitoring well. The groundwater samples will be packed in jars, labeled, and packed on ice at a temperature between 2°C and 6°C for shipment to Empirical Laboratories, LLC. This laboratory is National Environmental Laboratory Accreditation Program (NELAP)-certified and Navy-approved for chemical analysis.

During sample collection, sampling personnel will also record any observations made during the sampling (i.e., hydrocarbon odor, product). One soil waste characterization sample per ten drums will be collected after all wells have been installed and analyzed for TCLP (see Worksheet #15 for specific compounds). After the baseline and each quarterly groundwater sampling event a composite aqueous waste characterization sample will be collected and analyzed for RCRA compounds (see Worksheet #15 for specific compounds), reactivity (sulfide and cyanide), ignitability, and corrosivity as pH. For QA/QC purposes, up to 25 samples will be submitted for QC/QC analysis. These samples will include MS/MSDs, duplicate samples, and equipment blanks.

Sampling Procedures

All groundwater sampling procedures are presented in Appendix B.

Soil and aqueous waste characterization samples will be collected to evaluate the handling and transportation and disposal (T&D) requirements of accumulated purge water and decontamination water.

One soil composite sample (and one grab for VOC analysis) will be collected per 10 drums. Soil samples will be collected according to the following procedure:

1. From each 55-gallon drum containing soil waste generated during the installation of monitoring wells, a spoon full of soil will be collected from each drum and mix in bowl to form a composite soil sample.
2. Gently stir the sample in the container and place the composite soil sample into the appropriate sample jars.
3. Close the jars and label and package the sample for shipment to the laboratory for chemical analysis.

One aqueous composite sample (and one grab for VOC analysis) will be collected from each tank. Water samples will be collected according to the following procedure:

1. Using a bailer or dip jar, collect a water sample from the tank.
2. Fill the sample containers for volatile analyses first (grab sample). The 40-milliliter (mL) vials will be filled so that there is no headspace in each vial.
3. Fill the sample containers for the remaining analyses.
4. Label and package the samples for shipment to the laboratory.

A CH2M HILL Level B package will be required along with appropriate QC samples for the required waste characterization and incidental waste stream samples. All analytical data will be submitted by both hard copy and electronic files.

Sampling Equipment

The following equipment will be used during the work:

- Nitrile or latex gloves
- Durable ice chest (20-gallon) for shipping samples
- Ice for preserving samples
- Laboratory supplied sampling containers (jars/bottles)
- 55-gallon drums (U.S. Department of Transportation-approved) for containerizing waste
- Submersible pump or Peristaltic pump and associated tubing
- Battery to run pump
- Hach water testing kit for ferrous iron and colorimeter
- Multi-parameter water quality meter
- Oil/water interface probe and water level indicator

Sampling Container, Analytical Methods, Preservatives, and Holding Time

The analytical method, preservative, sampling containers and holding time for the groundwater samples are described in Table 2. Worksheet #19 presents all of the analytical SOP requirements, including the RCRA compounds (see Worksheet #15 for specific compounds). The sample containers will be provided by Empirical Laboratories, LLC. This laboratory will be responsible for the chemical analysis of the groundwater and QA/QC samples.

TABLE 2
Analytical Methodology

Parameter	EPA Method	Preservative	Container	Holding Time
1,2,4-Trimethylbenzene Benzene Ethylbenzene	SW 846-8260B	Hydrochloric acid (HCl) pH less than 2; Cool to 4˚C	(2) 40-mL vials	14 days
Sulfide	SM 4500-S2-F	Cool to 4˚C, pH greater than 9 with sodium hydroxide (NaOH)	(1) 500-mL plastic	7 days
Alkalinity	SM 2320-B	Cool to 4˚C	(1) 500-mL plastic	14 days
Nitrate/Nitrite	EPA 300.0	Cool to 4˚C	(1) 250-mL plastic	48 hours
Sulfate	EPA 300.0	Cool to 4˚C	(1) 250-mL plastic	28 days
TOC	SM 5310-B	Cool to 4˚C, pH less than 2 with HCl or sulfuric acid (H_2SO_4)	(2) 40-mL vials	28 days
Methane	RSK-175	HCl pH less than 2; Cool to 4˚C	(2) 40-mL vials	14 days

Well Gauging

During each sampling event, well gauging will be performed to determine light non-aqueous phase liquid (LNAPL) thickness and distribution on the water table, evaluate fluctuations in water table elevations, and prepare groundwater contour maps. Wells that contain LNAPL will not be sampled. The procedures that will be followed are discussed below.

Site-Wide Well Gauging

During each sampling event, AGVIQ-CH2M HILL personnel will gauge all site wells using a water level indicator or an oil/water interface probe. Site-wide gauging will be performed the day before beginning groundwater sampling. Gauging data will be recorded in a site-specific, waterproof logbook and on a field gauging sheet. The following guidelines adopted from American Society for Testing and Materials D4750 - *Standard Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well* will be used to gauge the wells:

1. Unlock and uncap the well and allow water levels to reach static levels for at least 15 minutes. If the cap has a vent hole, this step may be ignored.

2. Clean the water level indicator or oil/water interface probe with a Liquinox®/water solution and rinse with distilled water.
3. Turn on the water level indicator or oil/water interface probe and test the battery to verify proper charge. Verify that the probe is working by wetting the end of the probe. Dry the probe prior to measuring LNAPL/groundwater depth.
4. Measure depth to LNAPL/groundwater as follows:
    a. Adjust the gain/sensitivity (while probe is dry) to the maximum sensitivity that does not activate the audible sensor.
    b. Lower the probe into the well slowly until the audible sensor activates. A single tone indicates that LNAPL has been encountered. Multiple beeping tones indicate that groundwater has been encountered.
    c. Raise and lower the probe slowly to precisely measure the top of the LNAPL and/or water surface.
    d. Hold the tape (indicating depth) against the designated measuring point and read the DTW and/or depth to product (DTP) to the nearest 0.01 foot. Perform a second and third check to verify each reading. If LNAPL is encountered record the measurement to the nearest 0.01 foot and continue to lower the probe until multiple beeps are heard. Record this measurement as this indicates that groundwater has been encountered. The difference between the top and bottom measurements is the LNAPL thickness.
5. Record the DTW and/or DTP in the field logbook.
6. Recap and lock the well.

Important items to check include:

- If the well does not have a vent hole, vent the well before measurement.
- Use the same location on the well casing during each measurement event to ensure comparability of readings. If in doubt, measure on the northern side of the casing for all wells.
- Clean the water level indicator or oil/water interface probe with a Liquinox®/water solution and rinse with distilled water before and after each well measurement.

Equipment Decontamination

An area will be designated for the decontamination of equipment and the storage of all waste. All decontaminated materials will be handled only with new, unused nitrile or latex gloves to avoid contamination. Decontamination SOPs are presented in Appendix B.

Sampling Equipment and Water Level Indicator/ Interface Probe

Onsite equipment for groundwater sampling, water level measuring, and sample preparation will be cleaned prior to and after each use. During cleaning and decontamination, the substitution of higher-grade water for tap water is permitted and does not have to be noted as a variation. The sampling equipment (if not disposable) will be cleaned to prevent the introduction of contaminants according to the following procedure:

1. Wash equipment with a laboratory detergent (i.e., Alquinox®, Liquinox®, or the equivalent) and hot water, using a brush to remove any particulate matter or surface film.
2. Rinse equipment thoroughly with tap water.
3. Rinse equipment thoroughly with de-ionized or organic-free water.
4. Rinse equipment twice with isopropanol and allow to air dry.
5. Rinse equipment with de-ionized water.
6. Wrap equipment in aluminum foil, with dull side in, to prevent contamination during storage or transport to the field.

Sample Packaging, Marking, Labeling, Shipping, and Chain-of-Custody

Samples must be preserved to ensure that the samples are received at the laboratory at a temperature less than or equal to 4°C. Ice will be placed on top of sample containers and the ice chest will be wrapped with duct tape. Custody seals will be applied upon completing the inspection of the ice chest integrity and appropriate documentation.

All samples must be identified using a standard tag attached to the sample container and will include the following information (Appendix C):

- Project name
- Project number
- Sample ID
- Date and time of sample collection
- Sampler name(s)
- Analysis group and/or method
- Preservatives

Chain-of-custody records are used to record the custody of all samples. An example of the chain-of-custody is included as Appendix C. The following information must be supplied in the indicated spaces:

- Client name
- Project number
- Project name and site location
- Sample identification number of all samples included in the shipment
- Sample description
- Date and time of sample collection
- Name, company, and signature of field technician collecting samples
- Name and signature of laboratory custodian receiving the samples

Quality Control

All QC samples are listed in Worksheet #20. In reference to the field tasks, all fieldwork will be overseen by an FTL who is responsible for the QC of the sampling to make sure the proper work plans are followed for each task.

Accuracy and Precision

The QA/QC field program will be continuously implemented during all sampling activities. Prior to beginning any sampling activities, a decontamination area will be designed for cleaning both sampling and storage tools and containers. Upon completion of sampling, samples will be labeled and placed in an ice chest. All of the sampling information will be recorded in the field book and in the chain-of-custody. Decontamination procedures are discussed below and will be followed before moving to another sample location.

Improper sample handling may alter the accuracy of the analytical results. Consequently, the samples will only be collected by persons wearing disposable nitrile or latex gloves. At each sampling point, the sampling personnel will wear new pairs of gloves. Samples will be carefully transferred in the field from the sampling equipment directly into glass containers provided by the laboratory. QA/QC will consist of obtaining equipment blanks, MS/MSDs and field duplicates. Field duplicate samples and equipment blank samples will be collected at a minimum frequency of 10 percent times the total number of samples collected for an analysis and rounded to the nearest whole number. MS/MSDs will be required at a frequency of one per sampling event or a minimum of 5 percent of the total number of samples collected for an analysis and rounded to the nearest whole number.

Equipment Blanks

One equipment blank sample per 10 groundwater samples will be prepared in the field between the collection of two separate samples. A jar containing de-ionized water will be opened in the field and poured over or through cleaned sampling equipment before equipment blank sample collection. The flushing water will be collected in a 1-liter (L) amber bottle and sent to the laboratory for analysis. The equipment blank will constitute a test of effectiveness of sampling equipment decontamination.

Field Duplicates

One sample per 10 groundwater samples will be split into two separate portions. These two samples will be collected at the same time as two separate samples and placed under identical circumstances and treated exactly the same throughout field and laboratory procedures. Analyses of both samples give a measure of the precision associated with sample collection, preservation and storage, as well as with laboratory procedure.

Storage

All analytical data will be stored on AGVIQ-CH2M HILL's SQL Server Data Warehouse, after which the finalized data will be uploaded to the NIRIS database as part of AVGIQ-CH2M HILL final delivery package.

Sample Analysis

The laboratory will maintain, test, inspect, and calibrate analytical instruments (Worksheets #24 and 25). The laboratory will process and prepare samples for analysis. The laboratory will analyze soil samples for various groups of parameters as shown in Worksheets #15 and 18.

Data Management

The Project Database Manager, Duane Johnson, is responsible for data tracking and storage. In addition, a third party data validator will receive 10 percent of all analytical data from the

laboratory, and the remaining 90 percent will be validated internally by the AVGIQ-CH2M HILL data validator prior to its use by the Navy.

Procedures for Recording and Correcting Data

All field data will be recorded in field logbooks and updated in the electronic Field Input Sheets to be uploaded in the Database or recorded electronically via the Mobile Integrated Sample Tracking Personal Digital Assistant for upload in the Database.

Project Assessment/Audit: Worksheets #31 and 32.

Data Validation: Worksheets #35 and 36.

Data Usability Assessment: Worksheet #37.

Remediation Waste Management

Remediation waste will be managed and disposed of in accordance with the Waste Management Plan in the work plan for groundwater sampling at SWMU 7/8.

Environmental Protection Plan

General controls implemented during remediation-related construction activities to prevent pollution and protect the environment are presented in the work plan for groundwater sampling at SWMU 7/8.

Quality Control Plan

Quality control and the sampling inspections associated with SWMU 7/8 are presented in the work plan for groundwater sampling at SWMU 7/8.

Quarterly Groundwater Sample Reporting

Following the certification of the laboratory data by a Puerto Rican chemist and the validation of the laboratory data, AGVIQ-CH2M HILL will submit a letter-report to the PREQB to document the findings obtained during the baseline and quarterly groundwater sampling events. Data results of the groundwater sampling events will be reported in an initial baseline site characterization report, seven quarterly monitoring reports, and an MNA evaluation report at the end of the 2-year sampling period. The reports will include the following:

- Tabulated environmental-media analytical data (water levels/LNAPL thickness and analytical test results)
- Waste characterization sample results
- Map(s) illustrating the horizontal extent of 1,2,4-trimethylbenzene, benzene, and ethylbenzene in groundwater
- An isopach map illustrating the current product distribution and thickness
- A potentiometric map illustrating the direction of groundwater flow

The eighth quarterly report will also include a comprehensive data evaluation to determine if the CAOs for groundwater have been achieved. The report will also include recommendations for additional work if the COC exceed the CAOs.

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SAP Worksheet #16—Project Schedule

Activity ID	Activity Name	Start	Finish
WBS	JM04 P.R.B1 Baseline Site Characteristics		
B1	Mobe & Site Prep	5/17/2010	5/17/2010
B2	Site-Wide Groundwater Gauging Event	5/18/2010	5/18/2010
B3	Groundwater Sampling at Designated Wells	5/19/2010	5/27/2010
B4	Demobe	5/27/2010	5/27/2010
B5	Laboratory Analysis/ Data Validation	5/28/2010	7/9/2010
B6	Baseline Site Characterization Report	7/12/2010	7/30/2010
WBS	JM04 P.R.Q1 Quarterly Sampling Event		
Q11	Mobe & Site Prep	8/16/2010	8/16/2010
Q12	Site-Wide Groundwater Gauging Event	8/17/2010	8/17/2010
Q13	Groundwater Sampling at Designated Wells	8/18/2010	8/26/2010
Q14	Demobe	8/26/2010	8/26/2010
Q15	Laboratory Analysis/ Data Validation	8/27/2010	10/1/2010
Q16	Q1 Quarterly Sampling Report	10/4/2010	10/22/2010
WBS	JM04 P.R.Q2 Quarterly Sampling Event		
Q21	Mobe & Site Prep	11/8/2010	11/8/2010
Q22	Site-Wide Groundwater Gauging Event	11/9/2010	11/9/2010
Q23	Groundwater Sampling at Designated Wells	11/10/2010	11/18/2010
Q24	Demobe	11/18/2010	11/18/2010
Q25	Laboratory Analysis/ Data Validation	11/19/2010	12/31/2010
Q26	Q2 Characterization Report	1/3/2011	1/21/2011
WBS	JM04 P.R.Q3 Quarterly Sampling Event		
Q31	Mobe & Site Prep	2/14/2011	2/14/2011
Q32	Site-Wide Groundwater Gauging Event	2/15/2011	2/15/2011
Q33	Groundwater Sampling at Designated Wells	2/16/2011	2/24/2011
Q34	Demobe	2/24/2011	2/24/2011
Q35	Laboratory Analysis/ Data Validation	2/25/2011	4/8/2011
Q36	Q3 Quarterly Sampling Report	4/11/2011	4/29/2011
WBS	JM04 P.R.Q4 Quarterly Sampling Event		
Q41	Mobe & Site Prep	5/16/2011	5/16/2011
Q42	Site-Wide Groundwater Gauging Event	5/17/2011	5/17/2011
Q43	Groundwater Sampling at Designated Wells	5/18/2011	5/26/2011

Activity ID	Activity Name	Start	Finish
Q44	Demobe	5/26/2011	5/26/2011
Q45	Laboratory Analysis/ Data Validation	5/27/2011	7/8/2011
Q46	Q4 Quarterly Sampling Report	7/11/2011	7/29/2011
WBS	JM04 P.R.Q5 Quarterly Sampling Event		
Q51	Mobe & Site Prep	8/15/2011	8/15/2011
Q52	Site-Wide Groundwater Gauging Event	8/16/2011	8/16/2011
Q53	Groundwater Sampling at Designated Wells	8/17/2011	8/25/2011
Q54	Demobe	8/25/2011	8/25/2011
Q55	Laboratory Analysis/ Data Validation	8/26/2011	10/7/2011
Q56	Q5 Quarterly Sampling Report	10/10/2011	10/28/2011
WBS	JM04 P.R.Q6 Quarterly Sampling Event		
Q61	Mobe & Site Prep	11/7/2011	11/7/2011
Q62	Site-Wide Groundwater Gauging Event	11/8/2011	11/8/2011
Q63	Groundwater Sampling at Designated Wells	11/9/2011	11/17/2011
Q64	Demobe	11/17/2011	11/17/2011
Q65	Laboratory Analysis/ Data Validation	11/18/2011	12/30/2011
Q66	Q6 Quarterly Sampling Report	1/2/2012	1/20/2012
WBS	JM04 P.R.Q7 Quarterly Sampling Event		
Q71	Mobe & Site Prep	2/13/2012	2/13/2012
Q72	Site-Wide Groundwater Gauging Event	2/14/2012	2/14/2012
Q73	Groundwater Sampling at Designated Wells	2/15/2012	2/23/2012
Q74	Demobe	2/23/2012	2/23/2012
Q75	Laboratory Analysis/ Data Validation	2/24/2012	4/6/2010
Q76	Q7 Quarterly Sampling Report	4/9/2010	4/27/2010
WBS	JM04 P.R.Q8 Quarterly Sampling Event		
Q81	Mobe & Site Prep	5/14/2012	5/14/2012
Q82	Site-Wide Groundwater Gauging Event	5/15/2012	5/15/2012
Q83	Groundwater Sampling at Designated Wells	5/16/2012	5/24/2012
Q84	Demobe	5/24/2012	5/24/2012
Q85	Laboratory Analysis/ Data Validation	5/25/2012	7/6/2012
Q86	Q8 Quarterly Sampling Report	7/9/2012	7/27/2012

SAP Worksheet #17—Sampling Design and Rationale

A baseline groundwater characterization event and eight quarterly groundwater sampling events will be conducted at SWMU 7/8. The samples will be labeled based on the monitoring well location ID. In addition to the well location ID information, the task order (JM04), sampling event (baseline [BL], 1st quarterly event [Q1], Q2, Q3, Q4, Q5, Q6, Q7, and Q8), and sampling date will be added to the sample nomenclature. For example, for a groundwater sample collected during the second quarterly sampling event at monitoring well 7MW16, the sample ID would be labeled JM04-Q2-7MW16-mmddyy.

The rationale for the matrices to be sampled, the number of samples per matrix, the analytical groups, and the concentration levels are discussed in Worksheets #10, 11, 14, and 15. The tentative sampling locations for the groundwater sampling at SWMU 7/8 are shown on Figure 10 in Appendix A.

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SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table

Sampling Location	ID Number	Matrix	Depth (feet)	Analytical Group	No. Samples	Sampling SOP Reference[a]
CHMW01	JM04-BL-CHMW01-mmddyy or JM04-Q#-CHMW01-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
CHMW02	JM04-BL-CHMW02-mmddyy or JM04-Q#-CHMW02-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
CHMW03	JM04-BL-CHMW03-mmddyy or JM04-Q#-CHMW03-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
CHMW04	JM04-BL-CHMW04-mmddyy or JM04-Q#-CHMW04-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
CHMW05	JM04-BL-CHMW05-mmddyy or JM04-Q#-CHMW05-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
CHMW06	JM04-BL-CHMW06-mmddyy or JM04-Q#-CHMW06-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
CHMW09	JM04-BL-CHMW09-mmddyy or JM04-Q#-CHMW09-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
CHMW11	JM04-BL-CHMW11-mmddyy or JM04-Q#-CHMW11-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
CHMW12	JM04-BL-CHMW12-mmddyy or JM04-Q#-CHMW12-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
CHRW06	JM04-BL-CHRW06-mmddyy or JM04-Q#-CHRW06-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
CHRW09	JM04-BL-CHRW09-mmddyy or JM04-Q#-CHRW09-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

Sampling Location	ID Number	Matrix	Depth (feet)	Analytical Group	No. Samples	Sampling SOP Reference[a]
CHRW25	JM04-BL-CHRW25-mmddyy or JM04-Q#-CHRW25-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
CHRW31	JM04-BL-CHRW31-mmddyy or JM04-Q#-CHRW31-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
CHRW41	JM04-BL-CHRW41-mmddyy or JM04-Q#-CHRW41-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
CHRW44	JM04-BL-CHRW44-mmddyy or JM04-Q#-CHRW44-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
7MW05	JM04-BL-7MW05-mmddyy or JM04-Q#-7MW05-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
7MW06	JM04-BL-7MW06-mmddyy or JM04-Q#-7MW06-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
7MW15	JM04-BL-7MW15-mmddyy or JM04-Q#-7MW15-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
7MW18	JM04-BL-7MW18-mmddyy or JM04-Q#-7MW18-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
GW02	JM04-BL-GW02-mmddyy or JM04-Q#-GW02-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
GW04	JM04-BL-GW04-mmddyy or JM04-Q#-GW04-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

Sampling Location	ID Number	Matrix	Depth (feet)	Analytical Group	No. Samples	Sampling SOP Reference[a]
UGW06	JM04-BL-UGW06-mmddyy or JM04-Q#-UGW06-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
UGW07	JM04-BL-UGW07-mmddyy or JM04-Q#-UGW07-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
UGW15	JM04-BL-UGW15-mmddyy or JM04-Q#-UGW15-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
UGW20R	JM04-BL-UGW20R-mmddyy or JM04-Q#-UGW20R-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
UGW32	JM04-BL-UGW32-mmddyy or JM04-Q#-UGW32-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
UGW34	JM04-BL-UGW34-mmddyy or JM04-Q#-UGW34-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
CHMW01	JM04-Q#- CHMW01-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
CHMW02	JM04-Q#-CHMW02-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
CHMW03	JM04-Q#-CHMW03-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
CHMW04	JM04-Q#-CHMW04-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
CHMW05	JM04-Q#-CHMW05-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

Sampling Location	ID Number	Matrix	Depth (feet)	Analytical Group	No. Samples	Sampling SOP Reference[a]
CHMW06	JM04-Q#-CHMW06-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
CHMW09	JM04-Q#-CHMW09-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
CHMW11	JM04-Q#-CHMW11-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
CHMW12	JM04-Q#-CHMW12-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
CHRW06	JM04-Q#-CHRW06-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
CHRW09	JM04-Q#-CHRW09-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
CHRW25	JM04-Q#-CHRW25-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
CHRW31	JM04-Q#-CHRW31-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
CHRW41	JM04-Q#-CHRW41-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
CHRW44	JM04-Q#-CHRW44-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
7MW05	JM04-Q#-7MW05-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

Sampling Location	ID Number	Matrix	Depth (feet)	Analytical Group	No. Samples	Sampling SOP Reference[a]
7MW06	JM04-Q#-7MW06-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
7MW15	JM04-Q#-7MW15-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
7MW18	JM04-Q#-7MW18-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
GW02	JM04-Q#-GW02-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
GW04	JM04-Q#-GW04-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
UGW06	JM04-Q#-UGW06-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
UGW07	JM04-Q#-UGW07-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
UGW15	JM04-Q#-UGW15-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
UGW20R	JM04-Q#-UGW20R-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
UGW32	JM04-Q#-UGW32-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
UGW34	JM04-Q#-UGW34-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

Sampling Location	ID Number	Matrix	Depth (feet)	Analytical Group	No. Samples	Sampling SOP Reference[a]
NA	JM04-BL-7/8SLW-mmddyy	Soil Waste	NA	Toxicity compounds (see Worksheet #15 for specific compounds), reactivity (sulfide and cyanide), ignitability, and corrosivity as pH	1 per 10 drums	See Worksheet #14
NA	JM04-BL-7/8AQA-mmddyy	Aqueous Waste	NA	RCRA compounds (see Worksheet #15 for specific compounds), reactivity (sulfide and cyanide), ignitability, and corrosivity as pH	1 per tank	See Worksheet #14

Notes:

[a] The SOP describes the sample collection procedures.
[b] VOC list consists of 1,2,4-trimethylbenzene, benzene, and ethylbenzene.

SAP Worksheet #20—Field Quality Control Sample Summary Table

Matrix	Analytical Group	No. of Sampling Locations	No. of Field Duplicates	No. of MS/MSDs	No. of Field Blanks	No. of Equip. Blanks	No. of VOC Trip Blanks	No. of Proficiency Testing Samples	Total No. of Samples to Lab
Quarterly Groundwater Monitoring									
Groundwater	Select VOCs[a]	27	3	2 MS/ 2 MSD	0	3	4 (1 for each day of sample shipment)	0	328 (8 total sampling events)
	Nitrate, Nitrite, and Sulfate	27	3	0	0	3	NA	0	99
	TOC	27	3	0	0	3	NA	0	99
	Sulfide	27	3	0	0	3	NA	0	99
	Methane	27	3	0	0	3	NA	0	99
	Alkalinity	27	3	0	0	3	NA	0	99
Liquid Waste Characterization									
Aqueous	VOCs – RCRA compounds (see Worksheet #15 for specific compounds).	20	NA	NA	NA	NA	NA	NA	20

SAP Worksheet #20—Field Quality Control Sample Summary Table (continued)

Matrix	Analytical Group	No. of Sampling Locations	No. of Field Duplicates	No. of MS/MSDs	No. of Field Blanks	No. of Equip. Blanks	No. of VOC Trip Blanks	No. of Proficiency Testing Samples	Total No. of Samples to Lab
Aqueous	SVOCs – RCRA compounds (see Worksheet #15 for specific compounds).	20	NA	NA	NA	NA	NA	NA	20
	Pesticides – RCRA compounds (see Worksheet #15 for specific compounds).	20	NA	NA	NA	NA	NA	NA	20
	Herbicides – RCRA compounds (see Worksheet #15 for specific compounds).	20	NA	NA	NA	NA	NA	NA	20
	Metals – RCRA compounds (see Worksheet #15 for specific compounds).	20	NA	NA	NA	NA	NA	NA	20
	PCBs – RCRA compounds (see Worksheet #15 for specific compounds).	20	NA	NA	NA	NA	NA	NA	20
	Ignitability	20	NA	NA	NA	NA	NA	NA	20
	Corrosivity	20	NA	NA	NA	NA	NA	NA	20
	Reactive Cyanide	20	NA	NA	NA	NA	NA	NA	20

SAP Worksheet #20—Field Quality Control Sample Summary Table (continued)

Matrix	Analytical Group	No. of Sampling Locations	No. of Field Duplicates	No. of MS/MSDs	No. of Field Blanks	No. of Equip. Blanks	No. of VOC Trip Blanks	No. of Proficiency Testing Samples	Total No. of Samples to Lab
Aqueous	Reactive Sulfide	20	NA	NA	NA	NA	NA	NA	20
Soil Waste Characterization									
Solid/Soil	TCLP – VOC	10	NA	NA	NA	NA	NA	NA	10
	TCLP – Semivolatile Organic Compounds	10	NA	NA	NA	NA	NA	NA	10
	TCLP – Organochlorine Pesticides	10	NA	NA	NA	NA	NA	NA	10
	TCLP – Herbicides	10	NA	NA	NA	NA	NA	NA	10
	TCLP- Metals	10	NA	NA	NA	NA	NA	NA	10
	PCBs	10	NA	NA	NA	NA	NA	NA	10
	Corrosivity	10	NA	NA	NA	NA	NA	NA	10

SAP Worksheet #20—Field Quality Control Sample Summary Table (continued)

Matrix	Analytical Group	No. of Sampling Locations	No. of Field Duplicates	No. of MS/MSDs	No. of Field Blanks	No. of Equip. Blanks	No. of VOC Trip Blanks	No. of Proficiency Testing Samples	Total No. of Samples to Lab
Solid/Soil	Ignitability	10	NA	NA	NA	NA	NA	NA	10
	Reactivity Cyanide	10	NA	NA	NA	NA	NA	NA	10
	Reactivity Sulfide	10	NA	NA	NA	NA	NA	NA	10

Notes:
[a] Sampling for the baseline event and each of eight quarterly events will consist of: 27 samples, plus QC for all parameters.

SAP Worksheet #1—Title and Approval Page

Final
Sampling and Analysis Plan for Groundwater Sampling at
Solid Waste Management Units 7/8 at Naval Activity Puerto Rico
Ceiba, Puerto Rico
May 2010

Prepared for:

Prepared by:

Prepared under:
Small Business Remedial Action Contract N62470-08-D-1006
Task Order No. JM04

REVIEW SIGNATURE:

_____

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Executive Summary

AGVIQ-CH2M HILL Joint Venture III (AGVIQ-CH2M HILL) has been retained by the Department of the Navy, Naval Facilities Engineering Command Southeast (NAVFAC SE) to address the remediation of soil and groundwater at Solid Waste Management Units (SWMUs) 7 and 8 (SWMU 7/8) located at the Tow Way Fuel Farm (TWFF), Naval Activity Puerto Rico (NAPR) Ceiba, Puerto Rico (Figures 1 through 3 in Appendix A). This work is being performed under Contract No. N62470-08-D-1006, Task Order JM04.

This document is one of several Uniform Federal Policy Sampling and Analysis Plans (UFP-SAPs) for the work that will be performed at SWMU 7/8 to remediate soil and groundwater impacted by petroleum hydrocarbons that resulted from over 60 years of fueling operations at the TWFF. The following is a summary of the remediation activities at SWMU 7/8:

- Excavation of shallow soil from three areas of the site where arsenic and polynuclear aromatic hydrocarbon (PAH) compounds exceed the approved corrective action objectives (CAOs).
- Recovery of product from the water table using either skimmers or vacuum-enhanced technologies to reduce the thickness of free product in site wells to a thickness of 1/8-inch.
- Use of monitored natural attenuation (MNA) to reduce dissolved hydrocarbon concentrations in groundwater to the applicable CAOs.

The remedial plan for SWMU 7/8 is described in the revised final Corrective Measures Study (CMS) prepared by Baker Environmental, Inc. (Baker), in November 2005. The U.S. Environmental Protection Agency (EPA) approved the revised final CMS in February 2006.

According to the revised final CMS, the following three contaminants of concern detected in groundwater exceeded their respective human health-based CAOs: 1,2,4-trimethylbenzene, benzene, and ethylbenzene. The CAOs for 1,2,4-trimethylbenzene, benzene, and ethylbenzene are 3,300 micrograms per liter (µg/L), 550 µg/L, and 1,000 µg/L, respectively. According to the final CMS, the most recently observed concentrations for these contaminants are 4,600 µg/L, 19,000 µg/L, and 18,000 µg/L, respectively. (Baker, 2005)

This UFP-SAP focuses on the work that will be performed to collect and analyze groundwater samples from SWMU 7/8. The principal objective is to collect natural attenuation parameters, along with volatile organic compounds, within and along the edge of the dissolved plume. MNA activities to be conducted at SWMU 7/8 include:

- Collection of groundwater samples for the analysis of 1,2,4-trimethylbenzene, benzene, ethylbenzene, and select MNA parameters to evaluate if MNA is a viable remedial action to determine the assimilative capacity of the aquifer and ability of naturally occurring microorganisms to reduce dissolved hydrocarbon concentrations in groundwater beneath SMWU 7/8.
- Collection of water and soil samples for waste characterization analysis.

The following additional task has been included in this SAP to obtain the data necessary to complete the remediation activities for groundwater monitoring and sampling at SWMU 7/8:

- Measure the depth to water and/or product using a water level indicator or an oil/water interface probe.

Following data collection and analysis, the information will be evaluated and plans will be prepared to describe the ability of the aquifer to naturally attenuate dissolved hydrocarbons to the CAOs.

If after 2 years of MNA activities, the dissolved contaminants of concern for the groundwater exceed the associated CAOs, the CMS contains a provision to either evaluate alternate remedial technologies to enhance contaminant degradation, and/or to utilize a risk-based approach to calculate alternate CAOs that are protective of human health and the environment.

SAP Format

This SAP has been prepared in accordance with the UFP for Quality Assurance Project Plans (UFP-QAPP) (EPA, 2005) and the EPA Guidance for QAPPs, EPA QA/G-5, QAMS (EPA, 2002), and contains the 37 worksheets identified in Part 2A. It also contains several appendices that support the information presented in the worksheets. Appendix A presents the figures referenced in this document. Appendix B presents the field and laboratory standard operating procedures. Appendix C presents the standard label and chain-of-custody form utilized in the field.

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B Standard Operating Procedures

C Standard Label and Chain-of-Custody Record

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2 Analytical Methodology

Acronyms and Abbreviations

°C	degree Celsius
%D	percent difference
AGVIQ-CH2M HILL	AGVIQ-CH2M HILL Joint Venture III
ASAP	as soon as possible
Baker	Baker Environmental, Inc.
bgs	below ground surface
BRAC PMO SE	Base Realignment and Closure Program Management Office Southeast
BTEX	benzene, toluene, ethylbenzene, and xylenes
CA	Corrective Action
CAO	Corrective Action Objective
CAP	Corrective Action Plan
CCB	continuing calibration blank
CCC	calibration check compound
CCV	continuing calibration verification
CFR	Code of Federal Regulations
CMS	Corrective Measures Study
COC	contaminant of concern
DO	dissolved oxygen
DoD	U.S. Department of Defense
DQE	data quality evaluation
DQI	data quality indicator
DTP	depth to product
DTW	depth to water
ECD	electron capture donor
EIS	Environmental Information Specialist
EISOPQAM	Environmental Investigations Standard Operating Procedures and Quality Assurance Manual
ELAP	Environmental Laboratory Accreditation Program
EPA	U.S. Environmental Protection Agency
ERP	Environmental Restoration Program
FID	flame ionization detector
FIMS	flow injection mercury system
FTL	Field Team Leader
g	gram
GC/MS	gas chromatographer/mass spectrometer
gpm	gallon per minute
H_2SO_4	sulfuric acid
HCl	hydrochloride
HP	Hewlett Packard
HSP	Health and Safety Plan
IC	ion chromatograph
ICAL	initial calibration

ICB	initial calibration blank
ICP	Inductively coupled plasma
ICV	initial calibration verification
ID	identification
L	Liter
LCS	laboratory control sample
LIMS	Laboratory Information Management System
LNAPL	light non-aqueous phase liquid
MDL	method detection limit
µg/L	microgram per liter
mg/kg	milligram per kilogram
mg/L	milligram per liter
mL	Milliliter
MNA	monitored natural attenuation
MS	matrix spike
MSD	matrix spike duplicate
NA	not applicable
NaOH	sodium hydroxide
NAPR	Naval Activity Puerto Rico
NAVFAC SE	Naval Facilities Engineering Command Southeast
Navy	U.S. Department of Navy
NELAP	National Environmental Laboratory Accreditation Program
NFESC	Naval Facilities Engineering Service Center
NIRIS	Navy Installation Restoration Information System
NSRR	Naval Station Roosevelt Roads
ORP	oxidation-reduction potential
oz	Ounce
PAH	polynuclear aromatic hydrocarbon
PAL	Project Action Limit
PCB	polychloride biphenyl
PM	Project Manager
POC	point of contact
ppm	part per million
PQO	project quality objective
PREQB	Puerto Rico Environmental Quality Board
PVC	polyvinyl chloride
PWR	partially weathered rock
QA	quality assurance
QAMS	Quality Assurance Management Section
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	quality control
QL	quantitation limit
QSM	Quality Systems Manual
RCRA	Resource Conservation and Recovery Act
RF	response factor
RPD	relative percent difference
RPM	Remedial Project Manager

RSD	relative standard deviation
SAP	Sampling and Analysis Plan
SOP	standard operating procedure
SDG	sample delivery group
SPCC	system performance check compound
SSC	Site Safety Coordinator
SVOC	semivolatile organic compound
SWMU	solid waste management unit
SWMU 7/8	Solid Waste Management Units 7 and 8
TAL	target analyte list
TBD	to be determined
TCLP	Toxicity Characteristic Leaching Procedure
TOC	total organic carbon
TPH	total petroleum hydrocarbon
TWFF	Tow Way Fuel Farm
UCL	upper-bound confidence limit
UFP	Uniform Federal Policy
UST	underground storage tank
VOC	volatile organic compound

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SAP Worksheet #2—SAP Identifying Information

Site Name/Number: Naval Activity Puerto Rico (NAPR), Solid Waste Management Units (SWMUs) 7 and 8 (SWMU 7/8)

Operable Unit: 2

Contractor Name: AGVIQ-CH2M HILL Joint Venture III (AGVIQ-CH2M HILL)

Contract Number: N62470-08-D-1006

Contract Title: JM04 Naval Activity Puerto Rico

1. This Sampling and Analysis Plan (SAP) was prepared in accordance with the requirements of the Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP) (U.S. Environmental Protection Agency [EPA], 2005) and EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5, Quality Assurance Management Section (QAMS) (EPA, 2002).
2. Regulatory program: Resource Conservation and Recovery Act (RCRA)
3. This SAP is a project-specific SAP.
4. Dates of scoping sessions:

Scoping Session	Date
Site visit – Ceiba, Puerto Rico	December 16, 2008
Site visit – Ceiba, Puerto Rico	January 19 – 23, 2009
Technical Approach Meeting	February 4, 2009

5. Dates and titles of any SAP documents written for previous site work that are relevant to the current investigation:

Title	Date
Baker Environmental, Inc. (Baker). *Revised Draft RCRA Facility Investigation for Operable Unit 2 (SWMU 7/8)*	June 16, 1997
Baker Environmental, Inc. (Baker). *Revised Final Corrective Measures Study Final Report, Tow Way Fuel Farm*	November 22, 2005
Baker Environmental, Inc. (Baker). *RCRA § 7003 Administrative Order on Consent Quarterly Progress Report May 1, 2008 – July 31, 2008*	August 28, 2008

6. Organizational partners (stakeholders) and connection with lead organization:
   - **EPA Region 2 –** Regulatory stakeholder overseeing RCRA Ceiba Environmental Restoration Program (ERP) implemented by lead organization.

- **Puerto Rico Environmental Quality Board (PREQB) –** Regulatory stakeholder overseeing RCRA Ceiba ERP implemented by lead organization.
- **U.S. Naval Facilities Engineering Command Southeast (NAVFAC SE) –** Performs remedial activities at specified sites at the NAPR.

7. Lead organization (see Worksheet #7 for detailed list of data users):
   - **U.S. Department of Navy (Navy)**
8. The omitted SAP elements excluded and provide an explanation for their exclusion below:
   - Crosswalk table is excluded as all required information is provided in this SAP.

SAP Worksheet #3—Distribution List

Name of SAP Recipients	Title/Role	Organization	Telephone Number	E-mail Address or Mailing Address	Document Control Number
Mark E. Davidson	Base Realignment and Closure Program Management Office Southeast (BRAC PMO SE) Remedial Project Manager (RPM)/Lead Navy Point of Contact (POC)	Navy	(843) 743-2124	mark.e.davidson@navy.mil	
Debbie Sanders	Contracting Officer	Navy	843-743-2145	debbie.sanders@navy.mil	
TBD	Librarian and Records Manager/Final document archiving	Navy	TBD	TBD	
Amy Wolff (will distribute to the Program Management Office)	Program Assistant/Document Manager	AGVIQ-CH2M HILL	(678) 530-4393	Amy.Wolff@ch2m.com	
Doug Downey	Senior Technical Consultant	AGVIQ-CH2M HILL	(303) 674-6547	Doug.downey@ch2m.com	
Tom Beisel	Project Manager (PM)	AGVIQ-CH2M HILL	(678) 530-4033	Tom.beisel@ch2m.com	
Camden Robinson	Project Chemist and Data Validator	AGVIQ-CH2M HILL	(678) 530-4292	Camden.robinson@ch2m.com	
Thomas Kessler	Senior Geologist	AGVIQ-CH2M HILL	(678) 530-4197	Thomas.kessler@ch2m.com	
Ralph Abbondanza	Puerto Rican Chemist	Analytical Services, Inc.	(703) 801-0478	www.asincorp.com	
Janice Shilling	Laboratory PM	Empirical Laboratories, LLC	(615) 345-1115	jshilling@empirlabs.com	

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SAP Worksheet #4—Project Personnel Sign-Off Sheet

Name	Organization/Title/Role	Telephone Number	Signature/E-mail Receipt	SAP Section Reviewed	Date SAP Read
Mark E. Davidson	BRAC PMO SE RPM/Lead Navy POC	(843) 743-2124			
Tim Gordon	EPA/Ceiba RPM/Regulatory POC	(212) 637-4167			
Wilmarie Rivera	PREQB/Ceiba RPM/Regulatory POC	(787) 767-8181, ext. 6141			
Theresa Rojas	AGVIQ-CH2M HILL/Program Quality Assurance (QA)/Quality Control (QC) Manager/SAP Review	(678) 530-4297			
Camden Robinson	AGVIQ-CH2M HILL/Navy Program Chemist/SAP Review	(678) 530-4292			
Nancy Ballantyne	AGVIQ-CH2M HILL/ Environmental Manager/	(720) 286-5561			
Bethany Garvey Duane Johnson	AGVIQ-CH2M HILL/ Environmental Information Specialist (EIS)/Data Tracking and Management	(678) 530-4124 (678) 530-4185			
Andrew O'Conor Thomas Kessler Bryan Burkingstock	AGVIQ-CH2M HILL/ Geologists/Field Team Leaders (FTLs)	(678) 530-4073 (678) 530-4197 (678) 530-4060			
Janice Shilling	Empirical Laboratories, LLC/Chemist/Laboratory PM	(615) 345-1115			
Ralph Abbondanza,	Analytical Services, Inc./Puerto Rican Chemist	(703) 801-0478			

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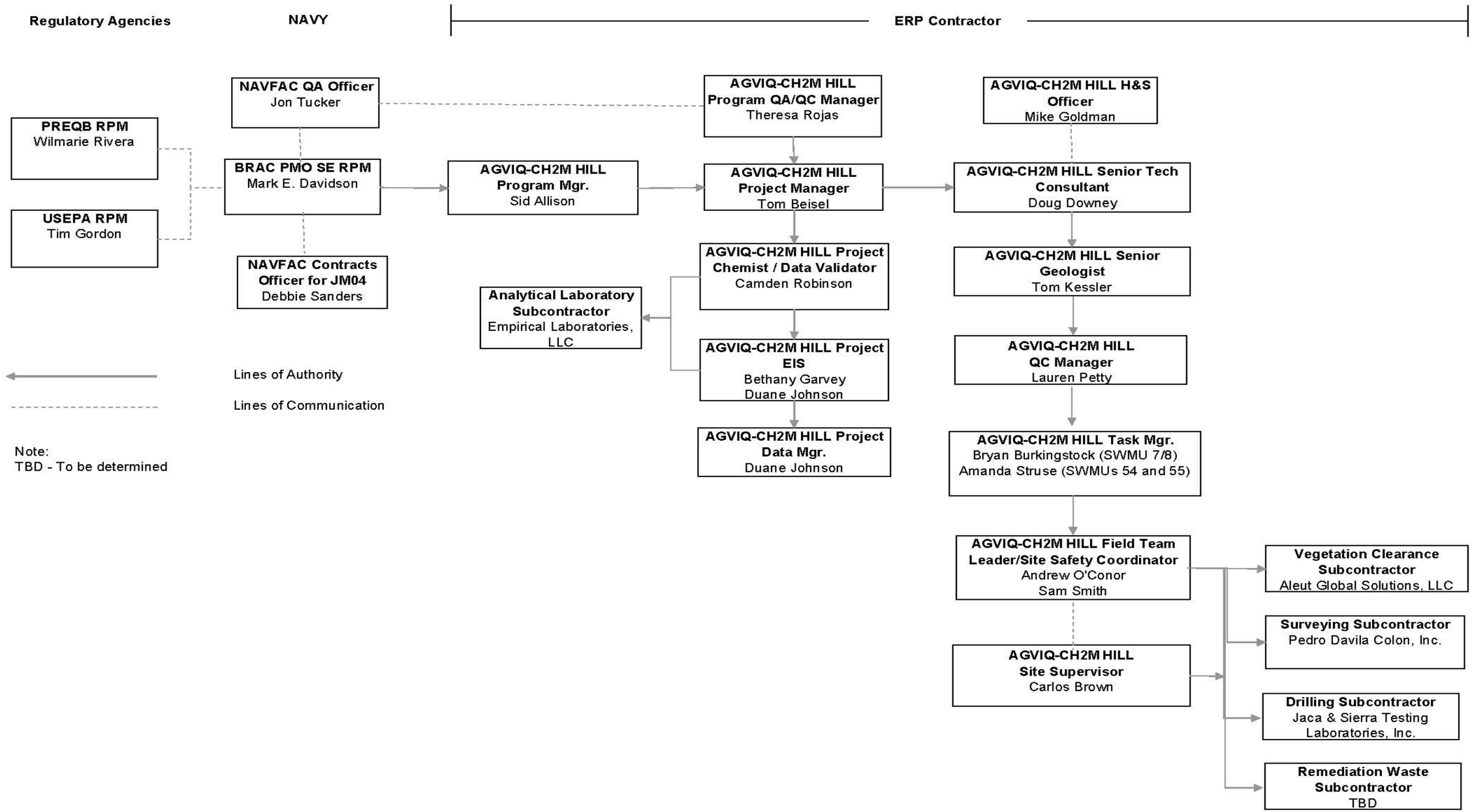
SAP Worksheet #5—Project Organizational Chart



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SAP Worksheet #6—Communication Pathways

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or E-mail	Procedure
Communication to/from Navy (e.g., submission of SAP for review; receipt of regulatory comments, etc.)	Navy RPM	Mark E. Davidson	(843) 743-2124/ mark.e.davidson@navy.mil	Primary POC for Navy (via e-mail, telephone, hardcopy, or in-person, as warranted); can delegate communication to other internal or external points of contact.
Communication to/from EPA (e.g., receipt of SAP for review; submission of EPA comments)	EPA RPM	Tim Gordon	(212) 637-4167 Gordon.timothy@epa.gov	Primary POC for EPA (via e-mail, telephone, hardcopy, or in-person, as warranted); can delegate communication to other internal or external points of contact.
Communication to/from PREQB (e.g., receipt of SAP for review; submission of PREQB comments) through Navy POC	PREQB RPM	Wilmarie Rivera	(787) 767-8181, ext. 6141	Primary POC for PREQB (via e-mail, telephone, hardcopy, or in-person, as warranted); can delegate communication to other internal or external points of contact.
Navy QA/QC input	Navy QA Officer (QAO)	Jon Tucker	(757) 322-8288 jonathan.tucker@navy.mil	Provides review comments to Navy RPM on draft SAP via e-mail. Provides overall Navy guidance via direct communication with Navy contractor QAO, as warranted.
Project administration and logistics Communication to/from Navy contractor (e.g., submission of SAP for review; receipt of regulatory comments, updates on project progress, communication of stakeholder expectations, etc.)	AGVIQ-CH2M HILL PM	Tom Beisel	(678) 530-4033	Direct communication (via e-mail, telephone, hardcopy, or in-person, as warranted) to/from Navy contractor project staff to ensure appropriate project implementation. Primary POC for Navy contractor (via e-mail, telephone, hardcopy, or in-person, as warranted); can delegate communication to other contractor staff, as appropriate.

SAP Worksheet #6—Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or E-mail	Procedure
Health and safety expectations and procedures	AGVIQ-CH2M HILL Health and Safety Officer	Mike Goldman	(678) 530-4133	Review of Health and Safety Plan (HSP). Direct communication (via e-mail, telephone, hardcopy, or in-person, as warranted) to/from AGVIQ-CH2M HILL project team to ensure implementation of appropriate health and safety procedures.
SAP changes in the field	AGVIQ-CH2M HILL FTL	Andrew O'Conor		Documentation of deviations from work plan made in field logbooks and rationale for deviations; deviations made only with approval from AGVIQ-CH2M HILL PM. Deviations to the SAP will be reported within 1 week from the time the issue is identified.
Field Corrective Actions (CAs)	AGVIQ-CH2M HILL FTL	Andrew O'Conor		See Worksheets #32 and 32-1. Field Corrective Actions will be reported within 1 week from the time the issue is identified.
Daily Field Progress Reports	AGVIQ-CH2M HILL FTL	Andrew O'Conor		FTL will e-mail or fax daily field progress reports to contractor PMs weekly; telephone communication with PMs on as-needed basis
Ensuring staff health and safety in the field	AGVIQ-CH2M HILL Site Safety Coordinator (SSC)	Andrew O'Conor		Daily safety tailgates; daily observations; real-time discussions of observations and changes to be implemented with field staff.
Ensuring that the project is meeting the requirements of this SAP and that any problems are corrected and communicated to the project administrator.	AGVIQ-CH2M HILL QC Manager	Lauren Petty		Complete daily QC reports and submit to PM and project administrator.

SAP Worksheet #6—Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or E-mail	Procedure
Data tracking from collection through upload to database	AGVIQ-CH2M HILL EIS	Bethany Garvey Duane Johnson	(678) 530-4124 (678) 530-4185	EIS will track data from sample collection through upload to database, ensuring QAPP requirements are met by laboratory and field staff. Tracking involves receipt of electronic and hardcopy data from laboratory and data validator. EIS communicates with AGVIQ-CH2M HILL project chemist, laboratory PM, and data validator PM, as warranted, to ensure adherence to project analysis and validation requirements. EIS also coordinates data upload with contractor database manager.
Uploading project data and maintaining the database to ensure data are stored properly and can be retrieved by the EIS.	AGVIQ-CH2M HILL Database Manager	Duane Johnson	(678) 530-4185	Once contractor chemist ensures data are appropriate for upload to database, EIS submits data electronically to contractor database manager, who uploads data to database.
Reporting lab data quality issues	Laboratory PM	Janice Shilling	(615) 345-1115	All QA/QC issues with project field samples will be reported by the lab to the EIS, Project Chemist, and Contractor QAO via e-mail within 2 business days.
Analytical CAs	AGVIQ-CH2M HILL Project Chemist	Camden Robinson	(770) 439-8363	See Worksheets #24, 25, and 28 for analytical CAs. Analytical CAs will be reported within 1 week from the time the issue is identified.
Validated data	Data Validator PM	Camden Robinson	(770) 439-8363	Data validator provides data validation reports (electronic and hardcopy) that provide the data qualifiers and associated explanations.
Release of analytical data for upload to database	AGVIQ-CH2M HILL Project Chemist	Camden Robinson	(770) 439-8363	Upon review of validated data to ensure adherence to project requirements, project chemist communicates via e-mail to EIS that data are ready for release (i.e., upload to database).

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SAP Worksheet #7—Personnel Responsibilities and Qualifications Table

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications[a]
Mark E. Davidson	BRAC PMO SE RPM	Navy	Environmental restoration program activities implemented under this SAP.	
Jon Tucker	QAO	Navy	Navy review of SAP and QA input.	
Pedro Ruiz	Ceiba ERP Site Manager	Navy	On-island Navy liaison; provides logistical support for implementation of environmental restoration program activities under this SAP.	
Tom Beisel	PM	AGVIQ-CH2M HILL	Project administration; coordinates staffing; monitors project performance; directs and oversees project staff.	BS, Geology; over 18 years experience in project management, including staff supervision and project performance monitoring
Theresa Rojas	Program QA/QC Manager	AGVIQ-CH2M HILL	Oversees compliance with program and project-specific quality requirements.	BS, Chemistry; over 20 years experience in laboratory analysis, sampling, data validation, and field testing; over 15 years experience in construction quality management
Eric Burrell	Quality Control Coordinator	AGVIQ-CH2M HILL	Oversees project-specific QC requirements.	BS, Civil Engineering; over 5 years experience in construction quality management
Camden Robinson	Project Chemist Data Validator	AGVIQ-CH2M HILL	Establishes laboratory scope of work; ensures selected laboratory can meet project-required analytical protocol; primary communications with laboratory and data validator; performs data quality evaluation (DQE) to determine availability of analytical data. Responsible for validating analytical data in accordance with project-specific UFP-SAP.	BA, Chemistry; over 10 years experience in chemistry, including laboratory analysis, sampling, data validation, and field testing
Bryan Burkingstock	Task Manager	AGVIQ-CH2M HILL	Coordinates staffing; directs and oversees project staff; supervises field sampling and coordinates all field activities; ensures onsite compliance with work plan; oversees and ensures safety of onsite personnel.	Mr. Burkingstock has an MS and a BS in Hydrogeology and over 12 years experience in task management, including staff coordination and supervision, project compliance, and safety assurance

SAP Worksheet #7—Personnel Responsibilities and Qualifications Table (continued)

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications[a]
Andrew O'Conor	FTL and SSC	AGVIQ-CH2M HILL	Supervises field sampling and coordinates all field activities; ensures onsite compliance with work plan; oversees and ensures safety of onsite personnel.	BS, Geology; over 5 years experience in environmental consulting, geology, and groundwater investigations.
Lauren Petty	QC Manager	AGVIQ-CH2M HILL	Responsible for daily QC reports, oversight of quality. Monitor and report on subcontractor quality and quantities and audit subcontractors' offsite fabrication. Maintain Submittal Register. Participate in continuous improvement of project team and maintain lessons learned log.	BS, Hydrogeology; over 2 years experience in environmental consulting, remediation activities, site characterization, soil and groundwater investigations, and regulatory reporting
Mike Goldman	Health and Safety Officer	AGVIQ-CH2M HILL	Responsible for overall Navy program health and safety performance; reviews project-specific HSP; interacts with SSC to ensure project-specific safety of field personnel.	BS, Biology; over 22 years experience in health and safety, including preparing, implementing, and ensuring compliance with project-specific HSPs
Duane Johnson	Database Manager	AGVIQ-CH2M HILL	Uploads validated data to environmental database. Manages sample tracking; coordinates assimilation of data from field collection through analysis, validation, and upload to environmental database; performs data queries for data evaluation and report writing.	BS, Chemistry; over 8 years experience designing data management systems, sample tracking, coordinates e-data deliverables with the laboratory, data validation and quality evaluation, and report preparation
Janice Shilling	QAO, Organics Department Manager/ PM	Empirical Laboratories, LLC	Responsible for laboratory QA program and review of QC data. Responsible for oversight, QC, and data review of organics and inorganics laboratory. Laboratory POC and overall manager for analytical work.	

SAP Worksheet #7—Personnel Responsibilities and Qualifications Table (continued)

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications[a]
Ralph Abbondanza	Puerto Rican Chemist	Analytical Services, Inc.	Responsible for certifying laboratory data	
Jaca & Sierra Testing Laboratories, Inc.	Drilling Services	Drilling Subcontractor	Responsible for performing slide-hammer, direct-push, or similar means for soil sampling; responsible for monitoring well installation.	
Aleut Global Solutions, LLC	NA	Vegetation Clearance Subcontractor	Responsible for vegetation clearance, as necessary, to access sites and sample locations.	
Pedro Davila Colon, Inc.	Surveying Services	Surveying Subcontractor	Responsible for horizontal coordinate and vertical elevation surveying of newly installed monitoring wells.	
TBD	TBD	Remediation Waste Subcontractor	Responsible for transport and disposal of remediation waste deemed necessary for offsite disposal.	

Notes:

[a] Resumes are maintained by the individuals' organizations and are available upon request; upon execution of the project, staff may be removed (if unnecessary to project execution) and other staff may be added or substituted, as necessary and available.

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SAP Worksheet #8—Special Personnel Training Requirements Table

Project Function	Specialized Training by Title or Description of Course	Training Provider	Training Date	Personnel/Groups Receiving Training	Personnel Titles/Organizational Affiliation	Location of Training Records/Certificates
Field activities	Cardiopulmonary resuscitation/First Aid Training	Various qualified training organizations	Training will be verified as current prior to starting field activities.	AGVIQ-CH2M HILL SSC	AGVIQ-CH2M HILL SSC	AGVIQ-CH2M HILL Human Resources
Field activities	SSC-hazardous waste training	Various qualified training organizations	Training will be verified as current prior to starting field activities by SSC.	AGVIQ-CH2M HILL SSC	AGVIQ-CH2M HILL SSC	AGVIQ-CH2M HILL Human Resources

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SAP Worksheet #9a—Project Scoping Session Participants Sheet

Project Name: SWMU 7/8	
Projected Date(s) of Sampling: March 2009	**Site Name:** NAPR
PM: Tom Beisel	**Site Location:** Ceiba, Puerto Rico
Dates of Session: December 16, 2008 **Scoping Session Purpose:** Site visit to SWMU 7/8 to familiarize project team with site layout, meet Navy and AGVIQ-CH2M HILL personnel, and gauge select wells.	

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Tom Beisel	PM	AGVIQ-CH2M HILL	678-530-4033	Tom.Beisel@ch2m.com	PM
Thomas Kessler	Senior Geologist	AGVIQ-CH2M HILL	678-530-4197	Thomas.Kessler@ch2m.com	Senior Geologist
Bryan Burkingstock	Project Geologist	AGVIQ-CH2M HILL	678-530-4060	Bryan.Burkingstock@ch2m.com	Task Manager
Kimberley Coke	Project Geologist	AGVIQ-CH2M HILL	678-530-4073	Kimberley.Coke@ch2m.com	Previous FTL/SSC
Amanda Struse	Project Engineer	AGVIQ-CH2M HILL	972-663-2350	Amanda.Struse@ch2m.com	Task Manager for SWMUs 54 and 55
BT Thomas	Project Geologist	AGVIQ-CH2M HILL	678-530-4415	BT.Thomas@ch2m.com	Previous QC Manager

Comments/Decisions: Second visit required to locate wells, clear site, and perform a comprehensive round of gauging.

Action Items: Product data will be used to finalize the optimization report and determine an action plan for well installation. Also, determined that clearing of site was necessary to mark soil delineation sample locations.

Consensus Decisions: Scheduled trip to perform clearing, gauging, and staking of delineation sample locations. Date set to complete tasks during the week of January 19, 2009.

SAP Worksheet #9b—Project Scoping Session Participants Sheet

Project Name: SWMU 7/8	
Projected Date(s) of Sampling: January 2010	**Site Name:** NAPR
PM: Tom Beisel	**Site Location:** Ceiba, Puerto Rico

Dates of Session: January 19 – 23, 2009
Scoping Session Purpose: Site visit to SWMU 7/8 to locate and mark wells, mark locations for soil delineation samples, clear site, and perform a comprehensive round of gauging.

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Doug Downey	Senior Engineer	AGVIQ-CH2M HILL	303-674-6507	Doug.Downey@ch2m.com	Senior Technology Consultant
Thomas Kessler	Senior Geologist	AGVIQ-CH2M HILL	678-530-4197	Thomas.Kessler@ch2m.com	Senior Geologist
Bryan Burkingstock	Project Geologist	AGVIQ-CH2M HILL	678-530-4060	Bryan.Burkingstock@ch2m.com	Task Manager
Kimberley Coke	Project Geologist	AGVIQ-CH2M HILL	678-530-4073	Kimberley.Coke@ch2m.com	Previous FTL/SSC
Philip Jones	Project Engineer	AGVIQ-CH2M HILL	678-530-4191	Philip.Jones@ch2m.com	Field Team Member

Comments/Decisions: Site conditions might warrant additional site clearing based on vegetative growth rate.

Action Items: The data from the comprehensive gauging event will be tabulated and a potentiometric map completed. The soil delineation samples need to be collected and the location coordinates surveyed. Product data will be used to finalize the optimization report and determine an action plan for well installation.

Consensus Decisions: Scheduled trip to perform soil sampling activities. Date set to complete tasks during the week of June 1, 2009.

SAP Worksheet #9c—Project Scoping Session Participants Sheet

Project Name: SWMU 7/8	
Projected Date(s) of Sampling: March 2009 for delineation sampling and October 2009 for groundwater sampling	**Site Name:** NAPR
PM: Tom Beisel	**Site Location:** Ceiba, Puerto Rico
Dates of Session: February 4, 2009 **Scoping Session Purpose:** Present and discuss technical approach for delineation and groundwater sampling.	

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
David Criswell	BRAC PMO SE RPM	Navy	843-743-2130	david.criswell@navy.mil	Previous Primary Navy POC
Tom Beisel	PM	AGVIQ-CH2M HILL	678-530-4033	Tom.Beisel@ch2m.com	PM
Doug Downey	Senior Engineer	AGVIQ-CH2M HILL	303-674-6507	Doug.Downey@ch2m.com	Senior Technology Consultant
Thomas Kessler	Senior Geologist	AGVIQ-CH2M HILL	678-530-4197	Thomas.Kessler@ch2m.com	Senior Geologist
Bryan Burkingstock	Project Geologist	AGVIQ-CH2M HILL	678-530-4060	Bryan.Burkingstock@ch2m.com	Task Manager
Kimberley Coke	Project Geologist	AGVIQ-CH2M HILL	678-530-4073	Kimberley.Coke@ch2m.com	Previous FTL/SSC
Theresa Rojas	QA/QC Manager	AGVIQ-CH2M HILL	678-530-4297	Theresa.Rojas@ch2m.com	Program QA/QC Manager
Shruti Shah	Environmental Scientist	AGVIQ-CH2M HILL	678-530-4316	Shruti.Shah@ch2m.com	UFP-SAP Coordinator
Amanda Struse	Project Engineer	AGVIQ-CH2M HILL	678-530-4339	Amanda.Struse@ch2m.com	Task Manager for SWMUs 54 and 55

Comments/Decisions: Technical approach was approved by the Navy RPM.

Action Items: Complete UFP-SAP with technical approach.

Consensus Decisions:

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SAP Worksheet #10—Problem Definition

General

Groundwater sampling will be performed at SWMU 7/8 to complete the following objectives:

- Determine the horizontal extent of the contaminants of concern (COCs): 1,2,4-trimethylbenzene, benzene, and ethylbenzene.
- Determine where the COCs in groundwater exceed the specific Corrective Action Objectives (CAOs).
- Evaluate the assimilative capacity of the aquifer to naturally attenuate dissolved hydrocarbons to the CAOs.
- Determine handling and disposal of aqueous waste by collecting aqueous samples for waste characterization.
- Determine the current horizontal extent of free product and groundwater flow direction by measuring depth to water and/or product using a water level indicator or an oil/water interface probe.

Background and Potential Release History

The NAPR occupies over 8,600 acres at the northeastern-most portion of Puerto Rico along the Vieques Passage (Figure 1). The northern entrance to NAPR is about 35 miles east along the coastal road (Route 3) from San Juan. The facility was commissioned in 1943 as a Naval Operations Base, but was re-designated a Naval Station in 1957.

The Tow Way Fuel Farm (TWFF) is located on a hillside along Forrestal Drive north of Ensenada Honda (Figure 2). The fuel farm was constructed prior to 1957 and originally consisted of nine bomb-proof underground storage tanks (USTs) (Figure 3). The USTs were used for the storage of marine diesel fuel, jet fuel (JP-5), and Bunker C fuel. Closure of USTs 56A and 56B was completed in November 1996 by Reliable Mechanical, Inc. Two 10,000-gallon steel tanks and 329 tons of contaminated soil were bio-remediated and disposed of as non-regulated waste. On March 31, 2004, base operations, including the storage and distribution of fuel, were discontinued. The seven remaining USTs (82, 83, 84, 85, 1080, 1082, and 1088) were drained and are currently empty. During the facility's operational history, numerous releases have occurred from the USTs, resulting in the release of almost 1 million gallons of petroleum hydrocarbons to the environment. Historically known fuel releases are shown on Figure 4.

Regulatory History

Prior to 1993, environmental activities at the former Naval Station Roosevelt Roads (NSRR) (now NAPR), exclusive of UST operations, were conducted in compliance with Comprehensive Environmental Response, Compensation, and Liability Act regulations under the Navy's Installation Restoration Program. On October 20, 1994, the EPA Region 2 issued a Final RCRA Part B Permit to the NSRR. The permit contained requirements for RCRA facility investigation activities at 24 SWMUs and 3 areas of concern, including SWMUs 54 and 55. The RCRA Part B Permit, issued for the Defense Reutilization and Marketing Office at NAPR, included provisions for CA under the Hazardous and Solid Waste Amendments provisions of RCRA.

EPA Region 2 is the primary agency that regulates environmental activities at the NAPR, and site work is performed under RCRA Administrative Order on Consent-7003. However, PREQB also provides regulatory input. The EPA has assigned the following SWMU designations to the TWFF:

- SWMU 7 – Encompasses environmental impacts associated with releases that emanated from the nine original USTs (currently seven in place) located on a hillside along Forrestal Drive north of Ensenada Honda.
- SWMU 8 – Encompasses the TWFF Sludge Disposal; however, previous investigations were unable to locate evidence of the pits. As a result, the EPA combined SMWU 8 with SWMU 7.

Site Geology and Hydrogeology

The geology at NAPR consists of four geologic units: fill, soil consisting of saprolite and partially weathered rock (PWR), bedrock, and marine sediments. Onsite fill is a combination of reworked native soil and dredge material from Ensenada Honda (fine- to medium-grained sand with varying amounts of silt and clay) and occurs at ground surface to depths as great as 25 feet below ground surface (bgs) in areas of the site that have been reworked. Soil consisting of saprolite (clayey-silt to silty-clay with rock fragments of varying size) and PWR gabbro bedrock underlies the fill. The percentage of rock fragments increases with depth and grades into a PWR zone that contains weathered gabbro rock fragments with occasional clay seams. There is no well-defined contact between the residual soil and bedrock; rather, a gradational change of decreased weathering and fracturing occurs with increasing depth. The thickness of this soil and PWR unit is variable and in some places is over 40 feet. Bedrock underlies the PWR. Bedrock consists of gabbro that in places is hard and massive; however, a few zones are highly fractured due to tectonic deformation. The final zone is a zone of marine sediments located in the lowland area of the site near the Ensenada Honda. The sediments consist of silt with lesser amounts of sand and clay with coral and shell fragments.

Groundwater beneath the site occurs at depths ranging from 5.40 feet bgs (UGW08) to 106.53 feet bgs (7MW19), as measured on January 21, 2009, in existing wells (Figure 5). The depth to water (DTW) is greatest in the upland areas of the site and is shallowest nearest the Ensenda Honda. Water level changes in the upland and lowland areas are likely caused by seasonal variations in precipitation. In the lowland area south of Forrestal Drive, water level fluctuations are also a result of tidal influence. The primary direction of flow is south towards the Ensenda Honda (Figure 6). The hydraulic gradient associated with the groundwater north of Forrestal Drive from UGW02 to 7MW15 over a distance of about 810 feet is 0.01 foot per foot; the hydraulic gradient associated with the groundwater south of Forrestal Drive from UGW12 to 7MW12 over a distance of about 734 feet is 0.004 foot per foot.

Test data collected by Baker and others indicate the hydraulic conductivity of the water table aquifer ranges from 0.1 to 13.7 feet per day (Baker, 2001). Aquifer pumping tests performed at PW-3 and RW-4 indicate the yield of the aquifer is extremely low; pumping rates at PW-3 and RW-4 were 0.009 and 0.13 gallon per minute, respectively. The low permeability of the formation is the primary reason cited by Baker and others for inability to rapidly recover product. (Baker, 1999a)

Synopsis of Secondary Data

Previous Site Investigations and Remedial Actions

The *Final Corrective Measures Study* [CMS] *Task I Report* (Baker, 2003a) documents the findings of previous investigations and the condition of soil and groundwater as a result of historical releases

of diesel and jet fuel at the TWFF. Numerous environmental investigations, one interim corrective measure, and two pilot tests have been performed and documented at this site:

- The investigations include an initial assessment study (1982), a confirmation study (1986), an underground fuel investigation (1991), preliminary site assessment for UST Site No. 443 (1992), Corrective Action Plan (CAP) (Law Environmental-Caribe, 1993), site characterization and CAP (Blasland, Bouck, and Lee, 1994), multi-stage product recovery test (Terra Vac, 1996), closure of USTs 56A/B (Reliable Mechanical, 1996), RCRA facility investigation (Baker, 1997), a CMS investigation (Baker, 1999b), and an additional data collection investigation (Baker, 2003b), included as Appendix E in the final CMS (Baker, 2003a).
- The interim corrective measure was documented in the *Project Close-Out Report Interim Corrective Measure Free Product Recovery System* (ICHOR Services, 1997).
- A CleanOX® pilot study was conducted in January 1999 (ManTech Environmental, 1999).
- A pneumatic fracturing pilot test to evaluate enhancement of product recovery at the TWFF was completed in August 2000.
- Ongoing reporting of water table measurements, product thickness, and product removal information from the remedial action contractor at various wells at the TWFF is documented in Attachment 1, the TWFF Quarterly Summary Progress Report, of each RCRA Final Permit Required Quarterly Progress Report (Baker, 2008).

Relevant previous site work performed to determine the extent of dissolved hydrocarbons in groundwater beneath the TWFF is summarized as follows:

1991: O'Brien and Gere Engineers, Inc., conducted initial investigatory work at the TWFF under the provisions of the RCRA UST program. The study included the installation of 18 monitoring wells (UGW-1 through UGW-18) at SWMU 7/8 to define the extent of groundwater contamination and free-floating product. The monitoring wells installed in February and March 1991 were constructed of 2-inch inside diameter polyvinyl chloride (PVC) and designated UGW-1 through UGW-18. Groundwater samples were collected during one sampling event and analyzed for volatile aromatic and unsaturated organic compounds (EPA Method 503.1) and lead.

Semi-confined aquifer conditions were encountered in nine monitoring wells (UGW-1, UGW-3, UGW-4, UGW-8, UGW-9, UGW-10, UGW-12, UGW-13, and UGW-14). At each of these locations, the monitoring well screen was placed across the top of the aquifer (first encountered saturated conditions); however, with time, the water level and/or product layer was discovered above the well screen. The field investigation defined the extent of free-floating product but only partially defined the extent of groundwater contamination.

1992: Groundwater samples were collected by Law Environmental-Caribe (1993) from 11 monitoring wells and analyzed for volatile aromatic and unsaturated organic compounds (EPA Method 502.2 and 503.1), lead, and total petroleum hydrocarbons (TPH). Groundwater and product thickness measurements were taken with an interface probe a total of four times (August 31, September 28, November 17, and December 12). Screened intervals for nine monitoring wells (UGW-1, UGW-3, UGW-4, UGW-8, UGW-9, UGW-10, UGW-12, UGW-13, and UGW-14) were confirmed to be below the measured groundwater and/or free product elevations. Free product was detected in nine monitoring wells (UGW-1, UGW-2, UGW-4, UGW-5, UGW-12, UGW-13, UGW-14, UGW-17, and GW-04). Free product was detected in UGW-2 in 1992, but was not detected in 1991. It was concluded that the horizontal extent of free product had not been adequately

determined. A four-phased CAP was proposed that included monthly groundwater and product measurements and quarterly collection of groundwater samples that would be analyzed for benzene, toluene, ethylbenzene, and xylenes (BTEX), lead, and TPH.

1994: Blasland, Bouck, and Lee, Inc. (1994), completed a site characterization study in April 1994. The groundwater investigation was designed to define the extent of contamination in groundwater at the TWFF through the installation of eight monitoring wells. The fieldwork was conducted from November to December 1993. Six monitoring wells (UGW-19, UGW-20, UGW-21, UGW-23, UGW-24, and UGW-25) were installed to the top of the water table. A separate monitoring well (UGW-26) was installed as a deep monitoring well 40 feet below the water table. UGW-22 was installed in the center of the free-product plume as a 6-inch monitoring well to accurately estimate the thickness of the free-floating product on top of the water table. Samples from the 8 newly installed monitoring wells (UGW-19 through UGW-26) and 10 existing monitoring wells (UGW-6 through UGW-11, UGW-15, UGW-16, UGW-18, and GW-02) that did not contain free product were analyzed for volatile organic compounds (VOCs) and TPH.

1998: A CMS investigation was performed by Baker (1999b) during the spring of 1998 to gather additional data on the fuel-related contamination to assist in the development of the CMS and the selection of a remedial approach. The investigation included groundwater sampling of 41 monitoring wells across the site. The groundwater samples were analyzed for BTEX, TPH (diesel range and gasoline range organics), methane, nitrate, sulfate, alkalinity, chloride, and ferrous iron.

2002 - 2008: An additional data collection investigation was performed by Baker (2003) during the first part of 2002 to address the additional data requirements identified from the previous investigations and to support the ongoing efforts of the CMS. This investigation included the installation of 11 monitoring wells. Groundwater samples were collected from the 11 new monitoring wells and 22 existing monitoring wells throughout the site and analyzed for VOCs, semivolatile organic compounds (SVOCs), and Appendix IX Inorganics. Select samples were also analyzed for natural attenuation parameters, including nitrate, nitrite, sulfate, methane, ethane, ethene, total organic carbon (TOC), and groundwater density.

Also presented in the final CMS (Baker, 2003a) were the CAOs for the COCs that were determined through a human health risk assessment and a screening level ecological risk assessment.

From the first quarter of 2003 through July 2008, Baker performed additional site work to determine the extent of product, evaluated product recovery rates, conducted a risk assessment, and monitored the configuration of the product plume. The results of their work culminated in the development of the revised final CMS (Baker, 2005) that was submitted to the EPA in November 2005. The remedial strategy proposed in the revised final CMS involved measuring natural attenuation parameters within the dissolved plume to determine if MNA is a viable remedial action for groundwater.

Groundwater Corrective Action Objectives

Table 1 includes the CAOs for the COCs as presented in the revised final CMS (Baker, 2005).

TABLE 1
SWMU 7/8 Contaminants of Concern

Media	COC	CAO	Maximum Observed	Most Recently Observed Maximum
Groundwater (µg/L)	1,2,4-Trimethylbenzene	3,300	4,600	4,600
	Benzene	550	26,000[a]	19,000[a]
	Ethylbenzene	1,000	95,702[b]	18,000[c]

Notes:
[a] Located at 470MW1, 4/1998 and 1/2002
[b] Located at 470MW3, 1/2002
[c] Located at UGW1, 3/1991
µg/L = microgram per liter

As previously indicated, the CAOs were proposed and then approved by the EPA; therefore, these existing CAOs will be used as sampling criteria during the verification sampling.

Historical Dissolved Contaminant Plume Distribution

Groundwater COCs include 1,2,4-trimethylbenzene, benzene, and ethylbenzene, and the extent of the dissolved plume of these COCs above their respective CAOs is shown on Figures 7 through 9, respectively.

Problem Definition

The primary objective for this SAP is to implement the remedial alternative for groundwater at SWMU 7/8, described in the revised final CMS (Baker, 2005) in an effort to achieve the following Remedial Action Objective:

- Collect natural attenuation parameters within the dissolved plume to determine if MNA is a viable remedial action.

A secondary objective for this SAP is to characterize the soil and aqueous waste that will be generated during the monitoring well installation and groundwater activities at SWMU 7/8.

Environmental Questions to be Answered by the Groundwater Sampling Work

1. **What is the current horizontal extent of 1,2,4-trimethylbenzene, benzene, and ethylbenzene in groundwater?**
   A baseline sampling event will be conducted to determine the horizontal extent of the dissolved plumes associated with 1,2,4-trimethylbenzene, benzene, and ethylbenzene.

2. **Are current concentrations of 1,2,4-trimethylbenzene, benzene, and ethylbenzene detected in groundwater above the CAOs?**
   A baseline sampling event will be conducted to determine if concentrations of 1,2,4-trimethylbenzene, benzene, and ethylbenzene still exceed the CAOs.

3. **What is the effectiveness of MNA to treat COCs in groundwater?**
   The potential (assimilative capacity) to effectively treat COCs in groundwater using MNA will be based on the analysis of MNA parameters, such as sulfate, sulfide, alkalinity, nitrate, nitrite,

TOC, ferrous iron, methane, and a measurable decline in the COC concentrations. COC and MNA parameter concentrations will be monitored for 2 years to evaluate the extent of contaminant degradation and determine if MNA is a viable remedial action.

4. **What are the characteristics of the soil and aqueous waste?**
   Data results from the monitoring well installation and groundwater sampling events will determine how the soil and aqueous waste will be handled and disposed.

5. **What is distribution of product and direction of groundwater flow?**
   A comprehensive round of well gauging will be completed during the baseline and each quarterly sampling event in order to determine the distribution of product and direction of groundwater flow. The data will be used to optimize the approach for product recovery.

SAP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements

1. **Who will use the data and what will the data be used for?**
   The Navy, EPA, PREQB, subcontractors, and AGVIQ-CH2M HILL will use the data collected during the groundwater sampling events to define horizontal extent of the COCs, determine if 1,2,4-trimethylbenzene, benzene, and ethylbenzene levels are above CAOs, evaluate the ability (assimilative capacity) of the aquifer to naturally attenuate dissolved hydrocarbons to CAOs, determine the current extent of product on the water table, and determine the direction of groundwater flow. The product distribution combined with historical data will also be used to optimize product recovery efforts.

   The data from the soil and aqueous waste characterization sampling will be used by AGVIQ-CH2M HILL to determine the disposal or treatment options for the soil waste generated during the monitoring well installation and aqueous waste generated from groundwater sampling activities.

2. **What are the Project Action Limits (PALs)?**
   The approved actions for the dissolved VOC plumes in groundwater are addressed under Alternative 1 in the revised final CMS (Baker, 2005). Under this alternative, groundwater samples will be collected and analyzed to determine if MNA is a viable remedial action. The groundwater CAOs are: 1,2,4-trimethylbenzene (3,300 µg/L), benzene (550 µg/L), and ethylbenzene (1,000 µg/L). PALs for the COCs are the CAO levels listed in Worksheets #10 and 15. The PALs for waste characterization are provided in Worksheet #15.

3. **What types of data are needed (matrix, target analytes, analytical groups, field screening, onsite analytical or offsite laboratory techniques, sampling techniques)?**
   Worksheets #10 and 17 contain detailed information on the types of data needed for this project. Worksheet #12 defines the matrices, analytical groups, and target analytes. As detailed in the revised final CMS, site-specific COCs have already been identified and only specific VOCs will be analyzed (Baker, 2005).

   Sample analyses for COCs will be conducted by an offsite laboratory in accordance with Worksheets #15, 19, 23, 24, 25, 28, and 30. Analyses for ferrous iron will be conducted onsite using a colorimeter. Measurements of turbidity, dissolved oxygen (DO), oxidation-reduction potential (ORP), temperature, pH, and conductivity will be conducted onsite using a multi-parameter, water quality meter.

   Groundwater sampling and related activities will be performed in accordance with the applicable standard operating procedures (SOPs) in Appendix B. Appendix B also presents the SOP for aqueous waste characterization sampling. Worksheet #14 presents well gauging procedures.

4. **How "good" do the data need to be in order to support the environmental decision?**
   All groundwater data will be validated against QA/QC criteria and measurement performance criteria listed in this SAP and certified by a Puerto Rican chemist, Ralph Abbondanza, Analytical Services, Inc. Level IV package and QC sampling are required. Data will be used to determine if MNA is a viable remedial action at SWMU 7/8 as stated in the revised final CMS (Baker, 2005). QC data requirements are detailed in Worksheet #20**.** The waste characterizations

data will be evaluated by the project chemist to ensure quantitation limits (QLs) are met and certificated by the Puerto Rican chemist as well. A Level III package is required.

Data need to be sufficient to meet the following:

Visual Observations – Visual observations will be used to determine the presence or absence of product. As such, the data are considered qualitative in that they do not need to provide an exact or quantified value.

Onsite Analytical Data – A Hach water testing kit with a colorimeter will be used to measure ferrous iron. In addition, a multi-parameter water quality meter will be used to measure turbidity, DO, ORP, temperature, pH, and conductivity during and after purging activities. Field parameters will be used to determine if well water during purging activities has stabilized. Stabilization for each field parameter is defined as follows: pH measurements ± 0.1 units, temperature measurements ±1 degree Celsius (°C), specific conductance measurements ± 10 percent, and ± 10 percent for turbidity.

Offsite Analytical Data – The data need to be "good" enough to evaluate results of groundwater sampling at SWMU 7/8, determine the effectiveness of MNA on the treatment of COCs in the groundwater, make decisions on how to treat or dispose of aqueous waste from the future excavation activities, and optimize the approach for product recovery. Ensuring data are "good" enough for this purpose is done via employing appropriate analytical protocol, validating the resulting data, including QA/QC samples to verify proper sampling and analysis protocol, and performing a DQE to assess the availability and usability of the data for the intended purpose. Each of these is further discussed below:

- Appropriate Analytical Protocol – See Worksheets #15, 19, 23, 24, 25, 28, and 30, and Item 5 below.

- Data Validation – Validation of data increases the level of confidence in a data set for a particular data use. The particular type and level of validation necessary to achieve acceptable confidence is subjective. In other words, the appropriate type and level of data validation is not an absolute. Rather, it is data use- and data user-specific. For the groundwater sampling events, analyses for potential contaminants will be certified by a Puerto Rican chemist, 90 percent of the data will be validated by an AGVIQ-CH2M HILL data validator, and 10 percent of the data will be validated by a third party validator (eDATApro) using guidance from the validation criteria outlined by the U.S. Department of Defense (DoD) Quality System Manual (QSM). The validation criteria and guidance documents are listed in Worksheet #36. These documents will help the validators create a thorough and systematic approach to the validation process. The data validator will also recalculate 100 percent of the results from the raw laboratory data, which may identify laboratory errors in identification or quantification, if present.

- QA/QC Samples – During the groundwater sampling events, QA/QC samples will be collected as a check on sampling and analytical protocol. Like data validation, the appropriate type and quantity of QA/QC samples is not an absolute. For the groundwater sampling events, field duplicates will be collected at a frequency of 1 per 10 field samples per matrix. Field duplicates help assess sample collection techniques and laboratory precision. Matrix spike (MS)/matrix spike duplicates (MSDs) are collected at a frequency of 1 pair per 20 field samples per matrix. The frequency is such that there is one MS/MSD pair per laboratory analytical batch. MS/MSD samples are often required by the analytical

method and/or data validation guidance. Equipment blanks are collected at a frequency of 1 per day per decontaminated equipment. Equipment blanks help assess equipment decontamination techniques and identify when contamination may have been carrying over from one sample location to another. It is important to maintain this equipment blank frequency because the equipment blank is collected after visiting the most contaminated location, and it is important to not associate too many locations with the potentially contaminated equipment blank. Trip blanks are collected at a frequency of one per cooler containing volatiles. Trip blanks accompany the empty sample containers while they are stored at the laboratory or shipped to the site, and while they are full and shipped back to the laboratory. Trip blanks are useful for assessing whether or not there is any contamination during periods of time when the samples are not directly supervised. No field blanks will be collected unless on a particular day of sampling, the ambient conditions suggest airborne particulates may contaminate the samples being collected.

– DQE – In order to support the environmental decision, each result must be *available* to and *usable* for the project team. All data sets will undergo a DQE prior to using the data to make site-specific determinations. The terms *data availability* and *data usability* and the DQE process in general are described in Worksheet #37.

5. **How much data should be collected (number of samples for each analytical group, matrix, and concentration)?**
A baseline site characterization event and eight quarterly sampling events will be conducted after the completion of well installation activities. Groundwater samples will be collected from 27 monitoring wells, as shown on Figure 10. Each sample will be analyzed for 1,2,4-trimethylbenzene, benzene, and ethylbenzene by SW846 8260B, and the following MNA parameters: sulfide (SM 4500-S2-F), alkalinity (SM 2320B), nitrate/nitrite/sulfate (EPA 300.0), TOC (SM 5310B), and methane (RSK-175). MNA parameters will be collected during the baseline sampling event and during the fourth and eighth quarterly events. Groundwater samples will not be collected in monitoring wells with measurable product. During purging activities and before sample collection, field measurements of turbidity, ferrous iron, DO, ORP, temperature, pH, and conductivity will also be recorded.

Detailed information on how much data will be collected is provided in Worksheets #10, 15, and 17. The number of QA/QC samples is detailed in Worksheet #20. One composite soil waste characterization sample will be collected for every ten drums after all the wells have been installed and analyzed for Toxicity Characteristic Leaching Procedure (TCLP) (see Worksheet #15 for specific compounds). At the conclusion of the baseline and each quarterly sampling event, one composite aqueous waste characterization sample will be collected from each tank and analyzed for RCRA compounds (see Worksheet #15 for specific compounds), reactivity (sulfide and cyanide), ignitability, and corrosivity as pH. All tanks will be located at the SWMU 7/8 lay down area. The number of QA/QC samples is detailed in Worksheet #20.

6. **Where, when, and how should the data be collected/generated?**
Figure 10 shows the tentative sampling locations for the groundwater sampling at SWMU 7/8. All site wells will be gauged prior to groundwater sampling. Well gauging and waste characterization sampling procedures are presented on Worksheet #14. All other SOPs are provided as Appendix B, and the sampling schedule is outlined in Worksheet #16. Well gauging and groundwater sample collection will occur for 2 years starting in the second quarter

of 2010 at SMWU 7/8. Waste characterization samples will be collected in the manner stated in question 5.

7. **Who will collect and generate the data? How will the data be reported?**
AGVIQ-CH2M HILL will gauge all the wells and collect the groundwater samples, aqueous and soil waste characterization samples. Analytical data will be generated by Empirical Laboratories, LLC. Two weeks following the certification of the laboratory data by a Puerto Rican chemist, and the validation of the laboratory data, AGVIQ-CH2M HILL will submit a letter-report to the PREQB to document the findings obtained during each groundwater sampling event. The report will include the following:

   - Tabulated environmental-media analytical data
   - Map(s) illustrating the horizontal extent of 1,2,4-trimethylbenzene, benzene, and ethylbenzene in groundwater

   The well gauging and groundwater data will then be presented to the stakeholders via technical memorandums completed subsequent to each groundwater sampling event to summarize results and provide recommendations as appropriate. The aqueous and soil waste characterization data will be presented to the Navy and the receiving facility to determine and ensure appropriate disposal of remediation waste.

8. **How will the data be archived?**
The electronic data will be loaded into the Navy Installation Restoration Information System (NIRIS) database. Raw data, as well as data summary tables, will be included in an initial baseline site characterization report, quarterly monitoring reports, and a MNA evaluation report at the end of the 2-year sampling period. Hardcopy data will be released to the Navy following completion of the project.

9. **List the project quality objectives in the form of if/then qualitative and quantitative statements.**
The regulatory-approved remedial action for SWMU 7/8, as described in the revised final CMS (Baker, 2005), includes the measuring natural attenuation parameters within the dissolved plume to determine if MNA is a viable remedial action for 1,2,4-trimethylbenzene, benzene, and ethylbenzene in groundwater. Data results of the groundwater sampling events will be reported in an initial baseline site characterization report, quarterly monitoring reports, and a MNA evaluation report at the end of the 2-year sampling period.

   The primary study question for this phase of work at SWMU 7/8 is: Is MNA a viable remedial action for 1,2,4-trimethylbenzene, benzene, and ethylbenzene in groundwater?

   Planned actions include:

   - If the baseline groundwater sampling data indicate concentrations for 1,2,4-trimethylbenzene, benzene, and ethylbenzene are no longer greater than the CAOs, then no further action will be taken.
   - If the groundwater sampling data indicate concentrations for 1,2,4-trimethylbenzene, benzene, and ethylbenzene are still greater than the CAOs, then groundwater sampling events will occur quarterly for a period of 2 years. However, it should be noted that the PREQB only requires that COC concentrations remain below the associated CAOs for four

consecutive quarters. Therefore, it is possible that the groundwater sampling events can occur for a period of less than 2 years.

- If after 2 years of collecting groundwater samples, the dissolved COCs for the groundwater exceed the associated CAOs, the Navy will re-evaluate alternate remedial technologies to enhance contaminant degradation and/or to use a risk-based approach to calculate alternate CAOs that are protective of human health and the environment.
- If during well gauging product is detected in any of the 27 monitoring wells, then the wells containing product will not be analyzed. If no product is detected in monitoring wells, then the wells will be sampled for VOCs and/or MNA parameters.
- If soil and aqueous waste sample results indicate that the material is hazardous, then material will be sent to a landfill that accepts hazardous waste. If material it not hazardous, then material will be sent to a landfill that accepts non-hazardous waste.

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SAP Worksheet #12—Measurement Performance Criteria Table – Field QC Sample

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Trip Blank	1,2,4-Trimethylbenzene, Benzene and Ethylbenzene SW-846 8260B Water	One set per cooler	Bias/Contamination	No target analytes greater than or equal to the QL; with the exception of common field/laboratory contaminants	S &A
MS/MSD		One MS/MSD per 20 samples	Accuracy/Bias/Precision	DoD QSM limits, 30%RPD	A
Field Duplicates		As required per sampling event	Precision	Values greater than 5 times the QL: ±50%	S & A
Equipment/Rinsate Blanks		As required per sampling event	Bias/Contamination	No target analytes greater than or equal to the QL; with the exception of common field/laboratory contaminants	S
Cooler Temperature Indicator		One per cooler	Accuracy/ Representativeness	Between 2°C and 6°C	S
Data Completeness Check		Not applicable (NA)	Data Completeness	85% Overall	S & A
MS/MSD	Nitrate, Nitrite, and Sulfate EPA 300.0 Water	One per batch	Accuracy/ Bias	± 25% of true value if sample is less than 4 times the spike added	A
Field Duplicates		As required per sampling event	Precision	Values greater than or equal to 5 times the QL: Relative percent difference (RPD) less than or equal to 50%	S & A
Equipment/Rinsate Blanks		As required per sampling event	Bias/Contamination	No target analytes greater than or equal to the QL	S

SAP Worksheet #12—Measurement Performance Criteria Table – Field QC Sample (continued)

QC Sample	Analytical Group	Frequency	DQIs	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Cooler Temperature Indicator	Nitrate, Nitrite, and Sulfate EPA 300.0 Water	One per cooler	Accuracy/ Representativeness	Between 2°C and 6°C	S
Data Completeness Check		NA	Data Completeness	85% Overall	S & A
MS	TOC SM 5310B Water	One per batch	Accuracy/Bias	± 25% of true value if sample is less than 4 times the spike added	A
Field Duplicates		As required per sampling event	Precision	Values greater than or equal to 5 times the QL: RPD less than 50%	S & A
Equipment/Rinsate Blanks		As required per sampling event	Bias/Contamination	No target analytes greater than the QL	S
Cooler Temperature Indicator		One per cooler	Accuracy/ Representativeness	Between 2°C and 6°C	S
Data Completeness Check		NA	Data Completeness	85% Overall	S & A
MS	Sulfide SM 4500-S_2 F Water	One per batch	Accuracy/Bias	± 25% of true value if sample is less than 4 times the spike added	A
Field Duplicates		As required per sampling event	Precision	Values greater than or equal to 5 times the QL: RPD less than or equal to 50%	S & A
Equipment/Rinsate Blanks		As required per sampling event	Bias/Contamination	No target analytes greater than or equal to the QL	S
Cooler Temperature Indicator		One per cooler	Accuracy/ Representativeness	Between 2°C and 6°C	S
Data Completeness Check		NA	Data Completeness	85% Overall	S & A

SAP Worksheet #12—Measurement Performance Criteria Table – Field QC Sample (continued)

QC Sample	Analytical Group	Frequency	DQIs	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
MS/MSD	Methane RSK-175 Water/	One per batch	Accuracy/Bias	± 25% of true value if sample is less than 4 times the spike added	A
Field Duplicates		As required per sampling event	Precision	Values greater than or equal to 5 times the QL: RPD less than or equal to 50%	S & A
Equipment/Rinsate Blanks		As required per sampling event	Bias/Contamination	No target analytes greater than or equal to the QL; with the exception of common field/laboratory contaminants	S
Cooler Temperature Indicator		One per cooler	Accuracy/ Representativeness	Between 2°C and 6°C	S
Data Completeness Check		NA	Data Completeness	85% Overall	S & A
Field Duplicates	Alkalinity SM 2320B Water	As required per sampling event	Precision	Values greater than or equal to 5 times the QL: RPD less than or equal to 50%	S & A
Equipment/Rinsate Blanks		As required per sampling event	Bias/Contamination	No target analytes greater than or equal to QL	S
Cooler Temperature Indicator		One per cooler	Accuracy/ Representativeness	Between 2°C and 6°C	S
Data Completeness Check		NA	Data Completeness	85% Overall	S & A

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SAP Worksheet #13—Secondary Data Criteria and Limitations Table

The table below provides general information on how secondary data will be used and the limitations on their use. Following the general table below, secondary data criteria and limitations tables are presented for each site where historical analytical data exist (applicable to the scope of work covered by this SAP), specifically to address the use and limitations of the historical analytical data.

Secondary Data	Data Source	Data Generator(s)	How Data Will Be Used	Limitations on Data Use
Site background information and the EPA- and PREQB-approved groundwater remedial action for SWMU 7/8	Prepared by: Baker Environmental, Inc. Report Title: Final Corrective Measures Study Task 1 Report, Tow Way Fuel Farm Date: April 22, 2003	Site history for SWMU 7/8	Data will be used to provide site history summaries and to gain an understanding of historical activities that led to the EPA- and PREQB-approved groundwater remedial action for SWMU 7/8.	More recent information may supersede historical information from this report.
Site background information and the EPA- and PREQB-approved groundwater remedial action for SWMU 7/8	Prepared by: Baker Environmental, Inc. Report Title: Revised Final Corrective Measures Study Final Report, Tow Way Fuel Farm Date: November 22, 2005	Site history for SWMU 7/8	Data will be used to provide site history summaries and to gain an understanding of historical activities that led to the EPA- and PREQB-approved groundwater remedial action for SWMU 7/8.	More recent information may supersede historical information from this report.
TWFF quarterly sampling report.	Prepared by: Baker Environmental, Inc. Report Title: RCRA 7003 Administrative Order on Consent Quarterly Progress Report, May 1, 2008 – July 31, 2008 Date: August 2008	Historical product gauging data	Data will be used to evaluate product distribution and identify areas of intermediate areas of thickest product information.	Based on fact that many screens are submerged, product distribution may be inaccurate. Data is also outdated.

SAP Worksheet #13—Secondary Data Criteria and Limitations Table (continued)

Secondary Data	Data Source	Data Generator(s)	How Data Will Be Used	Limitations on Data Use
Groundwater analytical data generated during the 2003 Additional Data Collection Investigation	Prepared by: Baker Environmental, Inc. Report Title: Final Additional Data Collection Investigation Report, Tow Way Fuel Farm Date: April 22, 2003	Groundwater samples were collected from the 33 monitoring wells throughout the site and analyzed for VOCs, SVOCs, and Appendix IX Inorganics. Select samples were also analyzed for natural attenuation parameters, including nitrate, nitrite, sulfate, methane, ethane, ethene, TOC, and groundwater density.	Data will be incorporated, as appropriate, into a comprehensive data set to confirm the limits of the dissolved plume for 1,2,4-trimethylbenzene, benzene, and ethylbenzene in groundwater as presented in the EPA- and PREQB-approved final CMS.	More recent information may supersede historical information from this report.

SAP Worksheet #14—Summary of Project Tasks

General Protocol

Mobilization

Mobilization will include AGVIQ-CH2M HILL staff and subcontractors traveling to the island. Mobilization will include the completion of the following task:

- Approval of the SAP by the stakeholders
- Arrival of groundwater sampling equipment

Sampling Locations and Quantities

During the groundwater sampling events, 27 wells will be gauged and then groundwater samples will be collected at SWMU 7/8. The approximate proposed monitoring well locations are illustrated on Figure 10. One soil waste characterization sample per ten drums will be collected after all wells have been installed. An aqueous waste characterization sample will be collected after the baseline and quarterly sampling event. All drums will be stored at the SWMU 7/8 lay down area.

Sampling

A baseline site characterization event and eight quarterly sampling events will be conducted after the completion of well installation activities. Groundwater samples will be collected from 27 monitoring wells, as shown on Figure 10. Each sample will be analyzed for the following VOC compounds: 1,2,4-trimethylbenzene, benzene, and ethylbenzene (SW846 8260B). Analyses of groundwater for the following MNA parameters will be performed during the baseline, fourth, and eighth quarterly events: sulfide (SM 4500-S2-F), alkalinity (SM 2320B), nitrate/nitrite/sulfate (EPA 300.0), TOC (SM 5310B), and methane (RSK-175). Groundwater samples will not be collected in monitoring wells with measurable product. Wells will be sampled in order of least to most contamination.

During purging activities and before sample collection, field measurements of turbidity, ferrous iron (Hach water testing kit with colorimeter), DO, ORP, temperature, pH, and conductivity will also be recorded.

Worksheet #18 lists the sampling identifications (IDs) and the analysis that will be performed at each monitoring well. The groundwater samples will be packed in jars, labeled, and packed on ice at a temperature between 2°C and 6°C for shipment to Empirical Laboratories, LLC. This laboratory is National Environmental Laboratory Accreditation Program (NELAP)-certified and Navy-approved for chemical analysis.

During sample collection, sampling personnel will also record any observations made during the sampling (i.e., hydrocarbon odor, product). One soil waste characterization sample per ten drums will be collected after all wells have been installed and analyzed for TCLP (see Worksheet #15 for specific compounds). After the baseline and each quarterly groundwater sampling event a composite aqueous waste characterization sample will be collected and analyzed for RCRA compounds (see Worksheet #15 for specific compounds), reactivity (sulfide and cyanide), ignitability, and corrosivity as pH. For QA/QC purposes, up to 25 samples will be submitted for QC/QC analysis. These samples will include MS/MSDs, duplicate samples, and equipment blanks.

Sampling Procedures

All groundwater sampling procedures are presented in Appendix B.

Soil and aqueous waste characterization samples will be collected to evaluate the handling and transportation and disposal (T&D) requirements of accumulated purge water and decontamination water.

One soil composite sample (and one grab for VOC analysis) will be collected per 10 drums. Soil samples will be collected according to the following procedure:

1. From each 55-gallon drum containing soil waste generated during the installation of monitoring wells, a spoon full of soil will be collected from each drum and mix in bowl to form a composite soil sample.
2. Gently stir the sample in the container and place the composite soil sample into the appropriate sample jars.
3. Close the jars and label and package the sample for shipment to the laboratory for chemical analysis.

One aqueous composite sample (and one grab for VOC analysis) will be collected from each tank. Water samples will be collected according to the following procedure:

1. Using a bailer or dip jar, collect a water sample from the tank.
2. Fill the sample containers for volatile analyses first (grab sample). The 40-milliliter (mL) vials will be filled so that there is no headspace in each vial.
3. Fill the sample containers for the remaining analyses.
4. Label and package the samples for shipment to the laboratory.

A CH2M HILL Level B package will be required along with appropriate QC samples for the required waste characterization and incidental waste stream samples. All analytical data will be submitted by both hard copy and electronic files.

Sampling Equipment

The following equipment will be used during the work:

- Nitrile or latex gloves
- Durable ice chest (20-gallon) for shipping samples
- Ice for preserving samples
- Laboratory supplied sampling containers (jars/bottles)
- 55-gallon drums (U.S. Department of Transportation-approved) for containerizing waste
- Submersible pump or Peristaltic pump and associated tubing
- Battery to run pump
- Hach water testing kit for ferrous iron and colorimeter
- Multi-parameter water quality meter
- Oil/water interface probe and water level indicator

Sampling Container, Analytical Methods, Preservatives, and Holding Time

The analytical method, preservative, sampling containers and holding time for the groundwater samples are described in Table 2. Worksheet #19 presents all of the analytical SOP requirements, including the RCRA compounds (see Worksheet #15 for specific compounds). The sample containers will be provided by Empirical Laboratories, LLC. This laboratory will be responsible for the chemical analysis of the groundwater and QA/QC samples.

TABLE 2
Analytical Methodology

Parameter	EPA Method	Preservative	Container	Holding Time
1,2,4-Trimethylbenzene Benzene Ethylbenzene	SW 846-8260B	Hydrochloric acid (HCl) pH less than 2; Cool to 4˚C	(2) 40-mL vials	14 days
Sulfide	SM 4500-S2-F	Cool to 4˚C, pH greater than 9 with sodium hydroxide (NaOH)	(1) 500-mL plastic	7 days
Alkalinity	SM 2320-B	Cool to 4˚C	(1) 500-mL plastic	14 days
Nitrate/Nitrite	EPA 300.0	Cool to 4˚C	(1) 250-mL plastic	48 hours
Sulfate	EPA 300.0	Cool to 4˚C	(1) 250-mL plastic	28 days
TOC	SM 5310-B	Cool to 4˚C, pH less than 2 with HCl or sulfuric acid (H_2SO_4)	(2) 40-mL vials	28 days
Methane	RSK-175	HCl pH less than 2; Cool to 4˚C	(2) 40-mL vials	14 days

Well Gauging

During each sampling event, well gauging will be performed to determine light non-aqueous phase liquid (LNAPL) thickness and distribution on the water table, evaluate fluctuations in water table elevations, and prepare groundwater contour maps. Wells that contain LNAPL will not be sampled. The procedures that will be followed are discussed below.

Site-Wide Well Gauging

During each sampling event, AGVIQ-CH2M HILL personnel will gauge all site wells using a water level indicator or an oil/water interface probe. Site-wide gauging will be performed the day before beginning groundwater sampling. Gauging data will be recorded in a site-specific, waterproof logbook and on a field gauging sheet. The following guidelines adopted from American Society for Testing and Materials D4750 - *Standard Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well* will be used to gauge the wells:

1. Unlock and uncap the well and allow water levels to reach static levels for at least 15 minutes. If the cap has a vent hole, this step may be ignored.

2. Clean the water level indicator or oil/water interface probe with a Liquinox®/water solution and rinse with distilled water.
3. Turn on the water level indicator or oil/water interface probe and test the battery to verify proper charge. Verify that the probe is working by wetting the end of the probe. Dry the probe prior to measuring LNAPL/groundwater depth.
4. Measure depth to LNAPL/groundwater as follows:
    a. Adjust the gain/sensitivity (while probe is dry) to the maximum sensitivity that does not activate the audible sensor.
    b. Lower the probe into the well slowly until the audible sensor activates. A single tone indicates that LNAPL has been encountered. Multiple beeping tones indicate that groundwater has been encountered.
    c. Raise and lower the probe slowly to precisely measure the top of the LNAPL and/or water surface.
    d. Hold the tape (indicating depth) against the designated measuring point and read the DTW and/or depth to product (DTP) to the nearest 0.01 foot. Perform a second and third check to verify each reading. If LNAPL is encountered record the measurement to the nearest 0.01 foot and continue to lower the probe until multiple beeps are heard. Record this measurement as this indicates that groundwater has been encountered. The difference between the top and bottom measurements is the LNAPL thickness.
5. Record the DTW and/or DTP in the field logbook.
6. Recap and lock the well.

Important items to check include:

- If the well does not have a vent hole, vent the well before measurement.
- Use the same location on the well casing during each measurement event to ensure comparability of readings. If in doubt, measure on the northern side of the casing for all wells.
- Clean the water level indicator or oil/water interface probe with a Liquinox®/water solution and rinse with distilled water before and after each well measurement.

Equipment Decontamination

An area will be designated for the decontamination of equipment and the storage of all waste. All decontaminated materials will be handled only with new, unused nitrile or latex gloves to avoid contamination. Decontamination SOPs are presented in Appendix B.

Sampling Equipment and Water Level Indicator/ Interface Probe

Onsite equipment for groundwater sampling, water level measuring, and sample preparation will be cleaned prior to and after each use. During cleaning and decontamination, the substitution of higher-grade water for tap water is permitted and does not have to be noted as a variation. The sampling equipment (if not disposable) will be cleaned to prevent the introduction of contaminants according to the following procedure:

1. Wash equipment with a laboratory detergent (i.e., Alquinox®, Liquinox®, or the equivalent) and hot water, using a brush to remove any particulate matter or surface film.
2. Rinse equipment thoroughly with tap water.
3. Rinse equipment thoroughly with de-ionized or organic-free water.
4. Rinse equipment twice with isopropanol and allow to air dry.
5. Rinse equipment with de-ionized water.
6. Wrap equipment in aluminum foil, with dull side in, to prevent contamination during storage or transport to the field.

Sample Packaging, Marking, Labeling, Shipping, and Chain-of-Custody

Samples must be preserved to ensure that the samples are received at the laboratory at a temperature less than or equal to 4°C. Ice will be placed on top of sample containers and the ice chest will be wrapped with duct tape. Custody seals will be applied upon completing the inspection of the ice chest integrity and appropriate documentation.

All samples must be identified using a standard tag attached to the sample container and will include the following information (Appendix C):

- Project name
- Project number
- Sample ID
- Date and time of sample collection
- Sampler name(s)
- Analysis group and/or method
- Preservatives

Chain-of-custody records are used to record the custody of all samples. An example of the chain-of-custody is included as Appendix C. The following information must be supplied in the indicated spaces:

- Client name
- Project number
- Project name and site location
- Sample identification number of all samples included in the shipment
- Sample description
- Date and time of sample collection
- Name, company, and signature of field technician collecting samples
- Name and signature of laboratory custodian receiving the samples

Quality Control

All QC samples are listed in Worksheet #20. In reference to the field tasks, all fieldwork will be overseen by an FTL who is responsible for the QC of the sampling to make sure the proper work plans are followed for each task.

Accuracy and Precision

The QA/QC field program will be continuously implemented during all sampling activities. Prior to beginning any sampling activities, a decontamination area will be designed for cleaning both sampling and storage tools and containers. Upon completion of sampling, samples will be labeled and placed in an ice chest. All of the sampling information will be recorded in the field book and in the chain-of-custody. Decontamination procedures are discussed below and will be followed before moving to another sample location.

Improper sample handling may alter the accuracy of the analytical results. Consequently, the samples will only be collected by persons wearing disposable nitrile or latex gloves. At each sampling point, the sampling personnel will wear new pairs of gloves. Samples will be carefully transferred in the field from the sampling equipment directly into glass containers provided by the laboratory. QA/QC will consist of obtaining equipment blanks, MS/MSDs and field duplicates. Field duplicate samples and equipment blank samples will be collected at a minimum frequency of 10 percent times the total number of samples collected for an analysis and rounded to the nearest whole number. MS/MSDs will be required at a frequency of one per sampling event or a minimum of 5 percent of the total number of samples collected for an analysis and rounded to the nearest whole number.

Equipment Blanks

One equipment blank sample per 10 groundwater samples will be prepared in the field between the collection of two separate samples. A jar containing de-ionized water will be opened in the field and poured over or through cleaned sampling equipment before equipment blank sample collection. The flushing water will be collected in a 1-liter (L) amber bottle and sent to the laboratory for analysis. The equipment blank will constitute a test of effectiveness of sampling equipment decontamination.

Field Duplicates

One sample per 10 groundwater samples will be split into two separate portions. These two samples will be collected at the same time as two separate samples and placed under identical circumstances and treated exactly the same throughout field and laboratory procedures. Analyses of both samples give a measure of the precision associated with sample collection, preservation and storage, as well as with laboratory procedure.

Storage

All analytical data will be stored on AGVIQ-CH2M HILL's SQL Server Data Warehouse, after which the finalized data will be uploaded to the NIRIS database as part of AVGIQ-CH2M HILL final delivery package.

Sample Analysis

The laboratory will maintain, test, inspect, and calibrate analytical instruments (Worksheets #24 and 25). The laboratory will process and prepare samples for analysis. The laboratory will analyze soil samples for various groups of parameters as shown in Worksheets #15 and 18.

Data Management

The Project Database Manager, Duane Johnson, is responsible for data tracking and storage. In addition, a third party data validator will receive 10 percent of all analytical data from the

laboratory, and the remaining 90 percent will be validated internally by the AVGIQ-CH2M HILL data validator prior to its use by the Navy.

Procedures for Recording and Correcting Data

All field data will be recorded in field logbooks and updated in the electronic Field Input Sheets to be uploaded in the Database or recorded electronically via the Mobile Integrated Sample Tracking Personal Digital Assistant for upload in the Database.

Project Assessment/Audit: Worksheets #31 and 32.

Data Validation: Worksheets #35 and 36.

Data Usability Assessment: Worksheet #37.

Remediation Waste Management

Remediation waste will be managed and disposed of in accordance with the Waste Management Plan in the work plan for groundwater sampling at SWMU 7/8.

Environmental Protection Plan

General controls implemented during remediation-related construction activities to prevent pollution and protect the environment are presented in the work plan for groundwater sampling at SWMU 7/8.

Quality Control Plan

Quality control and the sampling inspections associated with SWMU 7/8 are presented in the work plan for groundwater sampling at SWMU 7/8.

Quarterly Groundwater Sample Reporting

Following the certification of the laboratory data by a Puerto Rican chemist and the validation of the laboratory data, AGVIQ-CH2M HILL will submit a letter-report to the PREQB to document the findings obtained during the baseline and quarterly groundwater sampling events. Data results of the groundwater sampling events will be reported in an initial baseline site characterization report, seven quarterly monitoring reports, and an MNA evaluation report at the end of the 2-year sampling period. The reports will include the following:

- Tabulated environmental-media analytical data (water levels/LNAPL thickness and analytical test results)
- Waste characterization sample results
- Map(s) illustrating the horizontal extent of 1,2,4-trimethylbenzene, benzene, and ethylbenzene in groundwater
- An isopach map illustrating the current product distribution and thickness
- A potentiometric map illustrating the direction of groundwater flow

The eighth quarterly report will also include a comprehensive data evaluation to determine if the CAOs for groundwater have been achieved. The report will also include recommendations for additional work if the COC exceed the CAOs.

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SAP Worksheet #15—Reference Limits and Evaluation Table

Analyte	CAS Number	PAL	PAL Reference	Project QL Goal	Laboratory	
					QL	Method Detection Limit (MDL)
Matrix: Groundwater **Analytical Group:** VOCs and MNA Parameters						
Benzene	71-43-2	550 µg/L	Revised Final CMS (Baker, 2005)	275 µg/L	5 µg/L	1 µg/L
Ethylbenzene	100-41-4	1,000 µg/L	Revised Final CMS (Baker, 2005)	500 µg/L	5 µg/L	1 µg/L
1,2,4-Trimethylbenzene	95-63-6	3,300 µg/L	Revised Final CMS (Baker, 2005)	1,650 µg/L	5 µg/L	1 µg/L
Nitrate	14797-55-8	NA	NA	NA	0.15 milligrams per liter (mg/L)	0.05 mg/L
Nitrite	14797-65-0	NA	NA	NA	0.25 mg/L	0.05 mg/L
Sulfate	14808-79-8	NA	NA	NA	5 mg/L	1 mg/L
Sulfide	18496-25-8	NA	NA	NA	2.4 mg/L	0.8 mg/L
TOC	N/A	NA	NA	NA	1.5 mg/L	0.5 mg/L
Alkalinity	N/A	NA	NA	NA	1 mg/L	1 mg/L
Methane	74-82-8	NA	NA	NA	3 µg/L	1 µg/L
Matrix: Groundwater/Soil **Analytical Group:** Liquid and Solid Waste Characterization						
Benzene	71-43-2	0.5 mg/L	40 Code of Federal Regulations (CFR) 261.30 Table 1	0.5 mg/L	0.010	0.003
Butanone, 2- (Methyl ethyl ketone)	78-93-3	200 mg/L	40 CFR 261.30 Table 1	200 mg/L	0.10	0.030
Carbon Tetrachloride	56-23-5	0.5 mg/L	40 CFR 261.30 Table 1	0.5 mg/L	0.010	0.003

SAP Worksheet #15—Reference Limits and Evaluation Table (continued)

Analyte	CAS Number	PAL	PAL Reference	Project QL Goal	Laboratory	
					QL	MDL
Chlorobenzene	108-90-7	100 mg/L	40 CFR 261.30 Table 1	100 mg/L	0.010	0.003
Chloroform (Trichloromethane)	67-66-3	6 mg/L	40 CFR 261.30 Table 1	6 mg/L	0.010	0.003
1,4-Dichlorobenzene	106-46-7	7.5 mg/L	40 CFR 261.30 Table 1	7.5 mg/L	0.010	0.003
Dichloroethane, 1,2 (1,2-DCA)	107-06-2	0.5 mg/L	40 CFR 261.30 Table 1	0.5 mg/L	0.010	0.003
1,1-Dichloroethene	75-35-4	0.7 mg/L	40 CFR 261.30 Table 1	0.7 mg/L	0.010	0.003
Tetrachloroethene	127-18-4	0.7 mg/L	40 CFR 261.30 Table 1	0.7 mg/L	0.010	0.003
Trichloroethene (TCE)	79-01-6	0.5 mg/L	40 CFR 261.30 Table 1	0.5 mg/L	0.010	0.003
Vinyl Chloride	75-01-4	0.2 mg/L	40 CFR 261.30 Table 1	0.2 mg/L	0.010	0.003
Cresol	NA	200 mg/L	40 CFR 261.30 Table 1	200 mg/L	0.050	0.010
2,4-Dinitrotoluene	121-14-2	0.1 mg/L	40 CFR 261.30 Table 1	0.1 mg/L	0.050	0.010
Hexachlorobenzene	118-74-1	0.1 mg/L	40 CFR 261.30 Table 1	0.1 mg/L	0.050	0.010
Hexachlorobutadiene	87-68-3	0.5 mg/L	40 CFR 261.30 Table 1	0.5 mg/L	0.050	0.010
Hexachloroethane	67-72-1	3 mg/L	40 CFR 261.30 Table 1	3 mg/L	0.050	0.010
Nitrobenzene	98-95-3	2 mg/L	40 CFR 261.30 Table 1	2 mg/L	0.050	0.010
Pentachlorophenol	87-86-5	100 mg/L	40 CFR 261.30 Table 1	100 mg/L	0.20	0.020
Pyridine	110-86-1	5 mg/L	40 CFR 261.30 Table 1	5 mg/L	0.20	0.020
2,4,5-Trichlorophenol	95-95-4	400 mg/L	40 CFR 261.30 Table 1	400 mg/L	0.050	0.010
2,4,6-Trichlorophenol	88-06-2	2 mg/L	40 CFR 261.30 Table 1	2 mg/L	0.050	0.010
Chlordane, technical	57-74-9	0.03 mg/L	40 CFR 261.30 Table 1	0.03 mg/L	0.0005	0.0001
Endrin	72-20-8	0.02 mg/L	40 CFR 261.30 Table 1	0.02 mg/L	0.0001	0.00003

SAP Worksheet #15—Reference Limits and Evaluation Table (continued)

Analyte	CAS Number	PAL	PAL Reference	Project QL Goal	Laboratory	
					QL	MDL
HCH, gamma- (BHC, gamma-) (Lindane)	58-89-9	0.4 mg/L	40 CFR 261.30 Table 1	0.4 mg/L	0.0001	0.00003
Heptachlor	76-44-8	0.008 mg/L	40 CFR 261.30 Table 1	0.008 mg/L	0.0001	0.00003
Heptachlor epoxide	1024-57-3	0.008 mg/L	40 CFR 261.30 Table 1	0.008 mg/L	0.0001	0.00003
Methoxychlor	72-43-5	10 mg/L	40 CFR 261.30 Table 1	10 mg/L	0.0001	0.00003
Toxaphene	8001-35-2	0.5 mg/L	40 CFR 261.30 Table 1	0.5 mg/L	0.010	0.002
2,4-D	94-75-7	10 mg/L	40 CFR 261.30 Table 1	10 mg/L	0.010	0.003
2,4,5-TP (Silvex)	93-72-1	1 mg/L	40 CFR 261.30 Table 1	1 mg/L	0.001	0.0002
Arsenic	7440-38-2	5 mg/L	40 CFR 261.30 Table 1	5 mg/L	0.1	0.03
Barium	7440-39-3	100 mg/L	40 CFR 261.30 Table 1	100 mg/L	0.4	0.05
Cadmium	7440-43-9	1 mg/L	40 CFR 261.30 Table 1	1 mg/L	0.05	0.01
Chromium (total)	7440-47-3	5 mg/L	40 CFR 261.30 Table 1	5 mg/L	0.1	0.02
Lead	7439-92-1	5 mg/L	40 CFR 261.30 Table 1	5 mg/L	0.03	0.01
Mercury	7439-97-6	0.2 mg/L	40 CFR 261.30 Table 1	0.2 mg/L	0.002	0.0008
Selenium	7782492	1 mg/L	40 CFR 261.30 Table 1	1 mg/L	0.1	0.03
Silver	7440224	5 mg/L	40 CFR 261.30 Table 1	5 mg/L	0.1	0.01
Aroclor-1016	12674-11-2	50 mg/L or 50 milligrams per kilogram (mg/kg)	40 CFR 761.2	50 mg/L or 50 mg/kg	0.0005 mg/L or 0.017 mg/kg	0.00015 mg/L or 0.005 mg/kg
Aroclor-1221	11104-28-2	50 mg/L or 50 mg/kg	40 CFR 761.2	50 mg/L or 50 mg/kg	0.0005 mg/L or 0.017 mg/kg	0.00015 mg/L or 0.005 mg/kg
Aroclor-1232	11141-16-5	50 mg/L or 50 mg/kg	40 CFR 761.2	50 mg/L or 50 mg/kg	0.0005 mg/L or 0.017 mg/kg	0.00015 mg/L or 0.005 mg/kg

SAP Worksheet #15—Reference Limits and Evaluation Table (continued)

Analyte	CAS Number	PAL	PAL Reference	Project QL Goal	Laboratory	
					QL	MDL
Aroclor-1242	53469-21-9	50 mg/L or 50 mg/kg	40 CFR 761.2	50 mg/L or 50 mg/kg	0.0005 mg/L or 0.017 mg/kg	0.00015 mg/L or 0.005 mg/kg
Aroclor-1248	12672-29-6	50 mg/L or 50 mg/kg	40 CFR 761.2	50 mg/L or 50 mg/kg	0.0005 mg/L or 0.017 mg/kg	0.00015 mg/L or 0.005 mg/kg
Aroclor-1254	11097-69-1	50 mg/L or 50 mg/kg	40 CFR 761.2	50 mg/L or 50 mg/kg	0.0005 mg/L or 0.017 mg/kg	0.00015 mg/L or 0.005 mg/kg
Aroclor-1260	11096-82-5	50 mg/L or 50 mg/kg	40 CFR 761.2	50 mg/L or 50 mg/kg	0.0005 mg/L or 0.017 mg/kg	0.00015 mg/L or 0.005 mg/kg
Ignitability	N/A	140	40 CFR 261.4	140	158	NA
Corrosivity	N/A	0<pH<14	40 CFR 261.4	2<pH<12.5	NA	NA
Reactivity/Cyanide	57-12-5	NA	NA	NA	0.01 mg/L	0.005 mg/L
Reactivity/Sulfide	N/A	NA	NA	NA	57 mg/L	19 mg/L

SAP Worksheet #16—Project Schedule

Activity ID	Activity Name	Start	Finish
WBS	JM04 P.R.B1 Baseline Site Characteristics		
B1	Mobe & Site Prep	5/17/2010	5/17/2010
B2	Site-Wide Groundwater Gauging Event	5/18/2010	5/18/2010
B3	Groundwater Sampling at Designated Wells	5/19/2010	5/27/2010
B4	Demobe	5/27/2010	5/27/2010
B5	Laboratory Analysis/ Data Validation	5/28/2010	7/9/2010
B6	Baseline Site Characterization Report	7/12/2010	7/30/2010
WBS	JM04 P.R.Q1 Quarterly Sampling Event		
Q11	Mobe & Site Prep	8/16/2010	8/16/2010
Q12	Site-Wide Groundwater Gauging Event	8/17/2010	8/17/2010
Q13	Groundwater Sampling at Designated Wells	8/18/2010	8/26/2010
Q14	Demobe	8/26/2010	8/26/2010
Q15	Laboratory Analysis/ Data Validation	8/27/2010	10/1/2010
Q16	Q1 Quarterly Sampling Report	10/4/2010	10/22/2010
WBS	JM04 P.R.Q2 Quarterly Sampling Event		
Q21	Mobe & Site Prep	11/8/2010	11/8/2010
Q22	Site-Wide Groundwater Gauging Event	11/9/2010	11/9/2010
Q23	Groundwater Sampling at Designated Wells	11/10/2010	11/18/2010
Q24	Demobe	11/18/2010	11/18/2010
Q25	Laboratory Analysis/ Data Validation	11/19/2010	12/31/2010
Q26	Q2 Characterization Report	1/3/2011	1/21/2011
WBS	JM04 P.R.Q3 Quarterly Sampling Event		
Q31	Mobe & Site Prep	2/14/2011	2/14/2011
Q32	Site-Wide Groundwater Gauging Event	2/15/2011	2/15/2011
Q33	Groundwater Sampling at Designated Wells	2/16/2011	2/24/2011
Q34	Demobe	2/24/2011	2/24/2011
Q35	Laboratory Analysis/ Data Validation	2/25/2011	4/8/2011
Q36	Q3 Quarterly Sampling Report	4/11/2011	4/29/2011
WBS	JM04 P.R.Q4 Quarterly Sampling Event		
Q41	Mobe & Site Prep	5/16/2011	5/16/2011
Q42	Site-Wide Groundwater Gauging Event	5/17/2011	5/17/2011
Q43	Groundwater Sampling at Designated Wells	5/18/2011	5/26/2011

Activity ID	Activity Name	Start	Finish
Q44	Demobe	5/26/2011	5/26/2011
Q45	Laboratory Analysis/ Data Validation	5/27/2011	7/8/2011
Q46	Q4 Quarterly Sampling Report	7/11/2011	7/29/2011
WBS	JM04 P.R.Q5 Quarterly Sampling Event		
Q51	Mobe & Site Prep	8/15/2011	8/15/2011
Q52	Site-Wide Groundwater Gauging Event	8/16/2011	8/16/2011
Q53	Groundwater Sampling at Designated Wells	8/17/2011	8/25/2011
Q54	Demobe	8/25/2011	8/25/2011
Q55	Laboratory Analysis/ Data Validation	8/26/2011	10/7/2011
Q56	Q5 Quarterly Sampling Report	10/10/2011	10/28/2011
WBS	JM04 P.R.Q6 Quarterly Sampling Event		
Q61	Mobe & Site Prep	11/7/2011	11/7/2011
Q62	Site-Wide Groundwater Gauging Event	11/8/2011	11/8/2011
Q63	Groundwater Sampling at Designated Wells	11/9/2011	11/17/2011
Q64	Demobe	11/17/2011	11/17/2011
Q65	Laboratory Analysis/ Data Validation	11/18/2011	12/30/2011
Q66	Q6 Quarterly Sampling Report	1/2/2012	1/20/2012
WBS	JM04 P.R.Q7 Quarterly Sampling Event		
Q71	Mobe & Site Prep	2/13/2012	2/13/2012
Q72	Site-Wide Groundwater Gauging Event	2/14/2012	2/14/2012
Q73	Groundwater Sampling at Designated Wells	2/15/2012	2/23/2012
Q74	Demobe	2/23/2012	2/23/2012
Q75	Laboratory Analysis/ Data Validation	2/24/2012	4/6/2010
Q76	Q7 Quarterly Sampling Report	4/9/2010	4/27/2010
WBS	JM04 P.R.Q8 Quarterly Sampling Event		
Q81	Mobe & Site Prep	5/14/2012	5/14/2012
Q82	Site-Wide Groundwater Gauging Event	5/15/2012	5/15/2012
Q83	Groundwater Sampling at Designated Wells	5/16/2012	5/24/2012
Q84	Demobe	5/24/2012	5/24/2012
Q85	Laboratory Analysis/ Data Validation	5/25/2012	7/6/2012
Q86	Q8 Quarterly Sampling Report	7/9/2012	7/27/2012

SAP Worksheet #17—Sampling Design and Rationale

A baseline groundwater characterization event and eight quarterly groundwater sampling events will be conducted at SWMU 7/8. The samples will be labeled based on the monitoring well location ID. In addition to the well location ID information, the task order (JM04), sampling event (baseline [BL], 1st quarterly event [Q1], Q2, Q3, Q4, Q5, Q6, Q7, and Q8), and sampling date will be added to the sample nomenclature. For example, for a groundwater sample collected during the second quarterly sampling event at monitoring well 7MW16, the sample ID would be labeled JM04-Q2-7MW16-mmddyy.

The rationale for the matrices to be sampled, the number of samples per matrix, the analytical groups, and the concentration levels are discussed in Worksheets #10, 11, 14, and 15. The tentative sampling locations for the groundwater sampling at SWMU 7/8 are shown on Figure 10 in Appendix A.

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SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table

Sampling Location	ID Number	Matrix	Depth (feet)	Analytical Group	No. Samples	Sampling SOP Reference[a]
CHMW01	JM04-BL-CHMW01-mmddyy or JM04-Q#-CHMW01-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
CHMW02	JM04-BL-CHMW02-mmddyy or JM04-Q#-CHMW02-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
CHMW03	JM04-BL-CHMW03-mmddyy or JM04-Q#-CHMW03-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
CHMW04	JM04-BL-CHMW04-mmddyy or JM04-Q#-CHMW04-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
CHMW05	JM04-BL-CHMW05-mmddyy or JM04-Q#-CHMW05-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
CHMW06	JM04-BL-CHMW06-mmddyy or JM04-Q#-CHMW06-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
CHMW09	JM04-BL-CHMW09-mmddyy or JM04-Q#-CHMW09-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
CHMW11	JM04-BL-CHMW11-mmddyy or JM04-Q#-CHMW11-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
CHMW12	JM04-BL-CHMW12-mmddyy or JM04-Q#-CHMW12-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
CHRW06	JM04-BL-CHRW06-mmddyy or JM04-Q#-CHRW06-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
CHRW09	JM04-BL-CHRW09-mmddyy or JM04-Q#-CHRW09-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

Sampling Location	ID Number	Matrix	Depth (feet)	Analytical Group	No. Samples	Sampling SOP Reference[a]
CHRW25	JM04-BL-CHRW25-mmddyy or JM04-Q#-CHRW25-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
CHRW31	JM04-BL-CHRW31-mmddyy or JM04-Q#-CHRW31-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
CHRW41	JM04-BL-CHRW41-mmddyy or JM04-Q#-CHRW41-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
CHRW44	JM04-BL-CHRW44-mmddyy or JM04-Q#-CHRW44-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
7MW05	JM04-BL-7MW05-mmddyy or JM04-Q#-7MW05-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
7MW06	JM04-BL-7MW06-mmddyy or JM04-Q#-7MW06-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
7MW15	JM04-BL-7MW15-mmddyy or JM04-Q#-7MW15-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
7MW18	JM04-BL-7MW18-mmddyy or JM04-Q#-7MW18-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
GW02	JM04-BL-GW02-mmddyy or JM04-Q#-GW02-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
GW04	JM04-BL-GW04-mmddyy or JM04-Q#-GW04-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

Sampling Location	ID Number	Matrix	Depth (feet)	Analytical Group	No. Samples	Sampling SOP Reference[a]
UGW06	JM04-BL-UGW06-mmddyy or JM04-Q#-UGW06-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
UGW07	JM04-BL-UGW07-mmddyy or JM04-Q#-UGW07-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
UGW15	JM04-BL-UGW15-mmddyy or JM04-Q#-UGW15-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
UGW20R	JM04-BL-UGW20R-mmddyy or JM04-Q#-UGW20R-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
UGW32	JM04-BL-UGW32-mmddyy or JM04-Q#-UGW32-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
UGW34	JM04-BL-UGW34-mmddyy or JM04-Q#-UGW34-mmddyy	Groundwater/BL, Q4, and Q8	NA	VOCs[b], sulfide, sulfate, alkalinity, nitrate + nitrite, TOC, methane	1	See Appendix B
CHMW01	JM04-Q#- CHMW01-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
CHMW02	JM04-Q#-CHMW02-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
CHMW03	JM04-Q#-CHMW03-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
CHMW04	JM04-Q#-CHMW04-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
CHMW05	JM04-Q#-CHMW05-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

Sampling Location	ID Number	Matrix	Depth (feet)	Analytical Group	No. Samples	Sampling SOP Reference[a]
CHMW06	JM04-Q#-CHMW06-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
CHMW09	JM04-Q#-CHMW09-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
CHMW11	JM04-Q#-CHMW11-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
CHMW12	JM04-Q#-CHMW12-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
CHRW06	JM04-Q#-CHRW06-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
CHRW09	JM04-Q#-CHRW09-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
CHRW25	JM04-Q#-CHRW25-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
CHRW31	JM04-Q#-CHRW31-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
CHRW41	JM04-Q#-CHRW41-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
CHRW44	JM04-Q#-CHRW44-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
7MW05	JM04-Q#-7MW05-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

Sampling Location	ID Number	Matrix	Depth (feet)	Analytical Group	No. Samples	Sampling SOP Reference[a]
7MW06	JM04-Q#-7MW06-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
7MW15	JM04-Q#-7MW15-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
7MW18	JM04-Q#-7MW18-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
GW02	JM04-Q#-GW02-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
GW04	JM04-Q#-GW04-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
UGW06	JM04-Q#-UGW06-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
UGW07	JM04-Q#-UGW07-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
UGW15	JM04-Q#-UGW15-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
UGW20R	JM04-Q#-UGW20R-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
UGW32	JM04-Q#-UGW32-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B
UGW34	JM04-Q#-UGW34-mmddyy	Groundwater/ Quarterly Sampling Events (Q1, Q2, Q3, Q5, Q6, and Q7)	NA	VOCs[b]	1 per sampling event	See Appendix B

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

Sampling Location	ID Number	Matrix	Depth (feet)	Analytical Group	No. Samples	Sampling SOP Reference[a]
NA	JM04-BL-7/8SLW-mmddyy	Soil Waste	NA	Toxicity compounds (see Worksheet #15 for specific compounds), reactivity (sulfide and cyanide), ignitability, and corrosivity as pH	1 per 10 drums	See Worksheet #14
NA	JM04-BL-7/8AQA-mmddyy	Aqueous Waste	NA	RCRA compounds (see Worksheet #15 for specific compounds), reactivity (sulfide and cyanide), ignitability, and corrosivity as pH	1 per tank	See Worksheet #14

Notes:

[a] The SOP describes the sample collection procedures.
[b] VOC list consists of 1,2,4-trimethylbenzene, benzene, and ethylbenzene.

SAP Worksheet #19—Analytical SOP Requirements Table

Matrix	Analytical Group	Analytical and Preparation Method/SOP Reference	Containers	Sample Volume	Preservation Requirements	Maximum Holding Time
Groundwater	1,2,4-Trimethylbenzene, Benzene and Ethylbenzene	SW 5030B, 8260B/SOP-202	(3) 40-mL vials	5 mL	pH less than 2 with HCl, between 2°C and 6°C	14 days
	Sulfate, Nitrate, Nitrite	EPA 300.0/SOP-145	250-mL plastic	100 mL	Between 2°C and 6°C	28 days for sulfate; 48 hours for nitrate, nitrite
	Sulfide	SM 4500S-F/SOP-153	1,000-mL glass	500 mL	Between 2°C and 6°C, pH greater than 9 with NaOH and Zinc Acetate	7 days
	TOC	SM 5310C/SOP-221	250-mL plastic	40 mL	pH less than 2 with HCl or H_2SO_4, between 2°C and 6°C	28 days
	Methane	RSK-175/SOP-236	(3) 40-mL vials	15 mL	pH less than 2 with HCl, between 2°C and 6°C	14 days
	Alkalinity	SM 2320B/SOP-154	250-mL plastic	50 mL	Cool 4°C	14 days
Aqueous	VOCs – RCRA compounds (see Worksheet #15 for specific compounds).	SW 846 8260B/SOP-202	(3) 40-ml vials	5 mL	pH less than 2 with HCl, between 2°C and 6°C	14 days
	SVOCs – RCRA compounds (see Worksheet #15 for specific compounds).	SW 846 3510,8270C/SOP-201	1-L amber glass	100 mL	Between 2°C and 6°C	7 days extract/ 40 days analysis

SAP Worksheet #19—Analytical SOP Requirements Table (continued)

Matrix	Analytical Group	Analytical and Preparation Method/SOP Reference	Containers	Sample Volume	Preservation Requirements	Maximum Holding Time
Aqueous	Pesticides – RCRA compounds (see Worksheet #15 for specific compounds).	SW 846 3510,8081A/SOP-211	1-L amber glass	100 mL	Between 2°C and 6°C	7 days extract/ 40 days analysis
	Herbicides – RCRA compounds (see Worksheet #15 for specific compounds).	SW 846 3510,8151A/SOP-208	1-L amber glass	100 mL	Between 2°C and 6°C	7 days extract/ 40 days analysis
	Metals – RCRA compounds (see Worksheet #15 for specific compounds).	SW 846 6010B,7470A/SOP-100/105/103	250-mL plastic	150 mL	Between 2°C and 6°C, nitric acid to pH less than 2	180 days; 28 days-mercury
	Polychlorinated biphenyls (PCBs) – RCRA compounds (see Worksheet #15 for specific compounds).	SW 846 3510/8082/SOP-211	1-L amber glass	1000 mL	Between 2°C and 6°C	7 days extract/ 40 days analysis
	Ignitability	SW 846 1010A/SOP-149	250-mL plastic	50 mL	Between 2°C and 6°C	As soon as possible (ASAP)
	Corrosivity	SW 846 9045/SOP-187	250-mL plastic	100 mL	Between 2°C and 6°C	ASAP
	Reactive Cyanide	SW 846 9012A/SOP-164/175	250-mL plastic	100 mL	Between 2°C and 6°C, sodium hydroxide (NaOH) to pH greater than 12	ASAP
	Reactive Sulfide	SW 846, Chap.7, Sect.7.3.4/SOP-156	250-mL plastic	100 mL	Between 2°C and 6°C, NaOH to pH greater than 12, zinc acetate	ASAP

SAP Worksheet #19—Analytical SOP Requirements Table (continued)

Matrix	Analytical Group	Analytical and Preparation Method/SOP Reference	Containers	Sample Volume	Preservation Requirements	Maximum Holding Time
Solid/Soil	Toxicity Characteristic Leaching Procedure (TCLP) – VOC	SW-846 1311/8260B/SOP-198/202	4-ounce (oz) glass	25 grams (g)	Between 2°C and 6°C	14 days extract/ 14 days analysis
	TCLP – SVOCs	SW-846 1311/3510C/8270C/ SOP-198/201	4-oz glass	100 g	Between 2°C and 6°C	14 days TCLP extract /7 to prep extract /40 days analysis
	TCLP – Organochlorine Pesticides	SW-846 1311/3510C/8081A/ SOP-198/211	4-oz glass	100 g	Between 2°C and 6°C	14 days TCLP extract /7 to prep extract /40 days analysis
	TCLP – Herbicides	SW-846 1311/3510C/8151A/ SOP-198/208	4-oz glass	100 g	Between 2°C and 6°C	14 days TCLP extract /7 to prep extract /40 days analysis
	TCLP – Metals	SW-846 1311/3010A/6010B/ 7000 Series/SOP-198/100/105/103	4-oz glass	100 g	Between 2°C and 6°C	180 TCLP extract/180 days analysis; 28 TCLP extract/28 days analysis
	PCBs	SW-846 8082/ SOP-211	4-oz glass	15 g	Between 2°C and 6°C	14 days extract/14 days analysis
	Corrosivity	SW-846 9045C/ SOP-187	4-oz glass	20 g	Between 2°C and 6°C	Immediate
	Ignitability	SW-846 1010A/1030/ SOP-149	4-oz glass	20 g	Between 2°C and 6°C	Immediate
	Reactivity Cyanide	SW-846 7.3.4.2 SOP-164/175	4-oz glass	1.0 g	Between 2°C and 6°C	Immediate
	Reactivity Sulfide	SW-846 7.3.4.1/ SOP-156	4-oz glass	10 g	Between 2°C and 6°C	Immediate

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SAP Worksheet #20—Field Quality Control Sample Summary Table

Matrix	Analytical Group	No. of Sampling Locations	No. of Field Duplicates	No. of MS/MSDs	No. of Field Blanks	No. of Equip. Blanks	No. of VOC Trip Blanks	No. of Proficiency Testing Samples	Total No. of Samples to Lab
Quarterly Groundwater Monitoring									
Groundwater	Select VOCs[a]	27	3	2 MS/ 2 MSD	0	3	4 (1 for each day of sample shipment)	0	328 (8 total sampling events)
	Nitrate, Nitrite, and Sulfate	27	3	0	0	3	NA	0	99
	TOC	27	3	0	0	3	NA	0	99
	Sulfide	27	3	0	0	3	NA	0	99
	Methane	27	3	0	0	3	NA	0	99
	Alkalinity	27	3	0	0	3	NA	0	99
Liquid Waste Characterization									
Aqueous	VOCs – RCRA compounds (see Worksheet #15 for specific compounds).	20	NA	NA	NA	NA	NA	NA	20

SAP Worksheet #20—Field Quality Control Sample Summary Table (continued)

Matrix	Analytical Group	No. of Sampling Locations	No. of Field Duplicates	No. of MS/MSDs	No. of Field Blanks	No. of Equip. Blanks	No. of VOC Trip Blanks	No. of Proficiency Testing Samples	Total No. of Samples to Lab
Aqueous	SVOCs – RCRA compounds (see Worksheet #15 for specific compounds).	20	NA	NA	NA	NA	NA	NA	20
	Pesticides – RCRA compounds (see Worksheet #15 for specific compounds).	20	NA	NA	NA	NA	NA	NA	20
	Herbicides – RCRA compounds (see Worksheet #15 for specific compounds).	20	NA	NA	NA	NA	NA	NA	20
	Metals – RCRA compounds (see Worksheet #15 for specific compounds).	20	NA	NA	NA	NA	NA	NA	20
	PCBs – RCRA compounds (see Worksheet #15 for specific compounds).	20	NA	NA	NA	NA	NA	NA	20
	Ignitability	20	NA	NA	NA	NA	NA	NA	20
	Corrosivity	20	NA	NA	NA	NA	NA	NA	20
	Reactive Cyanide	20	NA	NA	NA	NA	NA	NA	20

SAP Worksheet #20—Field Quality Control Sample Summary Table (continued)

Matrix	Analytical Group	No. of Sampling Locations	No. of Field Duplicates	No. of MS/MSDs	No. of Field Blanks	No. of Equip. Blanks	No. of VOC Trip Blanks	No. of Proficiency Testing Samples	Total No. of Samples to Lab
Aqueous	Reactive Sulfide	20	NA	NA	NA	NA	NA	NA	20
Soil Waste Characterization									
Solid/Soil	TCLP – VOC	10	NA	NA	NA	NA	NA	NA	10
	TCLP – Semivolatile Organic Compounds	10	NA	NA	NA	NA	NA	NA	10
	TCLP – Organochlorine Pesticides	10	NA	NA	NA	NA	NA	NA	10
	TCLP – Herbicides	10	NA	NA	NA	NA	NA	NA	10
	TCLP- Metals	10	NA	NA	NA	NA	NA	NA	10
	PCBs	10	NA	NA	NA	NA	NA	NA	10
	Corrosivity	10	NA	NA	NA	NA	NA	NA	10

SAP Worksheet #20—Field Quality Control Sample Summary Table (continued)

Matrix	Analytical Group	No. of Sampling Locations	No. of Field Duplicates	No. of MS/MSDs	No. of Field Blanks	No. of Equip. Blanks	No. of VOC Trip Blanks	No. of Proficiency Testing Samples	Total No. of Samples to Lab
Solid/Soil	Ignitability	10	NA	NA	NA	NA	NA	NA	10
	Reactivity Cyanide	10	NA	NA	NA	NA	NA	NA	10
	Reactivity Sulfide	10	NA	NA	NA	NA	NA	NA	10

Notes:
[a] Sampling for the baseline event and each of eight quarterly events will consist of: 27 samples, plus QC for all parameters.

SAP Worksheet #21—Project Sampling SOP Reference Table

Reference Number	Title, Revision Date, and/or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
SESDGUID-101-RO	Monitoring Well Installation	AGVIQ-CH2M HILL	Drill rig	N	Survey of monitoring wells will be conducted as indicated on Worksheet #14. See Appendix B for SOP, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), 2001.
SESDPROC-301-R1	Groundwater Sampling	AGVIQ-CH2M HILL	Groundwater sampling pumps and tubing	N	See Worksheet #18 for all groundwater sampling locations and Appendix B for groundwater sampling SOP.(EISOPQAM, 2001).
SESDPROC-202-R1	Soil Waste Characterization	AGVIQ-CH2M HILL	Stainless steel spoon and bowl	Y	See Appendix B for SOPs (EISOPQAM, 2001) and Worksheet #14.
Reference number not available.	Aqueous Waste Characterization	AGVIQ-CH2M HILL	None	N	See Worksheet #14 for sampling procedures.
SESDPROC-205-R1	Decontamination of Drilling Rigs and Equipment	AGVIQ-CH2M HILL	Pressure washer	N	See Appendix B for SOPs (EISOPQAM, 2001).
SESDPROC-205-R1	Decontamination of Personnel and Equipment	AGVIQ-CH2M HILL	Decontaminate equipment	N	See Appendix B for SOPs (EISOPQAM, 2001).

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SAP Worksheet #22—Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment	Calibration Activity	Maintenance Frequency	Testing/Inspection Activity	Frequency	Acceptance Criteria	CA	Responsible Person
YSI™ multi-meter	Calibrate probe using multiple calibration standard solutions.	Calibrate mechanical and electronic parts, verify system continuity, check battery, and clean probes. Calibration check.	Visual Inspection	Daily before use, at the end of the day, and when unstable readings occur	Stable readings after 3 minutes pH read 4.0 +/- 3% Conductivity reads 4.49 +/- 3%	Clean probe with de-ionized water and calibrate again. Do not use this instrument if unable to calibrate properly.	FTL
Colorimeter for Ferrous Iron Testing	No calibration required.	Replace batteries when needed.	Visual Inspection	NA	Ferrous iron sample must be less than 3 mg/L.	If ferrous iron sample is greater than 3 mg/L, then solution will need to be diluted and reanalyzed.	FTL
Photoionization detector	Calibrate using ambient air and isobutylene 100-parts per million (ppm) calibration gas.	Recharge battery daily.	Visual Inspection	Daily, before use	Ambient air reads 0.0 ppm +/- 3% Isobutylene gas reads 100 ppm +/- 3%	Follow instructions in manual to clean sensor. Do not use this instrument if unable to calibrate properly.	FTL
Flame ionization detector (FID)	Calibrate using ambient air and isobutylene 100-ppm calibration gas.	Recharge battery daily.	Visual Inspection	Daily, before use	Methane gas reads 100 ppm +/- 3%	Follow instructions in manual to clean sensor. Do not use this instrument if unable to calibrate properly.	FTL

SAP Worksheet #22—Field Equipment Calibration, Maintenance, Testing, and Inspection Table (continued)

Field Equipment	Calibration Activity	Maintenance Frequency	Testing/Inspection Activity	Frequency	Acceptance Criteria	CA	Responsible Person
Groundwater sampling pumps and tubing	No calibration required. An absorbance testing standard will be purchased from the manufacturer and used daily to ensure instrument is functioning properly.	NA	Inspect pumps, tubing and air/sample line quick-connects	Regularly	Maintained in good working order per manufacturer's recommendations	Replace items.	FTL
Interface probe/water level meter	Calibration will be performed by the equipment supplier. Supplier to provide calibration sheet to document the equipment performs within manufacturer's-specifications.	NA	Test function in accordance with owners' manual	Regularly	Maintained in good working order per manufacturer's recommendations	Follow trouble shooting guidelines in owners' manual. If functionality cannot be restored in the field replace meter	FTL

SAP Worksheet #23—Analytical SOP References Table

Lab SOP Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
Empirical SOP-100	Metals Digestion/Preparation Methods 3005A,3010A, 3020A, 3030, 3040A, 3050B, USEPA CLP ILMO 4.1 Aqueous & Soil/Sediment, USEPA Method 200.7 (Standard Methods) 3030C. Rev. 19	Definitive	Inorganic/Metals	NA/ Metals	Empirical	N
Empirical SOP-105	Metals Analysis by ICP Technique Methods 200.7, SW846 6010B, SM 19th Edition 2340B, USEPA ILMO 4.1, Rev. 15	Definitive	Inorganic/Metals	Inductively coupled plasma (ICP)	Empirical	N
Empirical SOP-103	Mercury Analysis in Water by Manual Cold Vapor Technique Methods SW846 7470A & 245.1, CLP-M 4.1, Rev. 16	Definitive	Inorganic/Metals	Flow injection mercury system (FIMS)	Empirical	N
Empirical SOP-104	Mercury Analysis in Soil/Sediment by Manual Cold Vapor Technique Methods SW846 7471A & 245.5, CLP-ILM 4.1, Rev. 17	Definitive	Inorganic/Metals	FIMS	Empirical	N
Empirical SOP-145	Determination of Inorganic Anions in water by ION Chromatography using Dionex DX-500 Ion Chromatograph with Hydroxide Eluent And Dionex Column AS18, Method 300.0 Guidance, Rev. 6	Definitive	Inorganic/Anions	Ion Chromatograph (IC)	Empirical	N
Empirical SOP-149	Flashpoint Ignitibility Method SW-846 1010, Rev. 3	Definitive	Inorganic	Flashpoint Tester	Empirical	N
Empirical SOP-153	Sulfide Method 376.1 and Standard Methods SM4500S-2 F(19th ED) (Titrimetric, Iodine) with Sample Pretreatment to Remove Interfering Substances or to Concentrate the Sulfide, Rev. 3	Definitive	Inorganic	NA	Empirical	N
Empirical SOP-154	Alkalinity by EPA Method 310.1, SM2320B, Rev. 5	Definitive	Inorganic	pH Meter	Empirical	N

SAP Worksheet #23—Analytical SOP References Table (continued)

Lab SOP Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
Empirical SOP-156	Reactive Sulfide Method SW-846, Chapter 7, Section 7.3.4, Rev. 4	Definitive	Inorganic	NA	Empirical	N
Empirical SOP-164	Distillation of Aqueous/Solid Samples for Total and Non-Amenable Cyanide Analysis Methods 335.1/335.4, SW-846 9012A/USEPA CLP ILMO 4.1, Rev. 14	Definitive	Inorganic	Lachat	Empirical	N
Empirical SOP-175	Post-Distillation Analysis for Cyanide By the LACHAT Methods 335.4;SW846 9012A;USEPA-CLP 4.1;Addendum for USEPA CLP ILM 05.2 Aqueous & Soil/Sediment, Rev. 9	Definitive	Wet Chem	Lachat	Empirical	N
Empirical SOP-187	Electrometric Determination of pH, Methods 150.1, Standard Methods 4500H+B and 9040B for Waters, Liquids and Liquid Wastes, 9045C for Soils and Solids Wastes, Rev. 7	Definitive	Wet Chem	pH Meter	Empirical	N
Empirical SOP-198	Toxicity Character Leaching Procedure (Method 1311), Rev. 6	Definitive	Inorganic	NA	Empirical	N
Empirical SOP-201	GC/MS Semivolatiles by Method 625 and SW846 Method 8270C, Rev. 18	Definitive	Organic/GC/MS	Agilent/Hewlett Packard (HP) gas chromatograph/ mass spectrometer (GC/MS)	Empirical	N
Empirical SOP-202	GC/MS Volatiles by Method 624 and SW846 Method 8260B, Rev. 21	Definitive	Organic/GC/MS	Agilent/HP GC/MS	Empirical	N
Empirical SOP-208	GC/ECD Chlorinated Herbicides by SW846 Method 8150B/8151A, Rev. 13	Definitive	Organic/GC	Agilent/HP GC/electron capture donor (ECD)	Empirical	N

SAP Worksheet #23—Analytical SOP References Table (continued)

Lab SOP Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
Empirical SOP-211	GC/ECD Organochlorine Pesticides/PCBs by EPA Method 608 and SW846 Method 8081A, 8081B/8082, 8082A, Rev. 20	Definitive	Organic/GC	Agilent/HP GC/ECD	Empirical	N
Empirical SOP-221	Total Organic Carbon SM5310C, USEPA Method 415.1 and SW846 Method 9060/9060A and Lloyd Kahn Method, Rev. 8	Definitive	Inorganic	TOC Analyzer	Empirical	N
Empirical SOP-236	Methane, Ethane, Ethene in Aqueous Samples by Modified RSK-175 (Automated Headspace), Rev.1	Definitive	Organic/GC	Agilent/HP GC/FID	Empirical	N
Empirical SOP-300	GC/MS- Semivolatile BNA-Aqueous Matrix Extraction Using SW-846 Method 3510C for 8270C/625 Analysis, Rev. 17	Definitive	Organic/Extraction	NA/Extraction	Empirical	N
Empirical SOP-302	Pesticide/PCBs – Aqueous Matrix Extraction for EPA Method 608 and SW846 Method 8081A/8082 Using SW846 Method 3510C, Rev. 16	Definitive	Organic/Extraction	NA/Extraction	Empirical	N
Empirical SOP-304	Herbicides Aqueous Matrix by EPA Method SW846 8151A, Rev. 11	Definitive	Organic/Extraction	NA/Extraction	Empirical	N
Empirical SOP-329	Soxhlet Extraction- BNA and Pest/PCB Using SW-846 Method 3541, Rev. 16	Definitive	Organic/Extraction	NA/Extraction	Empirical	N
Empirical SOP-404	Laboratory Sample Receiving Log-in and Storage Standard Operating Procedures, Rev. 11	Definitive	Log-in	NA/ Log-in	Empirical	N
EmpiricalSOP-405	Analytical Laboratory Waste Disposal, Rev. 4	Definitive	Log-in	NA/ Log-in	Empirical	N
Empirical SOP-410	Standard Operating Procedures for Laboratory Sample Storage, Secure Areas, and Sample Custody, Rev. 6	Definitive	Log-in	NA/ Log-in	Empirical	N

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SAP Worksheet #24—Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
GC/MS – VOCs	Initial Calibration (ICAL)	Calibrate the instrument when it is received and after a major change or if the daily calibration fails. A minimum 5 point calibration is required.	The percent relative standard deviation (RSD) for each calibration check compound (CCC) must be less than 30 percent. The minimum mean response factor (RF) for each system performance check compound (SPCC) must meet that stated in 8260B. If the RSD for an analyte is greater than 15 percent, use a linear curve (greater than 0.995 correlation) or quadratic curve (greater than 0.99 correlation, minimum 6 points) for quantitation.	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data.	Analyst/ Supervisor	Empirical SOP-202
	Continuing Calibration Verification (CCV)	Analyze a standard at the beginning of each 12 hour shift after a decafluoro-triphenylphosphine tune.	The minimum RF for SPCCs must meet that stated in method. The CCCs must be less than 20 percent difference (%D).	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data.	Analyst/ Supervisor	Empirical SOP-201
	Initial Calibration Verification (ICV)	Once after each ICAL	±25 percent Individual Compounds	Identify source of problem, correct, repeat calibration, rerun samples	Analyst/ Supervisor	Empirical SOP-201
GC/ECD – Pesticides/PCBs/ Herbicides	ICAL	Calibrate the instrument when it is received and after a major change or if the daily calibration fails. A minimum 5 point calibration is required.	Minimum 5 point calibration, 20% RSD, Linear correlation greater than 0.995, Quadratic correlation greater than 0.99 min. 6 points for all except toxaphene and chlordane. One point for toxaphene and chlordane	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards. Reanalyze affected data.	Analyst/ Supervisor	Empirical SOP-211/208

SAP Worksheet #24—Analytical Instrument Calibration Table (continued)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
GC/ECD – Pesticides/PCBs/ Herbicides	CCV	Analyze standard at the beginning and end of sequence and every 10 samples.	Less than 15%D	If %D is greater than +15% and samples are less than project QL, narrate. If %D is greater than ±15% only on one column, narrate. If %D is greater than ±15% for closing CCV and is likely due to matrix interference, narrate. Otherwise, reanalyze all samples back to the last acceptable CCV.	Analyst/ Supervisor	Empirical SOP-211/208
	ICV	Once after each ICAL	±20% Individual Compounds	Identify source of problem, correct, repeat calibration, rerun samples	Analyst/ Supervisor	Empirical SOP-211/208
ICP – Metals	ICAL	The instrument is calibrated at the beginning of each day or if the QC is out of criteria.	The instrument is calibrated by a one point calibration per manufacturer's guidelines. Analytes ran at their calibration levels must fall within 90-110% of the true values.	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data.	Analyst/ Supervisor	Empirical SOP-105
	CCV	Analyze a standard at the beginning and end of the sequence and after every 10 samples	The acceptance criteria for the continuing calibration standard is 90-110% of true value	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data.	Analyst/ Supervisor	Empirical SOP-105
	Initial Calibration Blank (ICB)	Before beginning a sample sequence	No analytes detected greater than 2 times the MDL	Correct the problem, then reprep and reanalyze.	Analyst/ Supervisor	Empirical SOP-105

SAP Worksheet #24—Analytical Instrument Calibration Table (continued)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
ICP – Metals	Continuing Calibration Blank (CCB)	After every ten samples and at the end of the sequence	No analytes detected greater than 2 times the MDL	Correct the problem, then reprep and reanalyze calibration blank and previous 10 samples	Analyst/ Supervisor	Empirical SOP-105
FIMS	ICAL	The instrument is calibrated at the beginning of each day or if the QC is out of criteria.	The calibration correlation coefficient is greater than 0.995	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data.	Analyst/ Supervisor	Empirical SOP-103/104
	CCV	The CCV is analyzed at the beginning and end of the sequence and after every 10 samples.	The acceptance criteria is 80-120% of the true value	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data.	Analyst/ Supervisor	Empirical SOP-103/104
	ICB	Before beginning a sample sequence	No analytes detected greater than 2 times the MDL	Correct the problem, then reprep and reanalyze.	Analyst/ Supervisor	Empirical SOP-103/104
	CCB	After every 10 samples and at the end of the sequence	No analytes detected greater than 2 times the MDL	Correct the problem, then reprep and reanalyze calibration blank and previous ten samples	Analyst/ Supervisor	Empirical SOP-103/104
Lachat - Cyanide	ICAL	The instrument is calibrated after an instrument change or if QC is outside criteria.	The correlation coefficient is greater than 0.995	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards	Analyst/ Supervisor	Empirical SOP-175

SAP Worksheet #24—Analytical Instrument Calibration Table (continued)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
Lachat - Cyanide	Continuing calibration	The CCV is analyzed at the beginning and end of the sequence and after every 10 samples.	The acceptance criteria is 90-110% of the true value	Recalibrate and/or perform necessary equipment maintenance. Reanalyze samples not bracketed by passing CCVs	Analyst/ Supervisor	Empirical SOP-175
Flashpoint Tester	Flashpoint of p-xylene	Calibrate at the beginning and end of each set of 20 samples or less	Flash at 27°C ±2.2°C	Check standard	Analyst/ Supervisor	Empirical SOP-149
pH Meter	Calibration	Calibrate before use with two buffers in the area to be measured. Check with a third buffer	0.05 pH units	Recalibrate and/or perform necessary equipment maintenance.	Analyst/ Supervisor	Empirical SOP-154/187
GC FID-Methane	ICAL	Calibrate the instrument when it is received and after a major change or if the daily calibration fails. A minimum 5 point calibration is required.	Minimum 5 point calibration, 20% RSD, Linear correlation greater than 0.995, Quadratic correlation greater than 0.99 min. 6 points for all except toxaphene and chlordane. One point for toxaphene and chlordane.	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards. Reanalyze affected data.	Analyst/ Supervisor	Empirical SOP-236

SAP Worksheet #24—Analytical Instrument Calibration Table (continued)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
GC FID-Methane	CCV	Analyze standard at the beginning and end of sequence and every 10 samples.	Less than 15% difference	If %D is greater than +15% and samples are less than the project QL, narrate. If %D is greater than ±15% only on one column, narrate. If %D is greater than ±15% for closing CCV and is likely due to matrix interference, narrate. Otherwise, reanalyze all samples back to the last acceptable CCV.	Analyst/ Supervisor	Empirical SOP-236
	ICV	Once after each ICAL	±20% Individual Compounds	Identify source of problem, correct, repeat calibration, rerun samples	Analyst/ Supervisor	Empirical SOP-236
IC - Anions	ICAL	Calibrate the instrument when it is received and after a major change or if the daily calibration fails. A minimum 8 point calibration is required.	15% RSD, 0.995 Linear	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data.	Analyst/ Supervisor	Empirical SOP-145
	CCV	Analyze a standard at the beginning and end of the sequence and after every 10 samples	85-115%	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data.	Analyst/ Supervisor	Empirical SOP-145

SAP Worksheet #24—Analytical Instrument Calibration Table (continued)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
TOC Analyzer	ICAL	Calibrate the instrument when it is received and after a major change or if the daily calibration fails. A minimum 6 point calibration is required.	0.995 Linear	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data.	Analyst/ Supervisor	Empirical SOP-221
	CCV	Analyze a standard at the beginning and end of the sequence and after every 10 samples	90-110%	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data.	Analyst/ Supervisor	Empirical SOP-221

SAP Worksheet #25—Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	CA	Responsible Person	SOP Reference
GC/MS	Clean the source and replace the filaments. Replace the seal, liner and septum. Change the column.	Volatiles/ Semivolatiles	Check the gas supply. Check the seal, liner, and septum.	Source cleaning is performed when the instrument response deteriorates. Other instrument maintenance is done as needed to keep the instrument performing at peak performance.	The minimum RF for SPCCs must meet that stated in method. The CCCs must be less than 20%D.	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data.	Analyst/ Supervisor	Empirical SOP-201/202
GC/ECD	Check pressure and gas supply daily. Bake out column, change septa, liner, seal as needed, cut column as needed.	Pesticides/ PCBs/ Herbicides	Liner, seal, septum, column	Prior to ICAL or as necessary	Less than or equal to 15%D	If %D is greater than +15% and samples are less than the project QL, narrate. If %D is greater than ±15% only on one column, narrate. If %D is greater than ±15% for closing CCV and is likely due to matrix interference, narrate. Otherwise, reanalyze all samples back to the last acceptable CCV.	Analyst/ Supervisor	Empirical SOP-208/211
ICP	Clean the torch assembly and the spray chamber when they become discolored or when degradation in data quality is observed. Clean the nebulizer, and check the argon supply. Replace the peristaltic pump tubing as needed	Target analyte list (TAL) Metals	Inspect the torch, nebulizer chamber, pump, and tubing	Maintenance is performed prior to ICAL or as necessary.	The acceptance criteria for the continuing calibration standard is 90-110% of true value	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data.	Analyst/ Supervisor	Empirical SOP-105
FIMS	Change the tubing, filter, clean windows, and check gas flow. Check the reagents and standards.	Mercury	Inspect the tubing, filter, and the optical cell	Maintenance is performed prior to ICAL or as necessary.	The acceptance criteria is 80-120% of the true value	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data.	Analyst/ Supervisor	Empirical SOP-103/104
Lachat	Degas solutions, change tubing, lamp, clean connectors	Cyanide	Tubing, rollers	Prior to ICAL or as necessary	The acceptance criteria is 90-110% of the true value	Recalibrate and/or perform necessary equipment maintenance. Reanalyze samples not bracketed by passing CCVs	Analyst/ Supervisor	Empirical SOP-175
Flashpoint Tester	Change propane tank, calibrate thermometer	Flashpoint	Tank, thermometer	Before use	Flash at 27°C ±2.2°C	Check standard	Analyst/ Supervisor	Empirical SOP-149
pH Meter	Clean, drain, refill reference electrode as needed	pH/Alkalinity	Reference electrode for white crystals, Inspect electrode for damage	Before use	0.05 pH units	Recalibrate and/or perform necessary equipment maintenance.	Analyst/ Supervisor	Empirical SOP-154/187
IC - Anions	Replace column	Anions	Check gas supply, check for leaks, check pistons	Daily or as needed	15% RSD, 0.995 correlation. Linear, 15%D CCVs	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards. Reanalyze affected data	Analyst/ Supervisor	Empirical SOP-145
TOC Analyzer	Check gas pressure, check permeation tube and scrubbers, clean and condition sample cups	TOC	Check gas pressure, check permeation tube and scrubbers	Prior to ICAL or as necessary	The CCV Standard must be within 10% Difference	Recalibrate and/or perform necessary equipment maintenance. Reanalyze samples not bracketed by passing CCVs	Analyst/ Supervisor	Empirical SOP-221

SAP Worksheet #25—Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table (continued)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	CA	Responsible Person	SOP Reference
GC/FID	Check pressure and gas supply daily. Bake out column, change septa, liner, seal as needed, cut column as needed.	Methane	Liner, seal, septum, column	Prior to ICAL or as necessary	%D less than or equal to 25%	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data	Analyst/ Supervisor	Empirical SOP-236

SAP Worksheet #26—Sample Handling System

Sample Collection, Packaging, and Shipment
Sample Collection (Personnel/Organization): Personnel/AGVIQ-CH2M HILL
Sample Packaging (Personnel/Organization): Personnel/AGVIQ-CH2M HILL
Coordination of Shipment (Personnel/Organization): Personnel/AGVIQ-CH2M HILL
Type of Shipment/Carrier: Overnight/FedEx
Sample Receipt and Analysis
Sample Receipt (Personnel/Organization): William Schwab/ Empirical Laboratories
Sample Custody and Storage (Personnel/Organization W. Schwab/ Empirical Laboratories
Sample Preparation (Personnel/Organization): A. Fei, K. Verdier, K. Huka/ Empirical Laboratories
Sample Determinative Analysis (Personnel/Organization): K. Huka, R. Burr, A. Monteiro, J. Hughes, D. Lynch, J. Holliman, W. Lancaster, B. Mekael/ Empirical Laboratories
Sample Archiving
Field Sample Storage (No. of days from sample collection): 60 days from receipt
Sample Extract/Digestate Storage (No. of days from extraction/digestion):): 3 months from sample digestion
Biological Sample Storage (No. of days from sample collection): NA
Sample Disposal
Personnel/Organization: W. Schwab Empirical Laboratories
Number of Days from Analysis: 30 days from submittal of final report or 60 days from receipt whichever is longer

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SAP Worksheet #27—Sample Custody Requirements Table

Sample Labeling

Sample labels will include, at a minimum, project name, project number, sample ID, date/time collected, analysis group and/or method, preservative, and sampler's name. Labels will be taped to the jar to ensure they do not separate.

Field Sample Custody Procedures (Sample Collection, Packaging, Shipment, and Delivery to Laboratory)

Samples will be collected by field team members under the supervision of the FTL. As samples are collected, they will be placed into containers containing ice, and labeled, as outlined above. Samples will be cushioned with packaging material and placed into coolers containing enough ice to keep the samples below 6°C until they are received by the laboratory. The chain-of-custody will also be placed into the cooler. Coolers will be shipped at the end of each day to the laboratory via FedEx, with the air bill number indicated on the chain-of-custody (to relinquish custody). Upon delivery, the laboratory will log in each cooler and report the status of the samples.

Laboratory Sample Custody Procedures (Receipt of Samples, Archiving, Disposal)

See the laboratory sample handling and disposal SOPs: Empirical SOP 404, SOP 405 and SOP 410.

Sample Identification Procedures

Upon opening the cooler, the receiving clerk signs the chain-of-custody and then takes the temperature using the temperature blank (if absent, then a sample container or infrared thermometer is used). The sample containers in the cooler are unpacked and checked against the client's chain-of-custody and any discrepancies or breakage is noted on the chain-of-custody. Next, if any water samples require preservative, the clerk will check the pH values to see if they are in the acceptable pH range. The clerk will deliver the chain-of-custody (and any other paperwork; e.g. temperature or pH QA notice) to the PM for Laboratory Information Management System (LIMS) entry and client contact (if needed).

The field logbook will identify the sample ID with the location, depth, date/time collected, and the parameters requested. The laboratory will assign each field sample a laboratory sample ID based on information in the chain-of-custody. The laboratory will send sample log-in forms to the EIS to check sample IDs and parameters are correct.

Chain-of-Custody Procedures

Chains-of-custody will include, at a minimum, laboratory contact information, client contact information, sample information, and relinquished by/received by information. Sample information will include sample ID, date/time collected, number and type of containers, preservative information, analysis method, and comments. The chain-of-custody will also have the sampler's name and signature. The chain-of-custody will link location of the sample from the field logbook to the laboratory receipt of the sample. The laboratory will use the sample information to populate the LIMS database for each sample.

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SAP Worksheet #28—Laboratory QC Samples Table

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Matrix: Groundwater and TCLP Soil/Water **Analytical Group:** VOCs **Analytical Method/SOP Reference:** SW-846 8260B/SOP 198/202						
Method Blank	One per batch of 20 or less	No target compounds should be greater than or equal to ½ the reporting limit except common lab contaminants which should be less than the reporting limit.	Re-clean, retest, re-extract, reanalyze, and/or qualify the data.	Analyst, Laboratory Supervisor and Data Validator	Bias/Contamination	No target compounds should be greater than or equal to ½ the reporting limit, except common lab contaminants, which should be less than the reporting limit.
Surrogates	3 per sample	DoD QSM limits	(1) Re-prepare and reanalyze for confirmation of matrix interference when appropriate.	Analyst, Laboratory Supervisor and Data Validator	Accuracy/ Bias	DoD QSM limits
Laboratory Control Sample (LCS)	One per batch of 20 or less	DoD QSM limits	(1) Evaluate and reanalyze if possible (2) If an MS/MSD was performed in the same 12-hour clock and acceptable narrate. (3) If the LCS recoveries are high but the sample results are less than the reporting limit, narrate. Otherwise, re-prepare and reanalyze the batch.	Analyst, Laboratory Supervisor and Data Validator	Precision/ Accuracy/ Bias	DoD QSM limits
Internal Standards	3 per sample	Retention times for internal standards must be ±30 seconds and the responses within -50% to +100% of last calibration verification (12 hours) for each internal standard.	Inspect mass spectrometer or Gas chromatograph for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning	Analyst, Laboratory Supervisor and Data Validator	Precision/ Accuracy/ Bias	Retention times for internal standards must be ±30 seconds and the responses within -50% to +100% of last calibration verification (12 hours) for each internal standard.
MS/MSD	One per sample delivery group (SDG) or every 20 samples.	DoD QSM limits	(1) CA will not be taken for samples when recoveries are outside limits and surrogate and LCS criteria are met (2) If both the LCS and MS/MSD are unacceptable re-prepare the samples and QC.	Analyst, Laboratory Supervisor and Data Validator	Precision/ Accuracy/ Bias	DoD QSM limits
Matrix: TCLP Soil and Water **Analytical Group:** SVOCs **Analytical Method/SOP Reference:** SW-846 8270C/SOP 198/201						
Method Blank	One per batch of 20 or less	No target compounds should be greater than or equal to ½ the reporting limit, except common lab contaminants, which should be less than the reporting limit.	Re-clean, retest, re-extract, reanalyze, and/or qualify the data.	Analyst, Laboratory Supervisor and Data Validator	Bias / Contamination	No target compounds should be greater than or equal to ½ the reporting limit, except common lab contaminants, which should be less than the reporting limit.
Surrogates	6 per sample	DoD QSM limits	(1) Re-prepare and reanalyze for confirmation of matrix interference when appropriate.	Analyst, Laboratory Supervisor and Data Validator	Accuracy / Bias	DoD QSM limits
LCS	One per batch of 20 or less	DoD QSM limits	(1) Evaluate and reanalyze if possible. (2) If an MS/MSD was performed in the same 12-hour clock and acceptable narrate. (3) If the LCS recoveries are high but the sample results are less than the reporting limit, narrate. Otherwise, re-prepare and reanalyze the batch.	Analyst, Laboratory Supervisor and Data Validator	Precision / Accuracy / Bias	DoD QSM limits

SAP Worksheet #28—Laboratory QC Samples Table (continued)

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Internal Standards	6 per sample	Retention times for internal standards must be ±30 seconds and the responses within -50% to +100% of last calibration verification (12 hours) for each internal standard.	Inspect GC/MS for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning	Analyst, Laboratory Supervisor and Data Validator	Precision / Accuracy / Bias	Retention times for internal standards must be ±30 seconds and the responses within -50% to +100% of last calibration verification (12 hours) for each internal standard.
MS/MSD	One per SDG or every 20 samples.	DoD QSM limits	(1) CA will not be taken for samples when recoveries are outside limits and surrogate and LCS criteria are met. (2) If both the LCS and MS/MSD are unacceptable, re-prepare the samples and QC.	Analyst, Laboratory Supervisor and Data Validator	Precision / Accuracy / Bias	DoD QSM limits
Matrix: TCLP Soil and Water **Analytical Group:** Pesticides/PCBs/Herbicides **Analytical Method/SOP Reference:** SW-846 8081A/8082/8151A/SOP 198/211/208						
Method Blank	One per 20 samples or less	No target compounds greater than or equal to ½ the reporting limit	Re-clean, retest, re-extract, reanalyze, and/or qualify data.	Analyst, Laboratory Supervisor and Data Validator	Bias / Contamination	No target compounds greater than or equal to ½ the reporting limit
Surrogates	Two per sample/one for herbicides	DoD QSM limits	(1) Re-prep and reanalyze for confirmation of matrix interference when appropriate.	Analyst, Laboratory Supervisor and Data Validator	Accuracy / Bias	DoD QSM limits
LCS	One per 20 samples or less	DoD QSM limits	(1) Evaluate and reanalyze if possible. (2) If an MS was performed in the same 12-hour clock and acceptable, narrate. (3) If the LCS recoveries are high but the sample results are less than the QL, narrate; otherwise, re-prep and reanalyze.	Analyst, Laboratory Supervisor and Data Validator	Precision / Accuracy / Bias	DoD QSM limits
MS/MSD	One per 20 samples or less	DoD QSM limits	(1) CA will not be taken for samples when recoveries are outside limits and surrogate and LCS criteria are met. (2) If both the LCS and MS are unacceptable, reprep the samples and QC.	Analyst, Laboratory Supervisor and Data Validator	Precision / Accuracy / Bias	DoD QSM limits
Matrix: TCLP Soil and Water **Analytical Group:** RCRA Metals/TAL Metals **Analytical Method/SOP Reference:** SW-846 6010B/7470A/7471A/SOP 198/100/105/103/104						
Method Blank	One per digestion batch of 20 or fewer samples	Contaminants in the method blank must be less than ½ the reporting limit.	Investigate the source of the contamination. Re-digest and reanalyze all associated samples if the sample concentration is greater than or equal to the reporting limit and less than 10 times the blank concentration.	Analyst, Laboratory Supervisor and Data Validator	Bias / Contamination	Contaminants in the method blank must be less than ½ the reporting limit.
LCS	One per digestion batch of 20 or fewer samples	Recovery must be within ±20% of the true value, unless vendor-supplied or statistical limits have been established.	Investigate source of problem. Re-digest and reanalyze all associated samples.	Analyst, Laboratory Supervisor and Data Validator	Accuracy / Bias / Contamination	Recovery must be within ±20% of the true value, unless vendor-supplied or statistical limits have been established.
Duplicate Sample	One per digestion batch of 20 or fewer samples	The RPD should be less than or equal to 20% for duplicate spikes.	Flag results.	Analyst, Laboratory Supervisor and Data Validator	Precision	The RPD should be less than or equal to 20% for duplicate spikes.
MS	One per digestion batch of 20 or fewer samples	Recovery should be ±25% of the true value, if sample is less than 4 times the spike added.	Flag results.	Analyst, Laboratory Supervisor and Data Validator	Accuracy / Bias	Recovery should be ±25% of the true value, if sample is less than 4 times the spike added.

SAP Worksheet #28—Laboratory QC Samples Table (continued)

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
ICP Serial Dilution	One per digestion batch	If original sample result is at least 50 times the instrument detection limit, 5-fold dilution must agree within ±10% of the original result.	Flag result or dilute and reanalyze sample to eliminate interference.	Analyst, Laboratory Supervisor and Data Validator	Accuracy / Bias	If original sample result is at least 50 times the instrument detection limit, 5-fold dilution must agree within ±10% of the original result.
Matrix: TCLP Soil and Water **Analytical Group:** Reactivity/Cyanide **Analytical Method/SOP Reference:** SW-846 9012A/SOP 164/175						
Distilled Prep Blank	Every batch of 20 samples or less	Less than ½ the reporting limit	If instrument problem, reanalyze prep blank. If distillation problem, samples 5 times the prep blank can be reported. If not less than ½ the reporting limit, redistill and reanalyze	Analyst, Laboratory Supervisor and Data Validator	Bias / Contamination	Less than ½ the reporting limit
LCS	Every batch of 20 samples or less	80-120%	Reanalyze when instrument is in control. If low, re-digest and reanalyze samples. If high and hits, re-digest and reanalyze.	Analyst, Laboratory Supervisor and Data Validator	Accuracy / Bias	80-120%
Distilled Calibration Verification	Every batch of 20 samples or less	90-110%	Check with supervisor before proceeding.	Analyst, Laboratory Supervisor and Data Validator	Accuracy / Bias	90-110%
MS/MSD	Every batch of 20 samples or less	80-120%	Check with supervisor before proceeding.	Analyst, Laboratory Supervisor and Data Validator	Precision/Accuracy / Bias	80-120%
Calibration Blanks	During sequence every 10 samples	Below MDL	Check with supervisor before proceeding.	Analyst, Laboratory Supervisor and Data Validator	Bias / Contamination	Below MDL
Matrix: TCLP Soil and Water **Analytical Group:** Reactivity/Sulfide **Analytical Method/SOP Reference:** SW-846 Chapter 7/SOP 156						
Method Blank	Every batch of 20 samples or less	Less than ½ the reporting limit	Reanalyze, and/or qualify data.	Analyst, Laboratory Supervisor and Data Validator	Bias / Contamination	Less than ½ the reporting limit
MS/MSD	Every batch Every batch of 20 samples or less	80-120%	Check with supervisor before proceeding.	Analyst, Laboratory Supervisor and Data Validator	Precision/Accuracy / Bias	75-125%
Matrix: TCLP Soil and Water **Analytical Group:** Ignitability **Analytical Method/SOP Reference:** SW-846 1010/SOP 149						
p-xylene flashpoint	At the beginning and end of each set of 20 samples	27°C + 2.2°C	Reanalyze, and/or qualify data.	Analyst, Laboratory Supervisor and Data Validator	Accuracy/Bias	27°C + 2.2°C
Matrix: TCLP Soil and Water **Analytical Group:** Corrosivity as pH **Analytical Method/SOP Reference:** SW-846 9040B/SOP 187						
Laboratory Duplicate	One per prep batch of 10 or fewer samples	±0.09 units	Recalibrate and reanalyze samples.	Analyst, Supervisor, QA Manager	Precision	±0.09 units
LCS	Once per 20 samples	±0.25 units	Re-analyze associated samples. If sample is within holding time, re-analyze affected sample batch.	Analyst, Supervisor, QA Manager	Accuracy/Bias	±0.25 units

SAP Worksheet #28—Laboratory QC Samples Table (continued)

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Matrix: Groundwater **Analytical Group:** Anions **Analytical Method/SOP Reference:** EPA 300.0/SOP 145						
Method Blank	One per batch	No analytes greater than ½ the reporting limit	If method blank is higher than the reporting limit, all samples less than 10 times the blank must be reanalyzed.	Analyst/Supervisor	Bias/Contamination	No analytes greater than ½ the reporting limit
Laboratory Fortified Blank	One per batch	80-120% recovery	If laboratory fortified blank is out high and sample concentrations are less than the reporting limit, no CA. Otherwise, all samples must be reanalyzed.	Analyst/Supervisor	Accuracy/Bias	80-120% recovery
Instrument Performance Check	Following calibration and at end of sequence and every 10 samples	10% difference	Column may require cleaning or replacement, check standards.	Analyst/Supervisor	Accuracy/Bias	10% difference
Lab Fortified Sample Matrix	Minimum of 10% of lab samples	80-120% recovery	If analyte level is greater than 4 times the spiking level, % recovery cannot be evaluated and no CA. If not, sample data qualified.	Analyst/Supervisor	Accuracy/Bias	80-120% recovery
Field or Lab Duplicate	Minimum of 10% of lab samples	20% RPD	Associated data qualified.	Analyst/Supervisor	Precision	20% RPD
Matrix: Groundwater **Analytical Group:** Sulfide **Analytical Method/SOP Reference:** SM 4500 S_2-F/SOP 153						
Method Blank	One per batch	Result less than reporting limit	Reanalyze samples	Analyst/Supervisor	Bias/Contamination	Result less than the reporting limit
LCS	One per batch	80-120%	If laboratory control sample is out high and sample concentrations are less than the reporting limit, no CA. Otherwise, all samples must be reanalyzed.	Analyst/Supervisor	Accuracy/Bias	80-120%
Sample Duplicate	One per batch	20% RPD	If RPD is greater than 20%, sample should be reanalyzed. If still high, result is flagged.	Analyst/Supervisor	Precision	20% RPD
Matrix: Groundwater **Analytical Group:** TOC **Analytical Method/SOP Reference:** SM 5310C/SOP 221						
Method Blank	One per batch	No analytes greater than ½ the reporting limit	Reanalyze samples.	Analyst/Supervisor	Bias/Contamination	No analytes greater than ½ the reporting limit
LCS	One per batch	80-120%	Recalibrate and reanalyze samples.	Analyst/Supervisor	Accuracy/Bias	80-120%
MS/MSD	One per batch	75-125%	CA will be not taken for samples when recoveries are outside limits and LCS criteria are met. If both the LCS and MS/MSD are unacceptable, reanalyze samples and QC.	Analyst/Supervisor	Accuracy/Bias/Precision	75-125%

SAP Worksheet #28—Laboratory QC Samples Table (continued)

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Matrix: Groundwater **Analytical Group:** Methane **Analytical Method/SOP Reference:** RSK-175/SOP 236						
Method Blank	One per batch of 20 or less	Result less than the reporting limit	Data flagged.	Analyst/Supervisor	Bias/Contamination	Result less than the reporting limit
LCS	One per batch of 20 or less	75-125%	If no targets detected, no CA. If targets detected, reanalyze.	Analyst/Supervisor	Accuracy/Bias	75-125%
MS/MSD	One per batch of 20 or less	75-125%	CA will be taken for samples when recoveries are outside limits and LCS criteria are met. If both the LCS and MS/MSD are unacceptable, reanalyze samples and QC.	Analyst/Supervisor	Accuracy/Bias/Precision	75-125%
Matrix: Groundwater **Analytical Group:** Alkalinity **Analytical Method/SOP Reference:** SM 2320B/SOP 154						
Method Blank	One per batch	Result less than the reporting limit	Reanalyze samples.	Analyst/Supervisor	Bias/Contamination	Result less than the reporting limit
LCS	One per batch	80-120%	If LCS is out high and sample concentrations are less than the reporting limit, no CA. Otherwise, all samples must be reanalyzed.	Analyst/Supervisor	Accuracy/Bias	80-120%
Sample Duplicate	One per batch	20% RPD	If RPD is greater than 20%, sample should be reanalyzed. If still high, result is flagged.	Analyst/Supervisor	Precision	20% RPD

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SAP Worksheet #29—Project Documents and Records Table

Document	Where Maintained
Field Notebooks	Electronic .pdf copies in the project file. Hardcopy (bound notebook) in the project file. Archived at project close-out.[a]
Chain-of-Custody Records	Electronic .pdf copies in the project file. Hardcopy in the project file. Archived at project closeout.
Air Bills	Hardcopy in the project file. Archived at project closeout.
Telephone Logs	Hardcopy in the project file. Archived at project closeout.
CA Forms	Electronic .pdf copies in the project file. Hardcopy in the project file. Archived at project closeout.
Electronic Field Data Deliverables	Loaded in the Field Database then transferred to the SQL Data Warehouse as the final repository.
Various field measurements	Recorded in Field Notebook and stored in SQL Data Warehouse.
All field equipment calibration information	Recorded in Field Notebook.
Pertinent telephone conversations	Recorded in Field Notebook.
Field equipment maintenance records	Inspected by FTL. Not maintained.
Sample Receipt, Custody, and Tracking Records	Electronic .pdf copies in the project file. Hardcopy in the full data package and stored in SQL sample tracking database.
Standard Traceability Logs	Hardcopy in the full data package. Archived at project closeout.
Equipment Calibration Logs	Hardcopy in the full data package. Archived at project closeout.
Sample Prep Logs	Hardcopy in the full data package. Archived at project closeout.
Run Logs	Hardcopy in the full data package. Archived at project closeout.
Equipment Maintenance, Testing, and Inspection Logs	Hardcopy in the full data package. Archived at project closeout.
Reported Field Sample Results	Electronic .pdf copies in the project file. Hardcopy in the data package. Archived at project closeout.
Reported Results for Standards, QC Checks, and QC Samples	Hardcopy in the full data package. Archived at project closeout.

SAP Worksheet #29—Project Documents and Records Table (continued)

Document	Where Maintained
Instrument Printouts (raw data) for Field Samples, Standards, QC Checks, and QC Samples	Hardcopy in the full data package. Archived at project closeout.
Data Package Completeness Checklists	Hardcopy in the data validation report. Archived at project closeout.
Sample Disposal Records	Maintained by the laboratory.
Extraction/Cleanup Records	Maintained by the laboratory.
Raw Data	Hardcopy in the full data package. Archived at project closeout. Hard copies at Iron Mountain and DVD/CD backups onsite at AGVIQ-CH2M HILL.
Field Sampling Audit Checklists	Hardcopy in the project file. Archived at project closeout.
Fixed Laboratory Audit Checklists	If completed, hardcopy in the project file. Archived at project closeout.
Data Validation Reports	Electronic .pdf copies in the project file. Hardcopy stored with the data package. Archived at project closeout. Hard copies at Iron Mountain and DVD/CD backups onsite at AGVIQ-CH2M HILL.
Electronic Data Deliverables and Electronic Login Deliverables	EDDs are loaded into the SQL Data Warehouse as the final repository. The ELDs are loaded into the SQL Sample Tracking DB as the final repository.

Notes:

[a] Data archiving will be done in accordance with Navy requirements. AGVIQ-CH2M HILL will provide the Navy (currently Bonnie Capito) all data and reports for archiving.

SAP Worksheet #30—Analytical Services Table

All samples will be shipped to Empirical Laboratories, LLC, in Nashville, Tennessee for analysis. The data package will include hardcopy data (including raw data), a CD-ROM containing portable document format (PDF) versions of the data package, and an electronic data deliverable. The data package will be due within 14 calendar days of sample receipt.

Matrix	Analytical Group	Sample Locations/ ID Number	Analytical Method	Data Package Turnaround Time	Laboratory/Organization	Backup Laboratory/ Organization
Groundwater	1,2,4-Trimethylbenzene, Benzene and Ethylbenzene	See Worksheet #18 and Figure 10 for monitoring well locations.	SW-846 5030B, 8260B	14 days	Empirical Laboratories, LLC 621 Mainstream Drive Suite 270 Nashville, TN 37228 Janice Shilling 615-345-1115	NA
Groundwater	Nitrate, Nitrite and Sulfate	See Worksheet #18 and Figure 10 for monitoring well locations.	EPA 300.0	14 days	Empirical Laboratories, LLC 621 Mainstream Drive Suite 270 Nashville, TN 37228 Janice Shilling 615-345-1115	NA
Groundwater	TOC	See Worksheet #18 and Figure 10 for monitoring well locations.	SM 5310B	14 days	Empirical Laboratories, LLC 621 Mainstream Drive Suite 270 Nashville, TN 37228 Janice Shilling 615-345-1115	NA
Groundwater	Sulfide	See Worksheet #18 and Figure 10 for monitoring well locations.	SM 4500 S_2-F	14 days	Empirical Laboratories, LLC 621 Mainstream Drive Suite 270 Nashville, TN 37228 Janice Shilling 615-345-1115	NA

SAP Worksheet #30—Analytical Services Table (continued)

Matrix	Analytical Group	Sample Locations/ ID Number	Analytical Method	Data Package Turnaround Time	Laboratory/Organization	Backup Laboratory/ Organization
Groundwater	Methane	See Worksheet #18 and Figure 10 for monitoring well locations.	RSK-175	14 days	Empirical Laboratories, LLC 621 Mainstream Drive Suite 270 Nashville, TN 37228 Janice Shilling 615-345-1115	NA
Groundwater	Alkalinity	See Worksheet #18 and Figure 10 for monitoring well locations.	SM 2320B	14 days	Empirical Laboratories, LLC 621 Mainstream Drive Suite 270 Nashville, TN 37228 Janice Shilling 615-345-1115	NA
Aqueous	VOCs – RCRA compounds (see Worksheet #15 for specific compounds).	See Worksheet #18.	SW 846 5030B, 8260B	14 days	Empirical Laboratories, LLC 621 Mainstream Drive Suite 270 Nashville, TN 37228 Janice Shilling 615-345-1115	NA
Aqueous	SVOCs – RCRA compounds (see Worksheet #15 for specific compounds).	See Worksheet #18.	SW 846 3510,8270C	14 days	Empirical Laboratories, LLC 621 Mainstream Drive Suite 270 Nashville, TN 37228 Janice Shilling 615-345-1115	NA
Aqueous	Pesticides – RCRA compounds (see Worksheet #15 for specific compounds).	See Worksheet #18.	SW 846 3510,8081A	14 days	Empirical Laboratories, LLC 621 Mainstream Drive Suite 270 Nashville, TN 37228 Janice Shilling 615-345-1115	NA

SAP Worksheet #30—Analytical Services Table (continued)

Matrix	Analytical Group	Sample Locations/ ID Number	Analytical Method	Data Package Turnaround Time	Laboratory/Organization	Backup Laboratory/ Organization
Aqueous	Herbicides – RCRA compounds (see Worksheet #15 for specific compounds).	See Worksheet #18.	SW 846 3510,8151A	14 days	Empirical Laboratories, LLC 621 Mainstream Drive Suite 270 Nashville, TN 37228 Janice Shilling 615-345-1115	NA
Aqueous	Metals – RCRA compounds (see Worksheet #15 for specific compounds).	See Worksheet #18.	SW 846 3010A, 6010B,7470A	14 days	Empirical Laboratories, LLC 621 Mainstream Drive Suite 270 Nashville, TN 37228 Janice Shilling 615-345-1115	NA
Aqueous	PCBs – RCRA compounds (see Worksheet #15 for specific compounds).	See Worksheet #18.	SW 846 3510/8082	14 days	Empirical Laboratories, LLC 621 Mainstream Drive Suite 270 Nashville, TN 37228 Janice Shilling 615-345-1115	NA
Aqueous	Ignitability	See Worksheet #18.	SW 846 1010A	14 days	Empirical Laboratories, LLC 621 Mainstream Drive Suite 270 Nashville, TN 37228 Janice Shilling 615-345-1115	NA
Aqueous	Corrosivity	See Worksheet #18.	SW 846 9045D	14 days	Empirical Laboratories, LLC 621 Mainstream Drive Suite 270 Nashville, TN 37228 Janice Shilling 615-345-1115	NA

SAP Worksheet #30—Analytical Services Table (continued)

Matrix	Analytical Group	Sample Locations/ ID Number	Analytical Method	Data Package Turnaround Time	Laboratory/Organization	Backup Laboratory / Organization
Aqueous	Reactive Cyanide	See Worksheet #18.	SW 846 9012A	14 days	Empirical Laboratories, LLC 621 Mainstream Drive Suite 270 Nashville, TN 37228 Janice Shilling 615-345-1115	NA
Aqueous	Reactive Sulfide	See Worksheet #18.	SW 846, Chap.7, Sect.7.3.4	14 days	Empirical Laboratories, LLC 621 Mainstream Drive Suite 270 Nashville, TN 37228 Janice Shilling 615-345-1115	NA
Solid/Soil	TCLP – VOC	See Worksheet #18.	SW-846 1311/5030B, 8260B	14 days	Empirical Laboratories, LLC 621 Mainstream Drive Suite 270 Nashville, TN 37228 Janice Shilling 615-345-1115	NA
Solid/Soil	TCLP – SVOCs	See Worksheet #18.	SW-846 1311/3510C/8270 C	14 days	Empirical Laboratories, LLC 621 Mainstream Drive Suite 270 Nashville, TN 37228 Janice Shilling 615-345-1115	NA
Solid/Soil	TCLP – Organochlorine Pesticides	See Worksheet #18.	SW-846 1311/3510C/8081 A	14 days	Empirical Laboratories, LLC 621 Mainstream Drive Suite 270 Nashville, TN 37228 Janice Shilling 615-345-1115	NA

SAP Worksheet #30—Analytical Services Table (continued)

Matrix	Analytical Group	Sample Locations/ ID Number	Analytical Method	Data Package Turnaroun d Time	Laboratory/Organization	Backup Laboratory / Organization
Solid/Soil	TCLP – Herbicides	See Worksheet #18.	SW-846 1311/3510C/8151A	14 days	Empirical Laboratories, LLC 621 Mainstream Drive Suite 270 Nashville, TN 37228 Janice Shilling 615-345-1115	NA
Solid/Soil	TCLP- Metals	See Worksheet #18.	SW-846 1311/3010A/6010B /7471A	14 days	Empirical Laboratories, LLC 621 Mainstream Drive Suite 270 Nashville, TN 37228 Janice Shilling 615-345-1115	NA
Solid/Soil	PCBs	See Worksheet #18.	SW-846 3541, 8082	14 days	Empirical Laboratories, LLC 621 Mainstream Drive Suite 270 Nashville, TN 37228 Janice Shilling 615-345-1115	NA
Solid/Soil	Corrosivity	See Worksheet #18.	SW-846 9045C	14 days	Empirical Laboratories, LLC 621 Mainstream Drive Suite 270 Nashville, TN 37228 Janice Shilling 615-345-1115	NA
Solid/Soil	Ignitability	See Worksheet #18.	SW-846 1010A/1030	14 days	Empirical Laboratories, LLC 621 Mainstream Drive Suite 270 Nashville, TN 37228 Janice Shilling 615-345-1115	NA

SAP Worksheet #30—Analytical Services Table (continued)

Matrix	Analytical Group	Sample Locations/ ID Number	Analytical Method	Data Package Turnaround Time	Laboratory/Organization	Backup Laboratory / Organization
Solid/Soil	Reactivity Cyanide	See Worksheet #18.	SW-846 7.3.4.2	14 days	Empirical Laboratories, LLC 621 Mainstream Drive Suite 270 Nashville, TN 37228 Janice Shilling 615-345-1115	NA
Solid/Soil	Reactivity Sulfide	See Worksheet #18.	SW-846 7.3.4.1	14 days	Empirical Laboratories, LLC 621 Mainstream Drive Suite 270 Nashville, TN 37228 Janice Shilling 615-345-1115	NA

SAP Worksheet #31—Planned Project Assessments Table

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing CA	Person(s) Responsible for Monitoring Effectiveness of CA
Field Performance Audit	One during sampling activities	Internal	AGVIQ-CH2M HILL	Lauren Petty, QC Manager AGVIQ-CH2M HILL	Project Field Team AGVIQ-CH2M HILL	Tom Beisel, PM AGVIQ-CH2M HILL	Theresa Rojas, Program QA/QC Manager AGVIQ-CH2M HILL
Safe Work Observation	One per week during field activities	Internal	AGVIQ-CH2M HILL	Andrew O'Conor, SSC AGVIQ-CH2M HILL	Project Field Team AGVIQ-CH2M HILL	Mike Goldman, H&S Officer AGVIQ-CH2M HILL	Andrew O'Conor, SSC AGVIQ-CH2M HILL
Offsite Laboratory Technical Systems Audit[a]	Laboratory must have current Naval Facilities Engineering Service Center (NFESC) and DoD Environmental Laboratory Accreditation Program (ELAP) evaluation letter, which will identify the period of performance. The laboratory must be re-evaluated prior to expiration of period of performance.	External	U.S. Navy NFESC and DoD ELAP	(U.S. Navy NFESC)	Randy Ward, Laboratory QAO Empirical Laboratories, LLC	Randy Ward, Laboratory QAO Empirical Laboratories, LLC	Camden Robinson, Project Chemist and Theresa Rojas, Program QA/QC Manager AGVIQ-CH2M HILL

Notes:
[a] If laboratory quality or performance issues occur during project execution, AGVIQ-CH2M HILL will perform an audit of the offsite laboratory.

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SAP Worksheet #32—Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Timeframe of Notification	Nature of CA Response Documentation	Individual(s) Receiving CA Response	Timeframe for Response
Field Performance Audit	Field Performance Audit Checklist	Field Team Tom Beisel, PM Theresa Rojas, Program QA/QC Manager AGVIQ-CH2M HILL	Within 1 day of audit	Verbal and CA Form	Andrew O'Conor, FTL AGVIQ-CH2M HILL	Within 1 day of receipt of CA Form
Safe Work Observation	Safe Work Observation Form	Field Team Andrew O'Conor, FTL Tom Beisel, PM AGVIQ-CH2M HILL	Immediately (person involved or observed person). Following day (field team). Within 1 week if worthy of elevation (H&S officer)	On Safe Work Observation Form	Andrew O'Conor, FTL, and individual being observed, and Tom Beisel, PM, and if elevated to Mike Goldman, H&S officer AGVIQ-CH2M HILL	Corrected in the field immediately, and within 1 week if elevated
Offsite Laboratory Technical Systems Audit	Written Audit Report	Randy Ward, Laboratory QAO Empirical Laboratories, LLC	Within 2 months of audit	Memorandum	NFESC Auditor and DoD ELAP Assessor	Within 2 months of receipt of initial notification

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SAP Worksheet #32-1—Corrective Action Form

Person initiating CA _____ **Date** _____

Description of problem and when identified: _____

_____

_____

_____

_____

Cause of problem, if known or suspected: _____

_____

_____

_____

Sequence of CA: (including date implemented, action planned and personnel/data affected) _

_____

_____

_____

_____

_____

_____

_____

CA implemented by: _____ **Date:** _____

CA initially approved by: _____ **Date:** _____

Follow-up date: _____

Final CA approved by: _____ **Date:** _____

Information copies to:

_____

_____

_____

SAP Worksheet #32-2—Field Performance Audit Checklist

Project Responsibilities

Project No.: **Date:**

Project Location: **Signature:**

Team Members:

Yes No 1) Is the approved work plan being followed?
Comments:

Yes No 2) Was a briefing held for project participants?
Comments:

Yes No 3) Were additional instructions given to project participants?
Comments:

Sample Collection:

Yes No 1) Is there a written list of sampling locations and descriptions?
Comments:

Yes No 2) Are samples collected as stated in the Master SOPs?
Comments:

Yes No 3) Are samples collected in the type of containers specified in the work plan?
Comments:

Yes No 4) Are samples preserved as specified in the work plan?
Comments:

Yes No 5) Are the number, frequency, and type of samples collected as specified in the work plan?
Comments:

Yes No 6) Are QA checks performed as specified in the work plan?
Comments:

Yes No 7) Are photographs taken and documented?
Comments:

Document Control:

Yes No 1) Have any accountable documents been lost?
Comments:

Yes No 2) Have any accountable documents been voided?
Comments:

Yes No 3) Have any accountable documents been disposed of?
Comments:

Yes No 4) Are the samples identified with sample tags?
Comments:

Yes No 5) Are blank and duplicate samples properly identified?
Comments:

Yes No 6) Are samples listed on a chain-of-custody record?
Comments:

Yes No 7) Is chain-of-custody documented and maintained?
Comments:

SAP Worksheet #32-3—Safe Work Observation Form

Project:		**Observer:**	**Date:**
Position/Title of worker observed:		**Background Information/comments:**	
Task/Observation Observed:			

- Identify and reinforce safe work practices/behaviors
- Identify and improve on at-risk practices/acts
- Identify and improve on practices, conditions, controls, and compliance that eliminate or reduce hazards
- Proactive PM support facilitates eliminating/reducing hazards (do you have what you need?)
- Positive, corrective, cooperative, collaborative feedback/recommendations

Actions & Behaviors	Safe	At-Risk	Observations/Comments
Current and accurate Pre-Task Planning/Briefing (Project Safety Plan, Safety Task Analysis Card, Activity Hazard Analysis, Pre-Task Safety Plan, tailgate briefing, etc., as needed)			**Positive Observations/Safe Work Practices:**
Properly trained/qualified/experienced			
Tools/equipment available and adequate			
Proper use of tools			**Questionable Activity/Unsafe Condition Observed:**
Barricades/work zone control			
Housekeeping			
Communication			
Work Approach/Habits			
Attitude			
Focus/attentiveness			**Observer's CAs/Comments:**
Pace			
Uncomfortable/unsafe position			
Inconvenient/unsafe location			
Position/Line of fire			
Apparel (hair, loose clothing, jewelry)			
Repetitive motion			**Observed Worker's CAs/Comments:**
Other…			

SAP Worksheet #33—QA Management Reports Table

Type of Report	Frequency	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation	Report Recipient(s)
Field Audit Report	One during sampling activities	Submitted with report in which data is analyzed and presented	Tom Beisel, PM AGVIQ-CH2M HILL	AGVIQ-CH2M HILL Regional Health, Safety, Environment, and Quality Manager, Included in project files
Field Progress Reports (during construction activities, only)	Daily	Weekly or daily reporting will be submitted the following construction activities.	Lauren Petty, Project QC Manager AGVIQ-CH2M HILL	Reports will be included as an attachment to the Construction Completion Report. Construction Completion Report distribution will include the Navy and EPA.
QA Management Report/Technical Memorandum	Per sampling event	Per Project Schedule	Project Chemist and Project Manager, AGVIQ-CH2M HILL	AGVIQ-CH2M HILL, EPA Region II, FDEP, NAVFAC SE

The following will be addressed in the QA/QC section of QA Management Report/Technical Memorandum:

- Summary of project QA/QC programs and trainings
- Conformance of project activities to SAP requirements and procedures
- Status of project and schedule delays
- Deviations from approved SAP and approved amendments to SAP
- Description and findings of audits
- Results of data review activities in terms of amount of usable data generated (results of the Chemist's QC check on data prior to loading into AGVIQ-CH2M HILL's database)
- Required CAs and effectiveness of CA implementation
- Data usability assessments in terms of accuracy, precision, representativeness, completeness, comparability, and sensitivity
- Limitations on use of measurement data generated

The report will also include data quality concerns:

- Narrative and timelines of project activities summary of project quality objective (PQO) development
- Reconciliation of project data with PQOs
- Summary of major problems encountered and their resolution
- Data summary, including tables, charts, graphs, with appropriate sample identification or station location numbers, concentration units, percent solids (NA), and data quality flags
- Conclusions and recommendations

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SAP Worksheet #34—Verification (Step I) Process Table

Verification Input	Description	Internal/ External	Responsible for Verification
Field Notebooks	Field notebooks will be reviewed internally and placed into the project file for archival at project closeout.	Internal	Andrew O'Conor/ AGVIQ-CH2M HILL
Chains of Custody and Shipping Forms	Chain-of-custody forms and shipping documentation will be reviewed internally upon their completion and verified against the packed sample coolers they represent. The shipper's signature on the chain-of-custody will be initialed by the reviewer, a copy of the chain-of-custody retained in the site file, and the original and remaining copies taped inside the cooler for shipment. Ensure that all data requested on the COC have been received.	Internal	Andrew O'Conor/ AGVIQ-CH2M HILL Project Chemist : Camden Robinson/ AGVIQ-CH2M HILL
Sample Condition upon Receipt	Any discrepancies, missing, or broken containers will be communicated to the project chemist or designee in the form of laboratory logins.	External	Randy Ward, Laboratory QA Officer/Empirical Laboratories, LLC
Laboratory Data	All laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal.	External	Randy Ward, Laboratory QA Officer/Empirical Laboratories, LLC
Laboratory Data	All received data packages will be verified by the project chemist	External	Project Chemist: Camden Robinson/AGVIQ-CH2M HILL
Audit Reports	Upon report completion, a copy of all audit reports will be placed in the site file. If CAs are required, a copy of the documented CA taken will be attached to the appropriate audit report in the QA site file. Periodically, and at the completion of site work, site file audit reports and CA forms will be reviewed internally to ensure that all appropriate CAs have been taken and that CA reports are attached. If CAs have not been taken, the site manager will be notified to ensure action is taken.	Internal	Project Manager: Tom Beisel/ AGVIQ-CH2M HILL Project QC Manager: Eric Burrell/ AGVIQ-CH2M HILL Program QA/QC Manager: Theresa Rojas/ AGVIQ-CH2M HILL
CA Reports	CA reports will be reviewed by the project chemist or PM and placed into the project file for archival at project closeout.	Internal	Project Chemist: Camden Robinson/AGVIQ-CH2M HILL Project Manager: Tom Beisel/AGVIQ-CH2M HILL

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SAP Worksheet #35—Validation (Steps IIa and IIb) Process Table

Step IIa/IIb	Validation Input	Description	Responsible for Validation
IIb	Onsite Screening	Ensure that all field data meet SAP requirements for completeness and accuracy based on the field calibration records.	Andrew O'Conor/ AGVIQ-CH2M HILL
IIa	SOPs	Ensure that all sampling and analytical SOPs were followed.	Andrew O'Conor/AGVIQ-CH2M HILL Randy Ward, Laboratory QA Officer/Empirical Laboratories, LLC
IIa	Method QC Results	Ensure that all required QC samples were run and met method and/or project required limits.	Camden Robinson/ AGVIQ-CH2M HILL
IIa	Preliminary Results	Ensure that field analysis was performed correctly and associated QC passed criteria Preliminary results will be reviewed for technical accuracy. Only the associated batch QC (method blank, blank spikes, matrix spikes, and surrogates) will be reviewed to determine if re-analysis/re-extraction is required before the holding time expires.	Camden Robinson/ AGVIQ-CH2M HILL
IIa	Sample Chronology	Holding times from collection to extraction or analysis and from extraction to analysis will be considered by the data validator during the data validation process.	Camden Robinson/AGVIQ-CH2M HILL
IIa	Electronic Data Deliverables	Electronic data deliverables will be compared against hardcopy laboratory results.	Project Data Coordinator: Kama White/ AGVIQ-CH2M HILL
IIb	SAP QC Sample Results	Ensure that all required SAP QC samples were run and met required limits.	Camden Robinson/ AGVIQ-CH2M HILL
IIb	QLs	Ensure all sample results met the project quantification limit specified in the SAP.	Camden Robinson/ AGVIQ-CH2M HILL
IIa	Case Narrative	Case narratives will be reviewed by the data validator during the data validation process.	Camden Robinson/AGVIQ-CH2M HILL

SAP Worksheet #35—Validation (Steps IIa and IIb) Process Table (continued)

Step IIa/IIb	Validation Input	Description	Responsible for Validation
IIa	Raw Data	Review all raw data to confirm laboratory calculations.	Camden Robinson/ AGVIQ-CH2M HILL

Notes:

IIa = Compliance with methods, procedures, and contracts
IIb = Comparison with measurement performance criteria in the SAP

SAP Worksheet #36—Analytical Data Validation (Steps IIa and IIb) Summary Table

Step IIa/IIb	Matrix	Analytical Group	Validation Criteria	Data Validator
IIa	Groundwater	Selected Volatiles and Methane	Analytical methods and laboratory SOPs as presented in this SAP will be used to evaluate compliance against QA/QC criteria. Should adherence to QA/QC criteria yield deficiencies (see Worksheets #12, 15, 24, and 28), data may be qualified. The data qualifiers that may be used are those presented in EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review, EPA540/R-99/008, October 1999 using guidance from DoD QSM - Version 3 Final, DoD, January 2006 (Based On NELAC Voted Version – 5 June 2003).	Camden Robinson/ AGVIQ-CH2M HILL
IIa	Groundwater	Nitrate, Nitrite, Sulfate, TOC, Sulfide, and Alkalinity	Analytical methods and laboratory SOPs as presented in this SAP will be used to evaluate compliance against QA/QC criteria. Should adherence to QA/QC criteria yield deficiencies (see Worksheets #12, 15, 24, and 28), data may be qualified. The data qualifiers that may be used are those presented in EPA Contract Laboratory Program National Functional Guidelines for In-Organics, EPA540-R-04-004, October 2004 using guidance from DoD QSM - Version 3 Final, DoD, January 2006 (Based on NELAC Voted Version – 5 June 2003).	Camden Robinson/ AGVIQ-CH2M HILL
IIa	Aqueous	VOCs, SVOCs, Pesticides, Herbicides, PCBs, Metals, Reactivity, Corrosivity, Ignitability	Data will be reviewed against the analytical methods for outstanding QA/QC issues (see Worksheets #12, 15, 24, and 28) and anomalies by the laboratory. Issues will be summarized in the case narrative. AGVIQ-CH2M HILL chemist and PM will review the analytical results and case narrative before the data is loaded to ensure no major problems exist.	Empirical Laboratories, LLC Camden Robinson/ AGVIQ-CH2M HILL Tom Beisel/ AGVIQ-CH2M HILL
IIa	Solids	TCLP VOCs, TCLP SVOCs, TCLP Pesticides, TCLP Herbicides, PCBs, TCLP Metals, Reactivity, Corrosivity, Ignitability	Data will be reviewed against the analytical methods for outstanding QA/QC issues (see Worksheets #12, 15, 24, and 28) and anomalies by the laboratory. Issues will be summarized in the case narrative. AGVIQ-CH2M HILL chemist and PM will review the analytical results and case narrative before the data is loaded to ensure no major problems exist.	Empirical Laboratories, LLC Camden Robinson/ AGVIQ-CH2M HILL Tom Beisel/ AGVIQ-CH2M HILL

SAP Worksheet #36—Analytical Data Validation (Steps IIa and IIb) Summary Table (continued)

Step IIa/IIb	Matrix	Analytical Group	Validation Criteria	Data Validator
IIb	Groundwater	Selected Volatiles and Methane	Results will be compared to PALs as specified in Worksheet #15.	Camden Robinson/ AGVIQ-CH2M HILL
IIb	Groundwater	Nitrate, Nitrite, Sulfate, TOC, Sulfide, and Alkalinity	Results will be compared to PALs as specified in Worksheet #15.	Camden Robinson/ AGVIQ-CH2M HILL
IIb	Aqueous	VOCs, SVOCs, Pesticides, Herbicides, PCBs, Metals, Reactivity, Corrosivity, Ignitability	Results will be compared to PALs in Worksheet #15.	Camden Robinson/ AGVIQ-CH2M HILL Tom Beisel/ AGVIQ-CH2M HILL
IIb	Solid	TCLP VOCs, TCLP SVOCs, TCLP Pesticides, TCLP Herbicides, PCBs, TCLP Metals, Reactivity, Corrosivity, Ignitability	Results will be compared to PALs in Worksheet #15.	Camden Robinson/ AGVIQ-CH2M HILL Tom Beisel/ AGVIQ-CH2M HILL

Notes:

IIa = Compliance with methods, procedures, and contracts
IIb = Comparison with measurement performance criteria in the SAP

SAP Worksheet #37—Usability Assessment

Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used:

- Non-detected site contaminants will be evaluated to ensure that project-required QLs in Worksheet #15 were achieved. If project QLs were achieved and the verification and validation steps yielded acceptable data, then the data are considered usable.
- During verification and validation steps, data may be qualified as estimated with the following qualifiers: J, UJ, B, or JB. These qualifiers represent minor QC deficiencies, which will not affect the usability of the data. When major QC deficiencies are encountered, data will be qualified with an R or UR, and in most cases, are not considered usable for project decisions.
- For statistical comparisons, non-detect values will be represented by a concentration equal to one-half the sample reporting limit. For duplicate sample results, the most conservative value will be used for project decisions.
- Analytical data will be checked to ensure the values and any qualifiers are appropriately transferred to the electronic database. These checks include comparison of hardcopy data and qualifiers to the electronic data deliverable. Once the data has been uploaded into the electronic database, another check will be performed to ensure all results were loaded accurately.
- Field and laboratory precision will be compared as RPD between the two results.
- Deviations from this SAP will be reviewed to assess whether CA is warranted and to assess impacts to achievement of project objectives.

Describe the evaluative procedures used to assess overall measurement error associated with the project:

- To assess whether a sufficient quantity of acceptable data is available for decision making, the data will be reconciled with measurement performance criteria following validation and review of DQIs.
- If significant biases are detected within laboratory QA/QC samples, they will be evaluated to assess impact on decision making. Low biases will be described in greater detail, as they represent a possible inability to detect compounds that may be present at the site.
- If significant deviations are noted between lab and field precision, the cause will be further evaluated to assess impact on decision making.

Describe the documentation that will be generated during the usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies:

The following will be prepared by AGVIQ-CH2M HILL and presented to and submitted to the Tier I Partnering Team for review and decisions on the path forward for the site:

- Data tables will be produced to reflect detected and non-detected site COCs. Data qualifiers will be reflected in the tables and discussed in the DQE.

- Graphical representations will be produced to reflect increasing and/or decreasing concentrations of COCs and geochemical parameters.
- Maps will be produced to reflect increasing and/or decreasing areas of soil contamination.
- A DQE considering all of the above will be provided as part of presentations to the Tier I Partnering Team, followed by the technical memorandum prepared to assess remedy effectiveness. The technical memorandum will identify any data usability limitations and make recommendations for CA if necessary.

Identify the personnel responsible for performing the usability assessment:

The AGVIQ-CH2M HILL team, including the PM, Project Chemist, and Senior Technologist, will review the data and compile a presentation for the Partnering Team. The Tier I Partnering Team as a whole will assess the usability of the data.

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APPENDIX A

Figures

City

Major Road

Naval Station Roosevelt Roads Boundary

N

0 5 10 20 Miles

FIGURE 1
NAPR Location in Puerto Rico
Naval Station Roosevelt Roads, Puerto Rico

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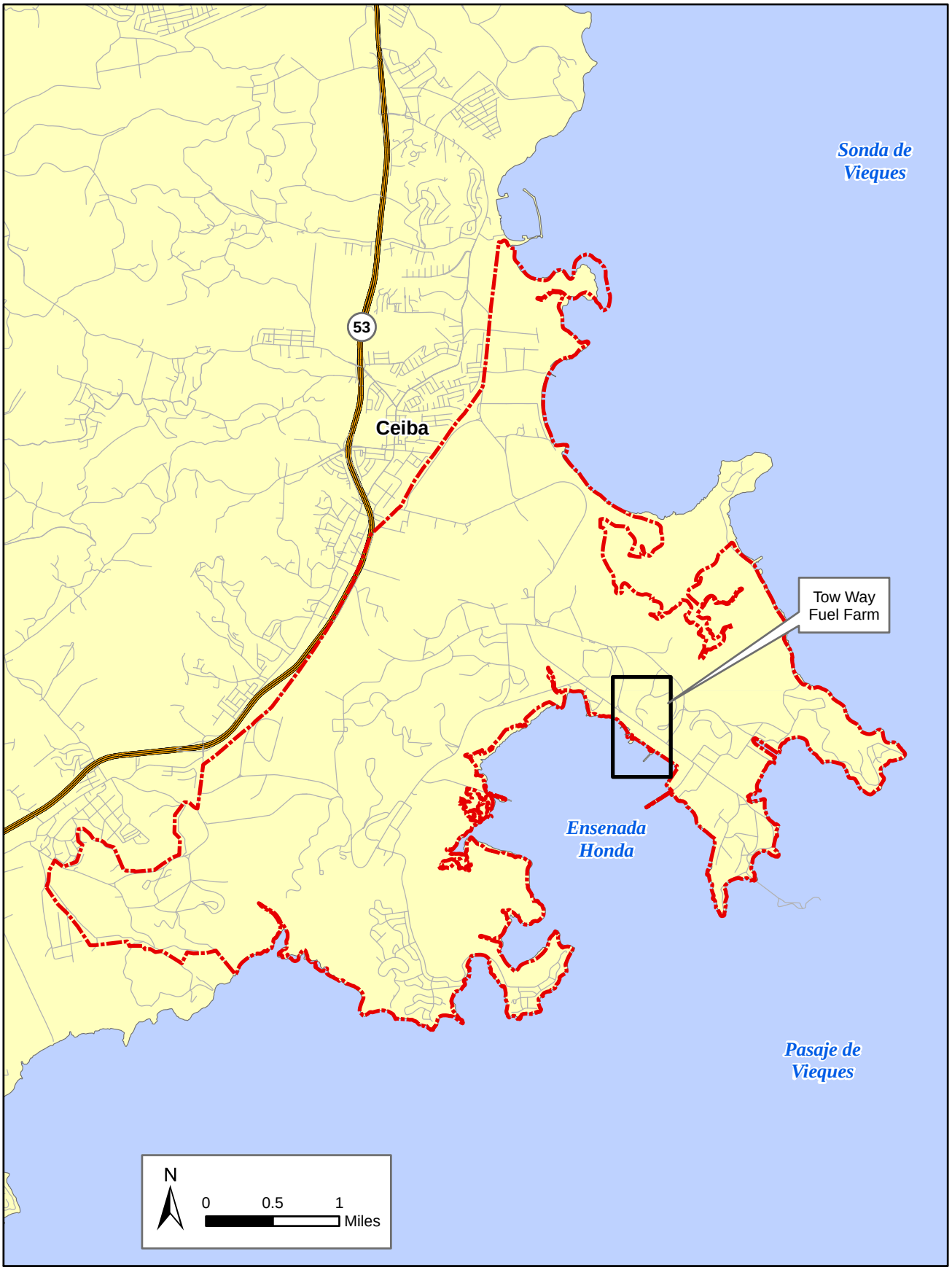

Road

Expressway

Naval Station Roosevelt Roads Boundary

FIGURE 2
Tow Way Fuel Farm Location
Naval Station Roosevelt Roads, Puerto Rico

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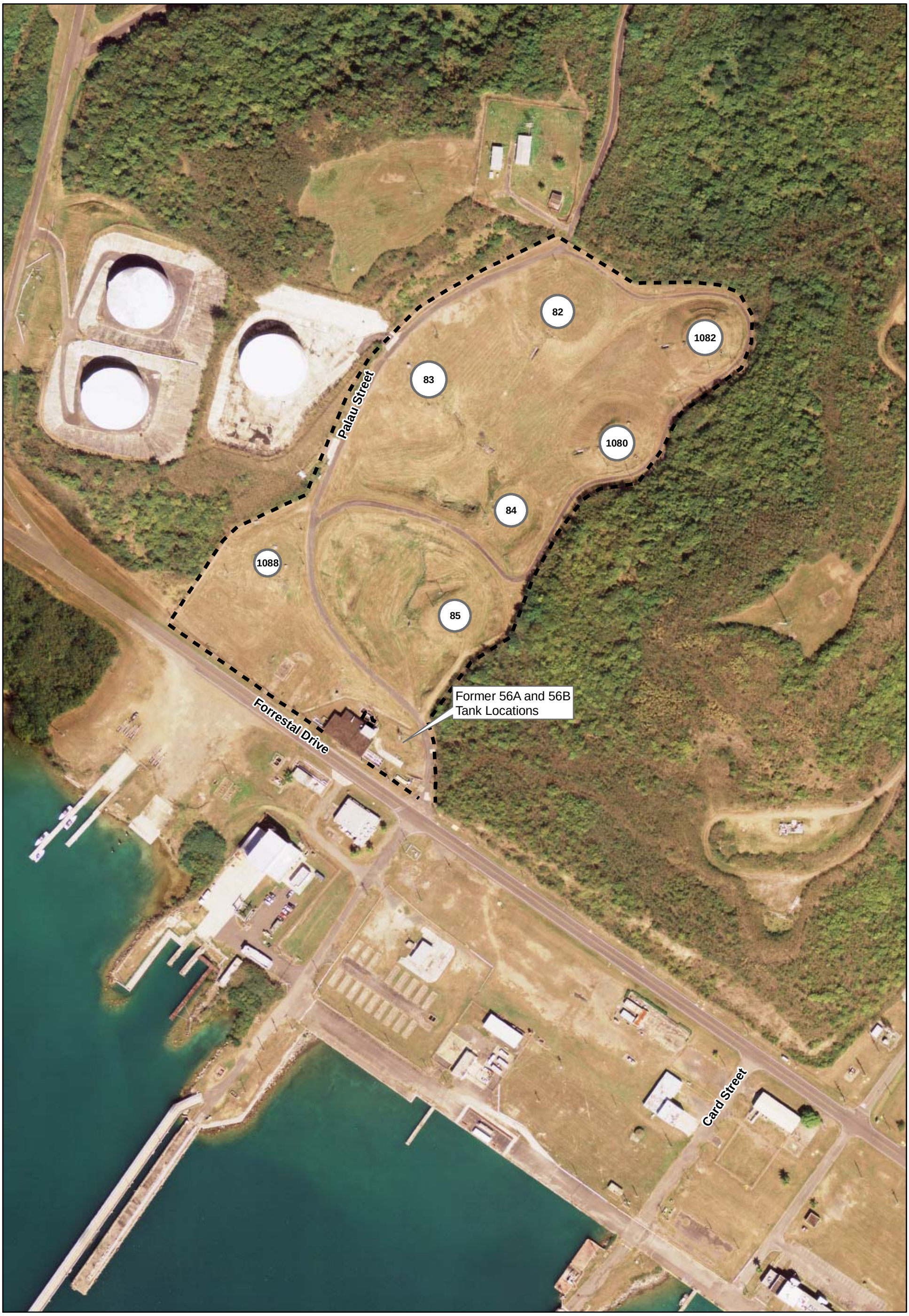

Fence

Former Fuel Tank

N

0 100 200 Feet

1 inch = 200 feet

FIGURE 3
SWMU 7/8 Base Map
Tow Way Fuel Farm
Naval Station Roosevelt Roads, Puerto Rico

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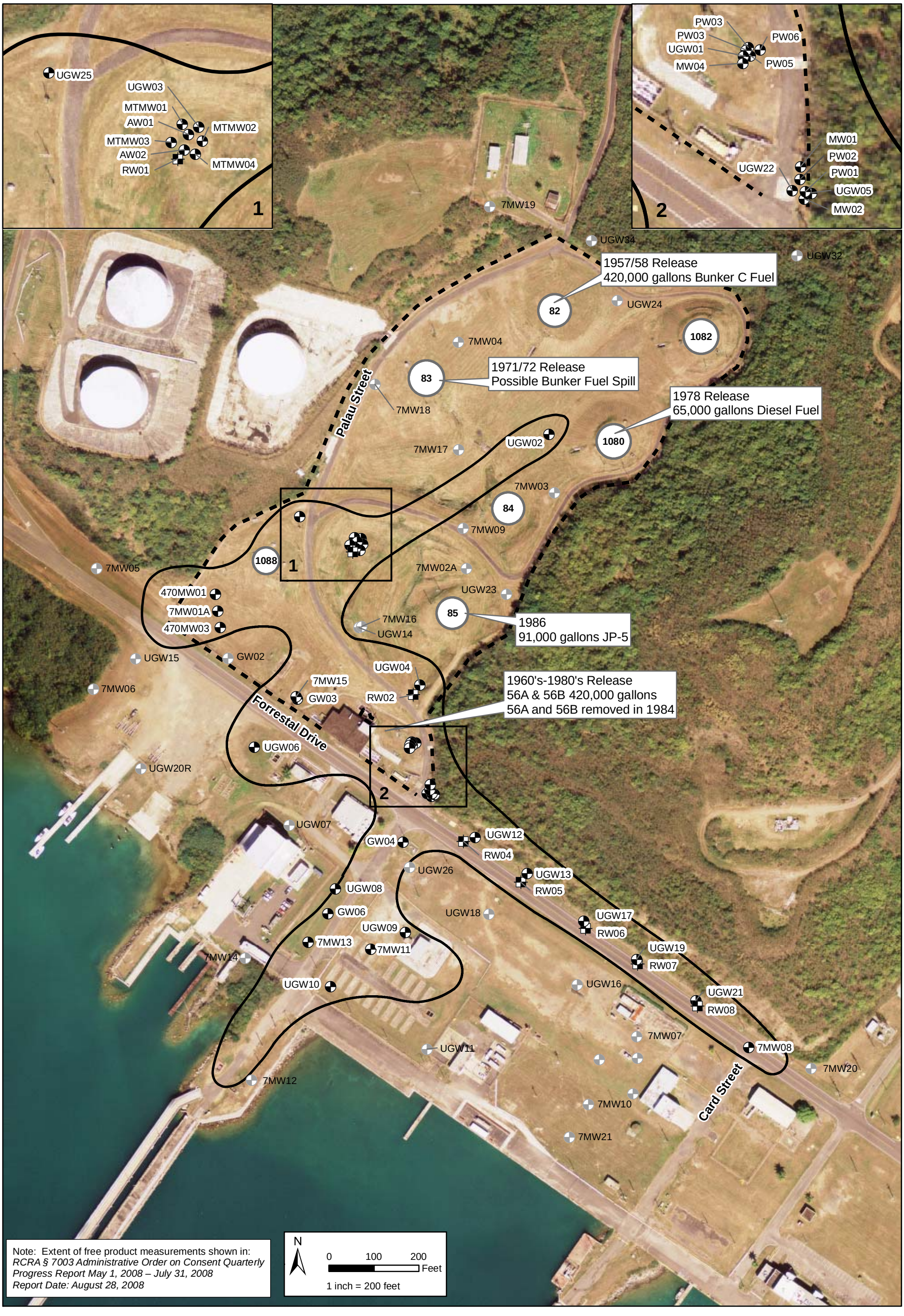

Note: Extent of free product measurements shown in:
RCRA § 7003 Administrative Order on Consent Quarterly Progress Report May 1, 2008 – July 31, 2008
Report Date: August 28, 2008

Wells

- Monitoring and Observation Well
- Recovery Well
- Historical Extent of Phase Separated Hydrocarbons (PSH)
- Fence
- Former Fuel Tank

UGW12	Well with measurable amount of free product.
UGW18	Well with no measurable amount of free product.

FIGURE 4
Historical Extent of Free Product
Tow Way Fuel Farm
Naval Station Roosevelt Roads, Puerto Rico

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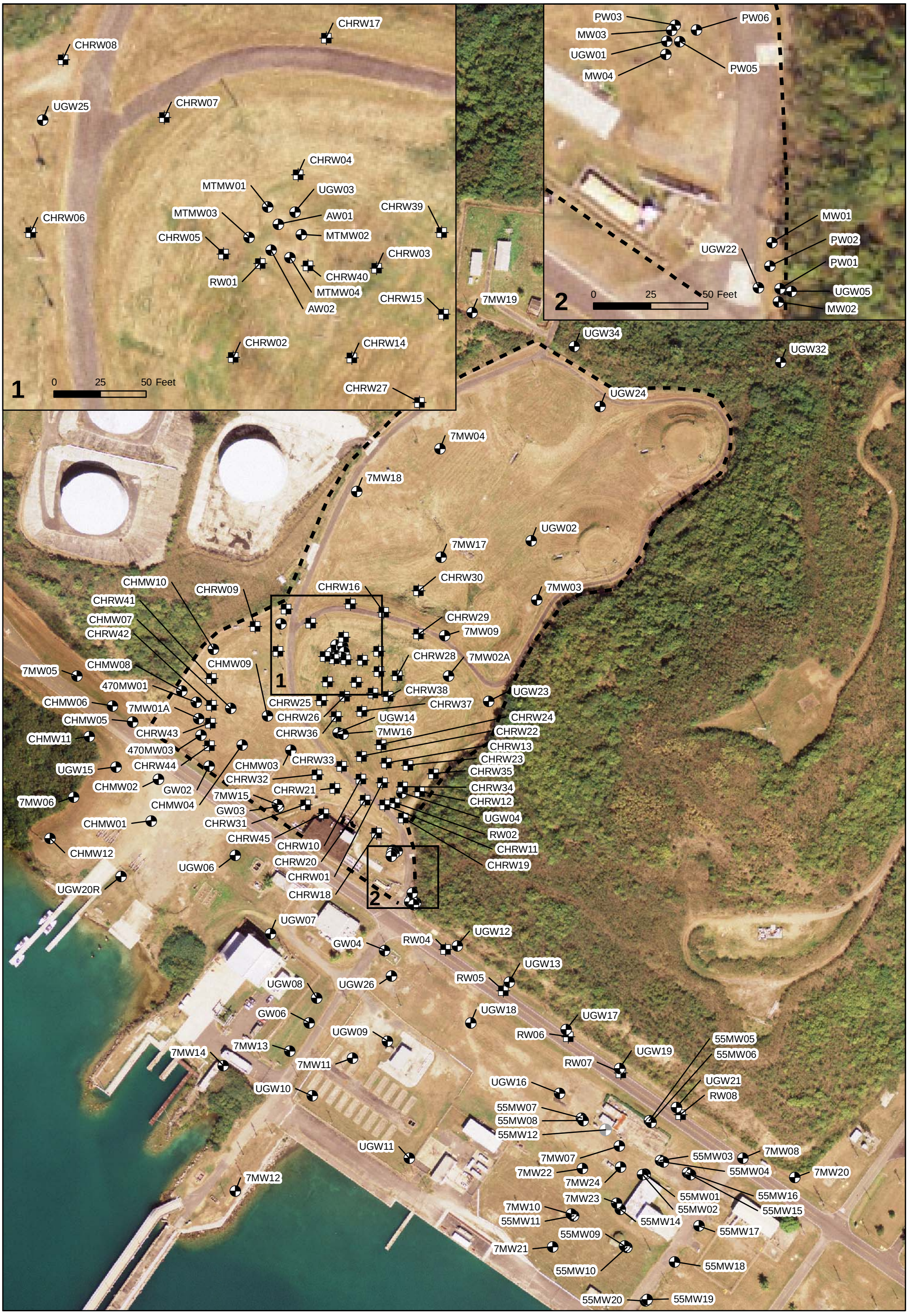

Wells

- Monitoring and Observation Well
- Monitoring Well (Not Surveyed)
- Recovery Well
- Fence

N

0 100 200 Feet

1 inch = 200 feet

FIGURE 5
Existing Well Locations
Tow Way Fuel Farm
Naval Station Roosevelt Roads, Puerto Rico

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Monitoring and Observation Well

Recovery Well

Groundwater Flow

Potentiometric Contour (Dashed Where Inferred)

Fence

Groundwater Elevation
in Feet NGVD29

N

0 100 200 Feet

1 inch = 200 feet

FIGURE 6
Groundwater Piezometric Surface (April 9, 2010)
Tow Way Fuel Farm
Naval Station Roosevelt Roads, Puerto Rico

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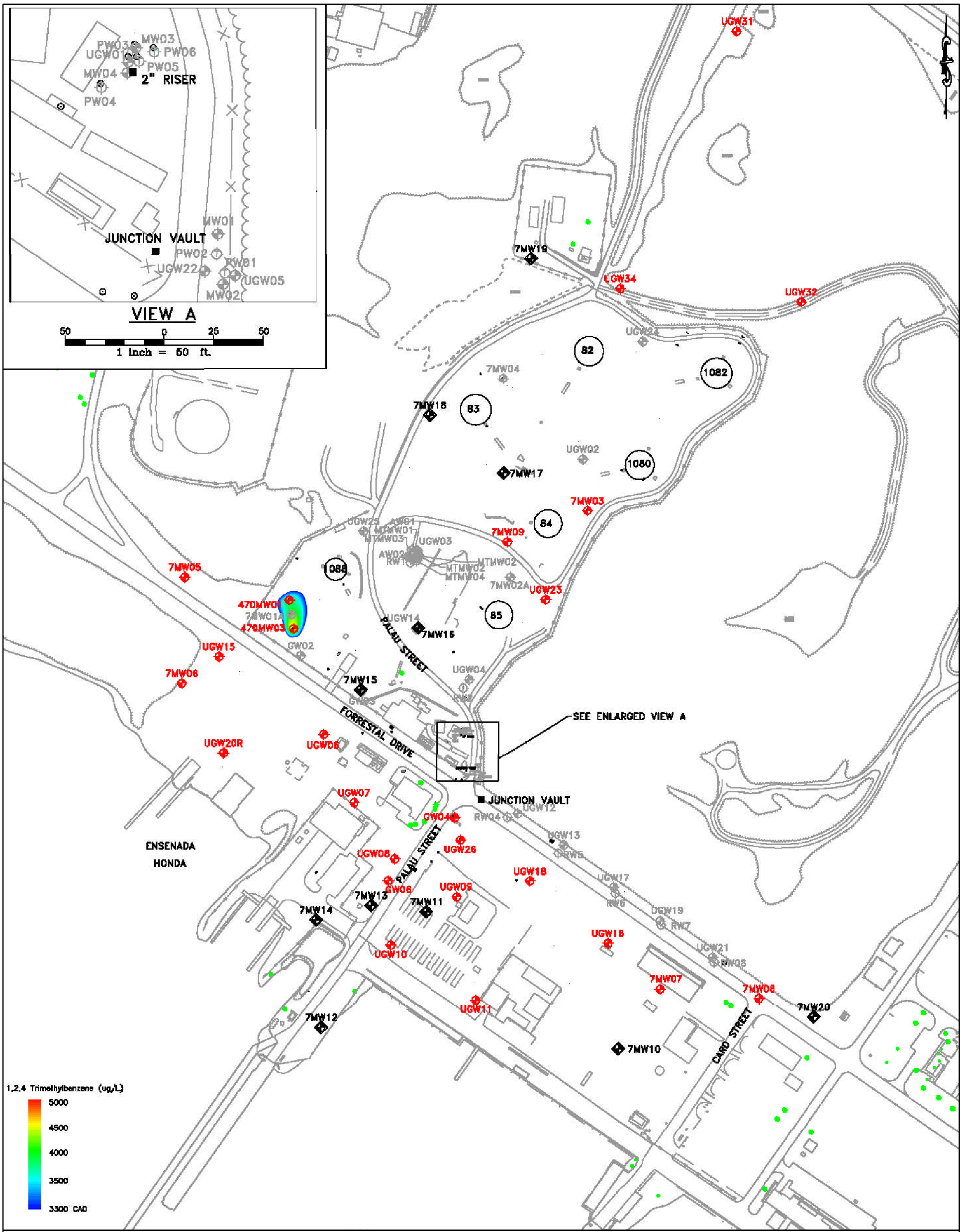

NOTE:
DATUM PLAN USED IS MEAN LOW WATER = 100.00 FT. AS ESTABLISHED BY U.S. NAVY SURVEY SECTION AS OF NOVEMBER 1941.

LEGEND

- NEW MONITOR WELL LOCATION
- MONITOR WELL LOCATION
- ICHOR PRODUCT RECOVERY WELL LOCATION
- TERRAVAC PRODUCT RECOVERY WELL LOCATION
- MANTECH MONITOR WELL
- MANTECH CLEANOx APPLICATION WELL

FIGURE 7
1,2,4 - Trimethylbenzene Dissolved Groundwater Plume
Tow Way Fuel Farm
Naval Station Roosevelt Roads, Puerto Rico

Source: Baker Environmental, Inc *Revised Final CMS Final Report for TWFF.* November 22, 2005

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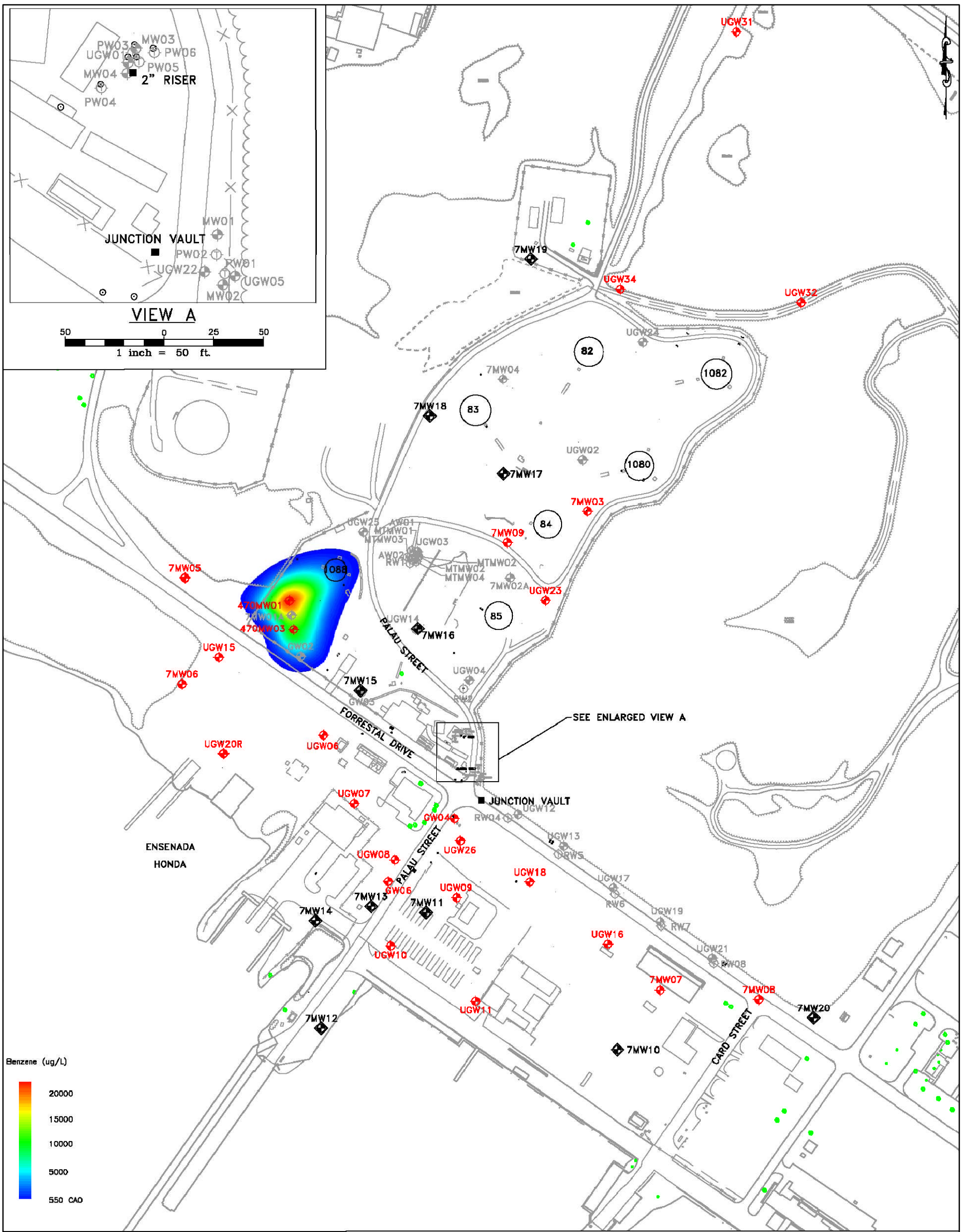

NOTE:
DATUM PLAN USED IS MEAN LOW WATER = 100.00 FT. AS ESTABLISHED BY U.S. NAVY SURVEY SECTION AS OF NOVEMBER 1941.

LEGEND

- NEW MONITOR WELL LOCATION
- MONITOR WELL LOCATION
- TERRAVAC PRODUCT RECOVERY WELL LOCATION
- ICHOR PRODUCT RECOVERY WELL LOCATION
- MANTECH MONITOR WELL
- MANTECH CLEANOx APPLICATION WELL

FIGURE 8
Benzene Dissolved
Groundwater Plume
Tow Way Fuel Farm
Naval Station Roosevelt Roads, Puerto Rico

Source: Baker Environmental, Inc *Revised Final CMS Final Report for TWFF.* November 22, 2005

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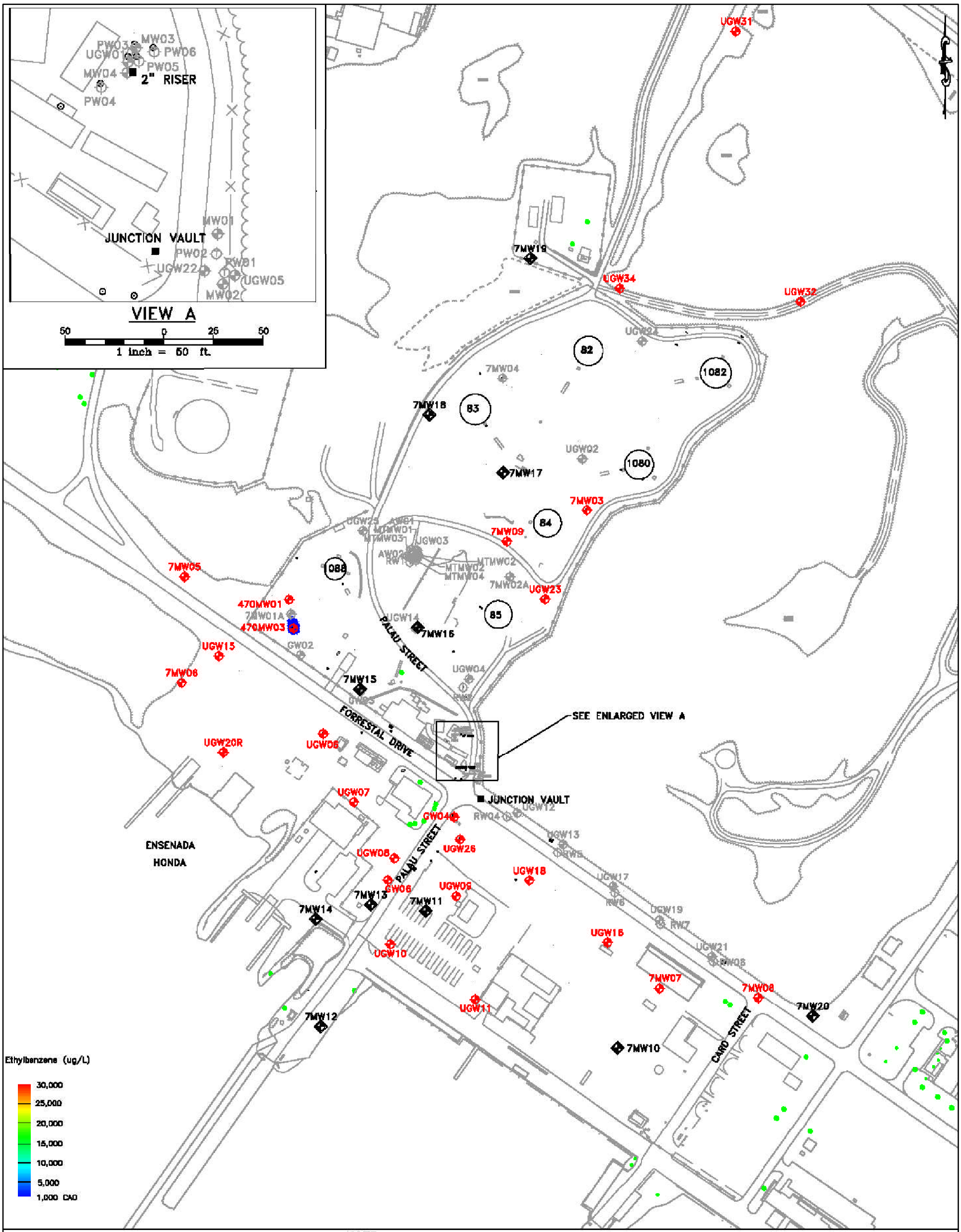

NOTE:
DATUM PLAN USED IS MEAN LOW WATER = 100.00 FT. AS ESTABLISHED BY U.S. NAVY SURVEY SECTION AS OF NOVEMBER 1941.

LEGEND

- NEW MONITOR WELL LOCATION
- MONITOR WELL LOCATION
- TERRAVAC PRODUCT RECOVERY WELL LOCATION
- ICHOR PRODUCT RECOVERY WELL LOCATION
- MANTECH MONITOR WELL
- MANTECH CLEANOx APPLICATION WELL

FIGURE 9
Ethylbenzene Dissolved
Groundwater Plume
Tow Way Fuel Farm
Naval Station Roosevelt Roads, Puerto Rico

Source: Baker Environmental, Inc *Revised Final CMS Final Report for TWFF.* November 22, 2005

Wells

- Monitoring and Observation Well
- Recovery Well
- Fence

N

0 100 200 Feet

1 inch = 200 feet

FIGURE 10
MNA Monitoring/Recovery Well Locations
Tow Way Fuel Farm
Naval Station Roosevelt Roads, Puerto Rico

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APPENDIX B

Standard Operating Procedures

Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

GUIDANCE

Title: **Design and Installation of Monitoring Wells**

Effective Date: February 18, 2008	**Number:** SESDGUID-101-R0

Authors

Name: Brian Striggow
Title: Environmental Engineer
Signature: Date: 2-13-08

Approvals

Name: Antonio Quiñones
Title: Chief, Enforcement and Investigations Branch
Signature: Date: 2/13/08

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Title: Field Quality Manager, Science and Ecosystem Support Division
Signature: Laura Ackerman Date: 02/13/08

Revision History

This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by the SESD Document Control Coordinator.

History	Effective Date
SESDGUID-101-R0, *Design and Installation of Monitoring Wells*, Original Issue	February 18, 2008

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1 General Information

1.1 Purpose

This document describes general and specific procedures, methods and considerations to be used and observed when designing and installing permanent and temporary groundwater monitoring wells to be used for collection of groundwater samples.

1.2 Scope/Application

The procedures contained in this document are to be used by field personnel when designing, constructing and installing groundwater monitoring wells. On the occasion that SESD field personnel determine that any of the procedures described in this section are either inappropriate, inadequate or impractical and that another procedure must be used for any aspect of the design, construction and/or installation of a groundwater monitoring well, the variant procedure will be documented in the field log book, along with a description of the circumstances requiring it's use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and has been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the H: drive of the SESD local area network. The Document Control Coordinator is responsible for ensuring the most recent version of the procedure is placed on the H: drive and for maintaining records of review conducted prior to its issuance.

1.4 References

USEPA Region 4 Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), November 2001

USEPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Science and Ecosystem Support Division, Region 4, Athens, GA.

SESD Operating Procedure for Field Sampling Quality Control, SESDPROC-011-Most Recent Version

SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205- Most Recent Version

SESD Operating Procedure for Field Records and Documentation, SESDPROC-204-Most Recent Version

SESD Operating Procedure for Groundwater Sampling, SESDPROC-301- Most Recent Version

SESD Operating Procedure for Management of Investigation Derived Waste, SESDPROC-202- Most Recent Version

EPA/540/S-95/503, *Nonaqueous Phase Liquids Compatibility with Materials Used in Well Construction, Sampling, and Remediation*

ASTM standard D5092, *Design and Installation of Ground Water Monitoring Wells in Aquifers*

1.5 General Precautions

1.5.1 Safety

Proper safety precautions must be observed when constructing and installing groundwater monitoring wells. Refer to the SESD Safety, Health and Environmental Management Program Procedures and Policy (SHEMP) Manual and any pertinent site-specific Health and Safety Plans (HASPs) for guidelines on safety precautions. These guidelines should be used to complement the judgment of an experienced professional. When using this procedure, minimize exposure to potential health hazards through the use of protective clothing, eye wear and gloves. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate. Section 2.6, Safety Procedures for Drilling Activities, contains detailed and specific safety guidelines that must be followed by Branch personnel when conducting activities related to monitoring well construction and installation.

1.5.2 Procedural Precautions

The following precautions should be considered when constructing and installing groundwater monitoring wells.

- Special care must be taken to minimize or prevent inadvertent cross-contamination between borehole locations. Equipment, tools and well materials must be cleaned and/or decontaminated according to procedures found in SESD Operating Procedure for Field Equipment Cleaning and Decontamination, (SESDPROC-205).
- All field activities are documented in a bound logbook according to the procedures found in SESD Operating Procedure for Field Records and Documentation, (SESDPROC-204).

2 Permanent Monitoring Well Design Considerations

2.1 General

The design and installation of permanent monitoring wells involves drilling into various types of geologic formations that exhibit varying subsurface conditions. Designing and installing permanent monitoring wells in these geologic environments may require several different drilling methods and installation procedures. The selection of drilling methods and installation procedures should be based on field data collected during a hydrogeologic site investigation and/or a search of existing data. Each permanent monitoring well should be designed and installed to function properly throughout the duration of the monitoring program. When designing monitoring wells, the following should be considered:

- Short-and long-term objectives;
- Purpose of the well(s);
- Probable duration of the monitoring program;
- Contaminants likely to be monitored;
- Surface and subsurface geologic conditions;
- Properties of the aquifer(s) to be monitored;
- Well screen placement;
- General site conditions; and
- Potential site health and safety hazards.

In designing permanent monitoring wells, the most reliable, obtainable data should be utilized. Once the data have been assembled and the well design(s) completed, a drilling method(s) must be selected. The preferred drilling methods for installing monitoring wells are those that temporarily case the borehole during drilling and the construction of the well, e.g. hollow-stem augers and sonic methods. However, site conditions or project criteria may not allow using these methods. When this occurs, alternate methods should be selected that will achieve the project objectives. The following discussion of methods and procedures for designing and installing monitoring wells will cover the different aspects of selecting materials and methods, drilling boreholes, and installing monitoring devices.

2.2 Drilling Methods

The following drilling methods may be used to install environmental monitoring wells or collect samples under various subsurface conditions. In all cases the preferred methods are those that case the hole during drilling, i.e. Hollow Stem Augers (HSA) and sonic methods using an override system. Other methods may be used where specific subsurface or project criteria dictate.

2.2.1 Hollow Stem Auger (HSA)

This type of auger consists of a hollow, steel stem or shaft with a continuous, spiraled steel flight, welded onto the exterior. A hollow auger bit, generally with carbide teeth, disturbs soil material when rotated, whereupon the spiral flights transport the cuttings to the surface. This method is best suited in soils that have a tendency to collapse when disturbed. A monitoring well can be installed inside of hollow-stem augers with little or no concern for the caving potential of the soils. If caving sands exist during monitoring well installations, a drilling rig must be used that has enough power to extract the augers from the borehole without having to rotate them. A bottom plug, trap door, or pilot bit assembly can be used at the bottom of the augers to keep out most of the soils and/or water that have a tendency to enter the bottom of the augers during drilling. Potable water (analyzed for contaminants of concern) may be poured into the augers during drilling to equalize pressure so that the inflow of formation materials will be held to a minimum. Water-tight center bits are not acceptable because they create suction when extracted from the augers. This suction forces or pulls cuttings and formation materials into the augers, defeating the purpose of the center plug. Augering without a center plug or pilot bit assembly is permitted, provided that the soil plug, formed in the bottom of the augers, is removed before sampling or installing well casings. Removing the soil plug from the augers can be accomplished by drilling and washing out the plug using a rotary bit, or augering out the plug with a solid-stem auger bit sized to fit inside the hollow-stem auger. Bottom plugs can be used where no soil sampling is conducted during the drilling process. The bottom plug is wedged into the bottom of the auger bit and is knocked out at depth with drill pipe or the weight of the casing and screen assembly. The plug material should be compatible with the screen and casing materials. The use of wood bottom plugs is not acceptable. The type of bottom plug, trap door, or pilot bit assembly proposed for the drilling activity should be approved by a senior field geologist prior to drilling operations. Boreholes can be augered to depths of 150 feet or more (depending on the auger size), but generally boreholes are augered to depths less than 100 feet.

2.2.2 Solid Stem Auger

This type of auger consists of a sealed hollow or solid stem or shaft with a continuous spiraled steel flight welded on the outside of the stem. An auger bit connected to the bottom disturbs soil material when rotated and the helical flights transport cuttings to the surface. At the desired depth the entire auger string is removed to gain access to the bottom of the borehole. This auger method is used in cohesive and semi-cohesive soils that do not have a tendency to collapse when disturbed. Boreholes can be augered to depths of 200 feet or more (depending on the auger size), but generally boreholes are augered to depths less than 100 feet.

Both of the previously discussed auger methods can be used in unconsolidated soils and semi-consolidated (weathered rock) soils, but not in competent rock.

Each method can be employed without introducing foreign materials into the borehole such as water and drilling fluids, minimizing the potential for cross contamination. Minimizing the risk of cross contamination is one of the most important factors to consider when selecting the appropriate drilling method(s) for a project.

2.2.3 Sonic Methods

These methods generally alternately advance concentric hollow drill stems using rotation in conjunction with axial vibration of the drill stem. After each stage of drill stem advancement, the inner string is removed with a core of drill cuttings while the outer 'override' string remains to hold the borehole open. The cuttings can be removed nearly intact from the inner casing for examination of the stratigraphy prior to sampling or disposal. Because there are no auger flights to increase the borehole diameter, the quantity of cuttings removed from the hole is minimized as compared to hollow stem augering. With moderate rotation, smearing of the formation materials on the borehole walls is reduced as well. This drilling method is useful in a variety of materials, from flowing sands to heavily consolidated or indurated formations.

In flowing sands, the drill casings can be filled and/or pressurized with potable water to prevent excess entry of formation materials into the drill string. The same QA/QC requirements for sampling of material introduced to the borehole apply as in other drilling methods. Because the amount of water introduced into the borehole can be significant, an approximation of the water used in the drilling process should be logged for use in estimating appropriate well development withdrawal.

Sonic drilling allows a larger diameter temporary casing to be set into a confining layer while drilling proceeds into deeper aquifers. This temporary casing is then removed during the grouting operation. In many cases this will be acceptable technique. However, the level of contamination in the upper aquifer, the importance of the lower aquifers for drinking water uses, the permeability and continuity of the confining layer, and state regulations should be taken into account when specifying this practice as opposed to permanent outer casing placed into the confining unit. Note that when using the temporary casing practice, it is critical that grout be mixed and placed properly as specified elsewhere in this section.

Because the total borehole diameter in sonic drilling is only incrementally larger than the inner casing diameter, particular care should be taken that the well casing is placed in the center of the drill stem while placing the filter pack. Centralizers should be used in most cases to facilitate centering, particularly in the case of deep wells with PVC casing.

2.2.4 Rotary Methods

These methods consist of a drill pipe or drill stem coupled to a drilling bit that rotates and cuts through the soils. The cuttings produced from the rotation of the drilling bit are transported to the surface by drilling fluids which generally consist of water, drilling mud, or air. The water, drilling mud, or air are forced down through the drill pipe, and out through the bottom of the drilling bit. The cuttings are then lifted to the surface between the borehole wall and the drill pipe, (or within a concentric drill stem in reverse rotary). Except in the case of air rotary, the drilling fluid provides a hydrostatic pressure that reduces or prevents borehole collapse. When considering this method, it is important to evaluate the potential for contamination when fluids and/or air are introduced into the borehole.

Due to the introduction of the various circulating fluids, the use of rotary methods requires that the potential for contamination by these fluids be evaluated. Water and mud rotary methods present the possibility of trace contamination of halogenated compounds when municipal water supplies are used as a potable water source. Air rotary drilling can introduce contamination through the use of lubricants or entrained material in the air stream. Unless contaminated formations are cased off, the circulation of drilling fluids presents a danger of cross contamination between formations. In any of the rotary (or sonic) methods, care must be exercised in the selection and use of compounds to prevent galling of drill stem threads.

2.2.4.1 Water Rotary

When using water rotary, potable water (that has been analyzed for contaminants of concern) should be used. If potable water (or a higher quality water) is not available on-site, then potable water will have to be transported to the site or an alternative drilling method will have to be selected. Water does not clog the formation materials, but the suspended drilling fines can be carried into the formation, resulting in a very difficult to develop well. This method is most appropriate for setting isolation casing.

2.2.4.2 Air Rotary

Air rotary drilling uses air as a drilling fluid to entrain cuttings and carry them to the surface. High air velocities, and consequently large air volumes and compressor horsepower are required. “Down-the-hole” (DTH) percussion hammers driven by the air stream can be used with this method to rapidly penetrate bedrock materials. Where a casing through unconsolidated material is required to prevent borehole collapse, it can be driven in conjunction with advancement of the drill stem.

When using air rotary drilling in any zone of potential contamination, the cuttings exiting the borehole must be controlled. This can be done using

the dual-tube reverse circulation method where cuttings are carried to the surface inside dual-wall drill pipe and separated with a cyclone separator. An air diverter with hose or pipe carrying cuttings to a waste container is also an acceptable alternative. Allowing cuttings to blow uncontrolled from the borehole is not acceptable.

When using air rotary, the issue of contaminants being introduced into the borehole by the air stream must be addressed. Screw compressor systems should have a coalescing filter system in good working order to capture excess entrained compressor oils. The lubricant to be used with DTH hammers as well as thread lubricants to be used on drill stem should be evaluated for their potential impact on analytical samples.

2.2.4.3 Mud Rotary

Mud rotary is an undesirable drilling method because contamination can be introduced into the borehole from the constituents in the drilling mud, cross contamination can occur along the borehole column, and it is difficult to remove the drilling mud from the borehole after drilling and during well development. The drilling mud can also carry contaminates from a contaminated zone to an uncontaminated zone thereby cross-contaminating the borehole. If mud rotary is selected, only potable water and pure (no additives) bentonite drilling muds should be used. All materials used should have adequate documentation as to manufacturer's recommendations and product constituents. QA/QC samples of drilling muds and potable water should be sampled at a point of discharge from the circulation system to assure that pumps and piping systems are not contributing cross-contamination from previous use.

2.2.5 Other Methods

Other methods such as the cable-tool method, jetting method, and boring (bucket auger) method are available. If these and/or other methods are selected for monitoring well installations, they should be approved by a senior field geologist before field work is initiated.

2.3 Borehole Construction

2.3.1 Annular Space

The borehole or hollow stem auger should be of sufficient diameter so that well construction can proceed without major difficulties. For open boreholes, the annular space should be approximately 2" to allow the uniform deposition of well materials around the screen and riser, and to allow the passage of tremie pipes and well materials without unduly disturbing the borehole wall. For example, a 2" nominal diameter (nom.) casing would require a 6" inside diameter (ID) borehole.

In hollow stem augers and sonic method drill casing, the ID should be of sufficient size to allow the passage of the tremie pipe to be used for well grout placement, as well as free passage of filter sands or bentonite pellets dropped through the auger or casing. In general, 4-1/4" ID should be the minimum size used for placement of 2" nom. casing and 8-1/4" ID for 4" nom. casing. Larger augers should be used where installation difficulties due to geologic conditions or greater depths are anticipated, e.g. larger augers might be required to place a bentonite pellet seal through a long water column.

2.3.2 Over-drilling the Borehole

Sometimes it is necessary to over-drill the borehole in anticipation of material entering the augers during center bit removal or knocking out of the bottom plug. Normally, 3 to 5 feet is sufficient for over-drilling. The borehole can also be over-drilled to allow for an extra space or a "sump" area below the well screen. This "sump" area provides a space to attach a 5 or 10 foot section of well casing to the bottom of the well screen. The extra space or "sump" below the well screen serves as a catch basin or storage area for sediment that flows into the well and drops out of suspension. These "sumps" are added to the well screens when the wells are screened in aquifers that are naturally turbid and will not yield clear formation water (free of visible sediment) even after extensive development. The sediment can then be periodically pumped out of the "sump" preventing the well screen from clogging or "silting up". If the borehole is inadvertently drilled deeper than desired, it can be backfilled to the design depth with bentonite pellets, chips, or the filter sand that is to be used for the filter pack.

2.3.3 Filter Pack Placement

When placing the filter pack into the borehole, a minimum of 6-inches of the filter pack material should be placed under the bottom of the well screen to provide a firm base. Also, the filter pack should extend a minimum of 2-feet above the top of the well screen to allow for settling and to isolate the screened interval from the grouting material. In open boreholes, the filter pack should be placed by the tremie or positive displacement method. Placing the filter pack by pouring the sand into an open drill stem is acceptable with the use hollow stem augers, and other methods where the borehole is temporarily cased down to the filter pack.

2.3.4 Filter Pack Seal – Bentonite Pellet Seal (Plug)

Bentonite pellets consist of ground, dried bentonite compacted into pellets available in several sizes. Bentonite pellets are compressed to a bulk density of 70-80 lbs/cu.ft. and hydrate to a 30% min. solids material. Where neat cement grouts are to be used, the placement of a bentonite pellet seal above the filter pack is mandatory to prevent the possibility of grout infiltration into the screened interval prior to setting. Bentonite chips or other sealing products should not be

substituted in this application. Where bentonite grouts are to be used, the placement of a bentonite pellet seal is optional, but desirable.

Since bentonite pellets begin hydrating rapidly, they can be very difficult to place properly. They are generally placed by pouring slowly into open boreholes, hollow stem augers or sonic drill pipe. In some cases, pellets are placed by tremie pipe and flushed into place with potable water. A tamper can be used to ensure that the material is being placed properly and to rapidly break up any pellet bridging that occurs.

Pellet seals should be designed for a two-foot thickness of dry pellets above the filter pack. Hydration may extend the height of the seal. Where neat cement grouts are to be used, the pellets should be hydrated for eight hours, or the manufacturer's recommended hydration time, whichever is greater. Where the water table is temporarily below the pellet seal, potable (or higher quality) water should be added repeatedly to hydrate the pellets prior to grouting.

2.3.5 Grouting the Annular Space

The annular space between the casing and the borehole wall should be filled with either a 30% solids bentonite grout, a neat cement grout, or a cement/bentonite grout. Each type of grout selected should be evaluated as to its intended use and integrity. Bentonite grouts are preferred unless the application dictates the use of another material.

Bentonite grout shall be a 30% solids pure bentonite grout. Drilling muds are not acceptable for grouting. The grout should be placed into the borehole, by the tremie method, from the top of the bentonite seal to within 2-feet of the ground surface or below the frost line, whichever is the greater depth. The bentonite pellet seal or filter pack should not be disturbed during grout placement, either by the use of a side discharge port on the tremie tube, or by maintaining clearance between the bottom of the tremie tube and the bentonite seal or filter pack. The grout should be allowed to cure for a minimum of 24 hours before the concrete surface pad is installed. The preferred method of achieving proper solids content is by measurement of ingredients per the manufacturer's specifications during mixing with a final check by grout balance after mixing. Bentonite grouts should have a minimum density of 10 lbs/gal to ensure proper gelling and low permeability. The density of the first batch of grout should be measured while mixing to verify proper measurement of ingredients. In addition, the grouting operation should not cease until the bentonite grout flowing out of the borehole has a minimum density of 10 lbs/gal. Estimating the grout density is not acceptable.

Cement grouts are generally dictated where a high level of dissolved solids or a particular dissolved constituent would prevent proper gelling of a bentonite grout. Neat cement grouts (cement without additives) should be mixed using 6 gallons of

water per 94-lb bag of Type 1 Portland cement to a density of 15lbs/gal. The addition of bentonite (5 to 10 percent) to the cement grout can be used to delay the "setting" time and may not be needed in all applications. The specific mixtures and other types of cement and/or grout proposed should be evaluated on a case by case basis by a senior field geologist.

2.3.6 Above Ground Riser Pipe and Outer Casing

The well casing, when installed and grouted, should extend above the ground surface a minimum of 2.5 feet. A vent hole should be drilled into the top of the well casing cap to permit pressure equalization, if applicable. An outer protective casing should be installed into the borehole after the annular grout has cured for at least 24 hours. The outer protective casing should be of steel construction with a hinged, locking cap. Generally, outer protective casings used over 2-inch well casings are 4 inches square by 5 feet long. Similarly, protective casings used over 4-inch well casings are 6 inches square and 5 feet long. Other types of protective casing including those constructed of pipe are also acceptable. All protective casings should have sufficient clearance around the inner well casings, so that the outer protective casings will not come into contact with the inner well casings after installation. The protective casings should have a weep hole to allow drainage of accumulated rain or spilled purge water. The weep hole should be approximately 1/4-inch in diameter and drilled into the protective casings just above the top of the concrete surface pad to prevent water from standing inside of the protective casings. Protective casings made of aluminum or other soft metals are normally not acceptable because they are not strong enough to resist tampering. Aluminum protective casing may be used in very corrosive environments such as coastal areas.

Prior to installing the protective casing, the bentonite grout in the borehole annulus is excavated to a depth of approximately two feet. The protective casing is installed by pouring concrete into the borehole on top of the grout. The protective casing is then pushed into the wet concrete and borehole a minimum of 2 feet. Extra concrete may be needed to fill the inside of the protective casing so that the level of the concrete inside of the protective casing is at or above the level of the surface pad. In areas where frost heave of the surface pad is possible, the protective casing should first be pressed into the top surface of the bentonite grout seal and concrete poured around the protective casing. A granular material such as sand or gravel can then be used to fill the space between the riser and protective casing. The use of granular material instead of concrete between the protective casing and riser will also facilitate the future conversion of the well to a flush-mount finish, if required. The protective casing should extend above the ground surface to a height so that the top of the inner well casing is exposed when the protective casing is opened. At each site, all locks on the outer protective casings should be keyed alike.

2.3.7 Concrete Surface Pad

A concrete surface pad should be installed around each well at the same time as the outer protective casing is being installed. The surface pad should be formed around the well casing. Concrete should be placed into the pad forms and into the borehole (on top of the grout) in one operation making a contiguous unit. The size of the concrete surface pad is dependent on the well casing size. If the well casing is 2 inches in diameter, the pad should be 3 feet x 3 feet x 4 inches. If the well casing is 4 inches in diameter, the pad should be 4 feet x 4 feet x 6 inches. Round concrete surface pads are also acceptable. The finished pad should be slightly sloped so that drainage will flow away from the protective casing and off of the pad. A minimum of one inch of the finished pad should be below grade to prevent washing and undermining by soil erosion.

2.3.8 Surface Protection – Bumper Guards

If the monitoring wells are located in a high traffic area, a minimum of three bumper guards consisting of steel pipes 3 to 4 inches in diameter and a minimum 5-foot length should be installed. These bumper guards should be installed to a minimum depth of 2 feet below the ground surface in a concrete footing and extend a minimum of 3 feet above ground surface. Concrete should also be placed into the steel pipe to provide additional strength. Substantial steel rails and/or other steel materials can be used in place of steel pipe. Welding bars between the bumper posts can provide additional strength and protection in high traffic areas, but the protective bumpers should not be connected to the protective casing.

2.4 Construction Techniques

2.4.1 Well Installation

The borehole should be bored, drilled, or augered as close to vertical as possible, and checked with a plumb bob or level. Deviation from plumb should be within 1° per 50ft of depth. Slanted boreholes are undesirable and should be noted in the boring logs and final construction logs. The depth and volume of the borehole, including the over-drilling if applicable, should have been calculated and the appropriate materials procured prior to drilling activities.

The well casings should be secured to the well screen by flush-jointed threads and placed into the borehole and plumbed by the use of centralizers and/or a plumb bob and level. Another method of placing the well screen and casings into the borehole and plumbing them at the same time is to suspend the string of well screen and casings in the borehole by means of a hoist on the drill rig. This wireline method is especially useful if the borehole is deep and a long string of well screen and casings have to be set and plumbed.

No lubricating oils or grease should be used on casing threads. No glue of any type should be used to secure casing joints. Teflon "O" rings can also be used to insure a tight fit and minimize leakage; however, "O" rings made of other materials are not acceptable if the well is going to be sampled for organic compound analyses.

Before the well screen and casings are placed on the bottom of the borehole, at least 6 inches of filter material should be placed at the bottom of the borehole to serve as a firm footing. The string of well screen and casings should then be placed into the borehole and plumbed. Centralizers can be used to plumb a well, but centralizers should be placed so that the placement of the filter pack, bentonite pellet seal, and annular grout will not be hindered. Centralizers placed in the wrong locations can cause bridging during material placement. Monitoring wells less than 50 feet deep generally do not need centralizers. If centralizers are used they should be placed below the well screen and above the bentonite pellet seal. The specific placement intervals should be decided based on site conditions.

When installing the well screen and casings through hollow-stem augers, the augers should be slowly extracted as the filter pack, bentonite pellet seal, and grout are tremied and/or poured into place. The gradual extraction of the augers will allow the materials being placed in the augers to flow out of the bottom of the augers into the borehole. If the augers are not gradually extracted, the materials (sand, pellets, etc.) will accumulate at the bottom of the augers causing potential bridging problems.

After the string of well screen and casing is plumb, the filter pack material should then be placed around the well screen to the designated depth. With cased drilling methods, the sand should be poured into the casing or augers until the lower portion is filled. The casing or augers are then withdrawn, allowing the sand to flow into the evacuated space. With hollow stem augers, sand should always fill the augers 6-12 inches, maintained by pouring the sand while checking the level with a weighted tag line. The filter pack sand in open boreholes should be installed by tremie methods, using water to wash the sand through the pipe to the point of placement.

After the filter pack has been installed, the bentonite pellet seal (if used) should be placed directly on top of the filter pack to an unhydrated thickness of two feet. When installing the seal for use with ~~neat~~ cement grouts, the bentonite pellet seal should be allowed to hydrate a minimum of eight hours or the manufacturer's recommended hydration time, whichever is longer.

After the pellet seal has hydrated for the specified time, the grout should then be pumped by the tremie method into the annular space around the casings. The grout should be allowed to set for a minimum of 24 hours before the surface pad and protective casing are installed.

After the surface pad and protective casing are installed, bumper guards should be installed (if needed). The bumper guards should be placed around the concrete surface pad in a configuration that provides maximum protection to the well. Each piece of steel pipe or approved material should be installed into an 8-to 10-inch diameter hole, to a minimum depth of 2 feet below ground surface, and filled with concrete. As previously stated, the bumper guard should extend above the ground surface a minimum of 3 feet. The total length of each bumper guard should be a minimum of 5 feet.

After the wells have been installed, the outer protective casing should be painted with a highly visible paint. The wells should be permanently marked with the well number, date installed, site name, elevation, etc., either on the cover or an appropriate place that will not be easily damaged and/or vandalized.

If the monitoring wells are installed in a high traffic area such as a parking lot, in a residential yard, or along the side of a road it may be desirable to finish the wells to the ground surface and install water-tight flush mounted traffic and/or man-hole covers. Flush mounted traffic and man-hole covers are designed to extend from the ground surface down into the concrete plug around the well casing. Although flush mounted covers may vary in design, they should have seals that make the unit water-tight when closed and secured. The flush mounted covers should be installed slightly above grade to minimize standing water and promote runoff. Permanent identification markings should be placed on the covers or in the concrete plug around the cover. Expansive sealing plugs should be used to cap the well riser to prevent infiltration of any water that might enter the flush cover.

2.4.2 Double-Cased Wells

Double-cased wells should be constructed when there is reason to believe that interconnection of two aquifers by well construction may cause cross-contamination or when flowing sands make it impossible to install a monitoring well using conventional methods. A highly contaminated surface soil zone may also be cased off so that drilling may continue below the casing with reduced danger of cross contamination. A pilot borehole should be bored through the overburden and/or the contaminated zone into the clay confining layer or bedrock. An outer casing (sometimes called surface or pilot casings) should then be placed into the borehole and sealed with grout. The borehole and outer casing should extend into tight clay a minimum of two feet and into competent bedrock a minimum of 1 foot. The total depths into the clay or bedrock will vary, depending on the plasticity of the clay and the extent of weathering and\or fracturing of the bedrock. The final depths should be approved by a senior field geologist. The size of the outer casing should be of sufficient inside diameter to contain the inner casing, and the 2-inch minimum annular space. In addition, the borehole should be of sufficient size to contain the outer casing and the 2-inch minimum outer annular space, if applicable.

The outer casing should be grouted by the tremie, displacement, grout shoe, or Halliburton method from the bottom to the ground surface. The grout should be pumped into the annular space between the outer casing and the borehole wall. A minimum of 24 hours should be allowed for the grout plug (seal) to cure before attempting to drill through it. The grout mixture used to seal the outer annular space should be either a neat cement, cement/bentonite, cement/sand, or a 30% solids bentonite grout. However, the seal or plug at the bottom of the borehole and outer casing should consist of a Type I portland cement/bentonite or cement/sand mixture. The use of a pure bentonite grout for a bottom plug or seal is not acceptable, because the bentonite grout cures to a gel-like material, and is not rigid enough to withstand the stresses of drilling. When drilling through the seal, care should be taken to avoid cracking, shattering, or washing out the seal. If caving conditions exist so that the outer casing cannot be sufficiently sealed by grouting, the outer casing should be driven into place and a grout seal placed in the bottom of the casing.

2.4.2.1 Bedrock Wells

The installation of monitoring wells into bedrock can be accomplished in two ways:

1. The first method is to drill or bore a pilot borehole through the soil overburden into the bedrock. An outer casing is then installed into the borehole by setting it into the bedrock, and grouting it into place as described in the previous section. After the grout has set, the borehole can then be advanced through the grout seal into the bedrock. The preferred method of advancing the borehole into the bedrock is rock coring. Rock coring makes a smooth, round hole through the seal and into the bedrock without cracking and/or shattering the seal. Roller cone bits are used in soft bedrock, but extreme caution should be taken when using a roller cone bit to advance through the grout seal in the bottom of the borehole because excessive water and "down" pressure can cause cracking, eroding (washing), and/or shattering of the seal. Low volume air hammers may be used to advance the borehole, but they have a tendency to shatter the seal because of the hammering action. If the structural integrity of the grout seal is in question, a pressure test can be utilized to check for leaks. A visual test can also be made by examining the cement/concrete core that is collected when the seal is cored with a diamond coring bit. If the seal leaks (detected by pressure testing) and/ or the core is cracked or shattered, or if no core is recovered because of washing, excessive down pressure, etc., the seal is not acceptable. The concern over the structural integrity of the grout seal applies to all double cased wells. Any proposed method of double casing and/or seal testing will be evaluated on its own merits, and will have to be approved by a senior field geologist before and during drilling activities, if

applicable. When the drilling is complete, the finished well will consist of an open borehole from the ground surface to the bottom of the well. There is no inner casing, and the outer surface casing, installed down into bedrock, extends above the ground surface, and also serves as the outer protective casing. If the protective casing becomes cracked or is sheared off at the ground surface, the well is open to direct contamination from the ground surface and will have to be repaired immediately or abandoned. Another limitation to the open rock well is that the entire bedrock interval serves as the monitoring zone. In this situation, it is very difficult or even impossible to monitor a specific zone, because the contaminants being monitored could be diluted to the extent of being non-detectable. The installation of open bedrock wells is generally not acceptable in the Superfund and RCRA programs, because of the uncontrolled monitoring intervals. However, some site conditions might exist, especially in cavernous limestone areas (karst topography) or in areas of highly fractured bedrock, where the installation of the filter pack and its structural integrity are questionable. Under these conditions the design of an open bedrock well may be warranted.

2. The second method of installing a monitoring well into bedrock is to install the outer surface casing and drill the borehole (by an approved method) into bedrock, and then install an inner casing and well screen with the filter pack, bentonite seal, and annular grout. The well is completed with a surface protective casing and concrete pad. This well installation method gives the flexibility of isolating the monitoring zone(s) and minimizing inter-aquifer flow. In addition, it gives structural integrity to the well, especially in unstable areas (steeply dipping shales, etc.) where the bedrock has a tendency to shift or move when disturbed. Omitting the filter pack around the well screen is a general practice in some open rock borehole installations, especially in drinking water and irrigation wells. However, without the filter pack to protect the screened interval, sediment particles from the well installation and/or from the monitoring zone could clog the well screen and/or fill the screened portion of the well rendering it inoperable. Also, the filter pack serves as a barrier between the bentonite seal and the screened interval. Rubber inflatable packers have been used to place the bentonite seal when the filter pack is omitted, but the packers have to remain in the well permanently and, over a period of time, will decompose and possibly contribute contaminants to the monitoring zone.

2.5 Well Construction Materials

2.5.1 Introduction

Well construction materials are chosen based on the goals and objectives of the proposed monitoring program and the geologic conditions at the site(s). In this section, the different types of available materials will be discussed.

2.5.2 Well Screen and Casing Materials

When selecting the materials for well construction, the prime concern should be to select materials that will not contribute foreign constituents, or remove contaminants of concern from the ground water. If the monitoring program is designed to analyze for organic compounds, stainless steel materials are the preferred choice. If the monitoring program calls for the analyses of only inorganic compounds or the contaminants or formation are highly corrosive, then rigid PVC materials meeting National Sanitary Foundation (NSF) Standard 14 type WC (Well Casing) are acceptable. PVC materials may be acceptable for monitoring identified organic compounds in a soluble aqueous phase where incompatibilities are known to not exist. EPA document EPA/540/S-95/503, *Nonaqueous Phase Liquids Compatibility with Materials Used in Well Construction, Sampling, and Remediation* (http://www.epa.gov/ada/-download/issue/napl.pdf) should be used for guidance in this area and in the use of PVC with non-aqueous phase liquids (NAPLs). Another concern is to select materials that will be rugged enough to endure the entire monitoring period. Site conditions will generally dictate the type of materials that can be used. A preliminary field investigation should be conducted to determine the geologic conditions, so that the most suitable materials can be selected. The best grade or highest quality material for that particular application should be selected. Each manufacturer can supply the qualitative data for each grade of material that is being considered. All materials selected for monitoring well installation should be evaluated and approved by a senior field geologist prior to field activities.

Well screen and casing materials generally used in monitoring well construction on RCRA and Superfund sites are listed in order of preference:

1. Stainless Steel (304 or 316)
2. Rigid PVC meeting NSF Standard 14 (type WC)
3. Other (where applicable)

There are other materials used for well screens and casings such as black iron, carbon steel, galvanized steel, and fiberglass, but these materials are not recommended for use in long term monitoring programs at hazardous waste sites, because of their low resistance to chemical attack and potential constituent contribution to the ground water. In cases where a driven casing is used, or a high strength outer casing is needed, carbon steel may be acceptable in non-corrosive aquifers. This outer casing should have threaded connections. Welding casing is

not an acceptable practice unless all relevant safety issues have been adequately addressed.

The minimum nominal casing size for most permanent monitoring wells will be 2". Where a complete program of installation, monitoring, and abandonment is being designed, smaller wells may be installed if suitable purging and sampling equipment for the smaller diameter wells can be specified and obtained. The length of well screens in permanent monitoring wells should be long enough to effectively monitor the interval or zone of interest. However, well screens designed for long term monitoring purposes should normally not be less than 5 feet in length. Well screens less than 5 feet long are generally only used in temporary monitoring wells where ground water samples are collected for screening purposes.

2.5.3 Filter Pack Materials

The filter pack materials should consist of clean, rounded to well-rounded, hard, insoluble particles of siliceous composition. The required grain-size distribution or particle sizes of the filter pack materials should be selected based upon a sieve analysis conducted on the soil samples collected from the aquifer materials and/or the formation(s) to be monitored. Filter pack materials should not be accepted unless proper documentation can be furnished as to the composition, grain-size distribution, cleaning procedure, and chemical analysis. If a data search reveals that there is enough existing data to adequately design the well screen and filter pack, then it may not be necessary to conduct a sieve analysis on the formation materials to be monitored. However, all data and design proposals will be evaluated and approved by a senior staff geologist before field activities begin.

2.5.4 Filter Pack and Well Screen Design

The majority of monitoring wells are installed in shallow ground water aquifers that consist of silts, clays, and sands in various combinations. These shallow aquifers are not generally characteristic of aquifers used for drinking water. Therefore, modifications to the procedures used for the design of water well filter packs may be required. In cases where insufficient experience exists with local or similar materials, the filter pack and well screen design should be based on the results of a sieve analysis conducted on soil samples collected from the aquifer or the formation(s) that will be monitored.

In formations consisting primarily of fines (silts and clays), the procedures for water well screen design may result in requirements for filter packs and screen slot sizes that are not available. In those cases the selection of 0.010" screen slots with a 20-40 sand filter pack, or 0.005" screen slots with 100 sand filter pack for very fine formations, will be acceptable practice. Table 6.6.1 provides size specifications for the selection of sand packs for fine formation materials. ASTM standard D5092, *Design and Installation of Ground Water Monitoring Wells in*

Aquifers, may be consulted for further guidance on specifications for sand appropriate for these applications.

Table 6.6.1
Sand Pack Specifications

Screen Opening (in)	Sand Pack Mesh Name	1% Passing Size (d-1) (in)	10% Passing Size (d-10) (in)	30% Passing Size (d-30) (in)	Derived 60% Passing Size (d-60) (in)	Range for Uniformity Coefficient
0.005-0.006	100	.0035 - .0047	.0055 - .0067	.0067 - .0083	.0085 - .0134	1.3 - 2.0
0.010"	20-40	.0098 - .0138	.0157 - .0197	.0197 -.0236	.020 - .0315	1.1 - 1.6

The following procedure should be used in coarser grained formations:

The data from the sieve analysis are plotted on a grain-size distribution graph, and a grain-size distribution curve is generated. From this grain-size distribution curve, the uniformity coefficient (Cu) of the aquifer material is determined. The Cu is the ratio of the 60 percent finer material (d60) to the 10 percent finer material (d10)

$$Cu = (d60/d10)$$

The Cu ratio is a way of grading or rating the uniformity of grain size. For example, a Cu of unity means that the individual grain sizes of the material are nearly all the same, while a Cu with a large number indicates a large range of particle sizes. As a general rule, a Cu of 2.5 or less should be used in designing the filter pack and well screen.

Before designing the filter pack and well screen, the following factors should be considered:

1. Select the well screen slot openings that will retain 90 percent of the filter pack material.

2. The filter pack material should be of the size that minimizes head losses through the pack and also prevents excessive sediment (sand, silt, clay) movement into the well.

3. A filter material of varying grain sizes is not acceptable because the smaller particles fill the spaces between the larger particles thereby reducing the void spaces and increasing resistance to flow. Therefore, filter material of the same grain size and well rounded is preferred.

4. The filter pack design is based on the gradation of the finest aquifer materials being analyzed.

Steps to design a filter pack in aquifers:

1. Construct a grain-size distribution curve, on a grain-size distribution graph, from the sieve analysis of the aquifer materials. The filter pack design (as stated above) is based on the gradation of the finest aquifer materials.

2. Multiply the d30 size from the grain-size distribution graph by a factor of four to nine (Pack-Aquifer ratio). A factor of four is used if the formation is fine-grained and uniform (Cu is less than 3), six if it is coarse-grained and non-uniform, and up to nine if it is highly non-uniform and contains silt. Head losses through filter packs increase as the Pack-Aquifer (P-A) ratios decrease. In order to design a fairly stable filter pack with a minimum head loss, the d30 size should be multiplied by a factor of four.

3. Plot the point from step 2 on the d30 abscissa of a grain-size distribution graph and draw a smooth curve with a uniformity coefficient of approximately 2.5.

4. A curve for the permissible limits of the filter pack is drawn plus or minus 8 per cent of the desired curve with the Cu of 2.5.

5. Select the slot openings for the well screen that will retain 90 per cent or more of the filter pack material.

The specific steps and procedures for sieve analysis and filter pack design can be found in soil mechanics, ground water, and water well design books. The staff geologists and/or engineers should be responsible for the correct design of the monitoring wells and should be able to perform the design procedures.

2.6 Safety Procedures for Drilling Activities

A site health and safety plan should be developed and approved by the Branch Safety Officer or designee prior to any drilling activities, and should be followed during all drilling activities. The driller or designated safety person should be responsible for the safety of the drilling team performing the drilling activities. All personnel conducting drilling activities should be qualified in proper drilling and safety procedures. Before any drilling activity is initiated, utilities should be marked or cleared by the appropriate state

or municipal utility protection organization. In developed areas, additional measures should be taken to locate utilities not covered by the utility protection program. Before operating the drill rig, a pilot hole should be dug (with hand equipment) to a depth of three feet to check for undetected utilities or buried objects. Proceed with caution until a safe depth is reached where utilities normally would not be buried. The following safety requirements should be adhered to while performing drilling activities:

1. All drilling personnel should wear safety hats, safety glasses, and steel toed boots. Ear plugs are required and will be provided by the safety officer or driller.

2. Work gloves (cotton, leather, etc.) should be worn when working around or while handling drilling equipment.

3. All personnel directly involved with the drilling rig(s) should know where the kill switch(s) is located in case of emergencies.

4. All personnel should stay clear of the drill rods or augers while in motion, and should not grab or attempt to attach a tool to the drill rods or augers until they have completely stopped rotating. Rod wipers, rather than gloves or bare hands should be used to remove mud, or other material, from drill stem as it is withdrawn from the borehole.

5. Do not hold drill rods or any part of the safety hammer assembly while taking standard penetration tests or while the hammer is being operated.

6. Do not lean against the drill rig or place hands on or near moving parts at the rear of the rig while it is operating.

7. Keep the drilling area clear of any excess debris, tools, or drilling equipment.

8. The driller will direct all drilling activities. No work on the rig or work on the drill site will be conducted outside of the driller's direction. Overall drill site activities will be in consultation with the site geologist or engineer, if present.

9. Each drill rig will have a first-aid kit and a fire extinguisher located on the rig in a location quickly accessible for emergencies. All drilling personnel will be familiarized with their location.

10. Work clothes will be firm fitting, but comfortable and free of straps, loose ends, strings etc., that might catch on some moving part of the drill rig.

11. Rings, watches, or other jewelry will not be worn while working around the drill rig.

12. The drill rig should not be operated within a minimum distance of 20 feet of overhead electrical power lines and/or buried utilities that might cause a safety hazard. In addition, the drill rig should not be operated while there is lightening in the area of the drilling site. If an electrical storm moves in during drilling activities, the area will be vacated until it is safe to return.

2.7 Well Development

A newly completed monitoring well should not be developed for at least 24 hours after the surface pad and outer protective casing are installed. This will allow sufficient time for the well materials to cure before development procedures are initiated. The main purpose of developing new monitoring wells is to remove the residual materials remaining in the wells after installation has been completed, and to try to re-establish the natural hydraulic flow conditions of the formations which may have been disturbed by well construction, around the immediate vicinity of each well. A new monitoring well should be developed until the column of water in the well is free of visible sediment, and the pH, temperature, turbidity, and specific conductivity have stabilized. In most cases the above requirements can be satisfied; however, in some cases the pH, temperature, and specific conductivity may stabilize but the water remains turbid. In this case the well may still contain well construction materials, such as drilling mud in the form of a mud cake and/or formation soils that have not been washed out of the borehole. Excessive or thick drilling mud can not be flushed out of a borehole with one or two well volumes of flushing. Continuous flushing over a period of several days may be necessary to complete the well development. If the well is pumped to dryness or near dryness, the water table should be allowed to sufficiently recover (to the static water level) before the next development period is initiated. Caution should be taken when using high rate pumps and/or large volume air compressors during well development because excessive high rate pumping and high air pressures can damage or destroy the well screen and filter pack. The onsite geologist should make the decision as to the development completion of each well. All field decisions should be documented in the field log book.

The following development procedures, listed in approximate increasing order of the energy applied to the formation materials, are generally used to develop wells:

1. Bailing
2. Pumping/overpumping
3. Surging
4. Backwashing ("rawhiding")
5. Jetting
6. Compressed air (with appropriate filtering): airlift pumping and air surging

These development procedures can be used, individually or in combination, in order to achieve the most effective well development. In most cases, over-pumping and surging will adequately develop the well without imparting undue forces on the formation or well materials. Except when compressed air is being used for well development, sampling can be initiated as soon as the ground water has re-equilibrated, is free of visible sediment, and the water quality parameters have stabilized. Since site conditions vary, even between wells, a general rule-of-thumb is to wait 24 hours after development to sample a new monitoring well. Wells developed with stressful measures may require as long as a 7-day interval before sampling. In particular, air surge developed wells require 48 hours or longer after development so that the formation can dispel the compressed air and re-

stabilize to pre-well construction conditions. Because of the danger of introducing contaminants with the airstream, the possibility of entraining air in the aquifer, and the violent forces imparted to the formation, air surging is the least desired method of development and should only be used where there is a specific need for the procedure. Air-lift pumping is permissible where an eductor pipe is used and several well volumes of water are removed from the well by other by pumping means after air-lift pumping. The selected development method(s) should be approved by a senior field geologist before any well installation activities are initiated.

2.8 Well Decommisioning (Abandonment)

When a decision is made to decommission (abandon) a monitoring well, the borehole should be sealed in such a manner that the well can not act as a conduit for migration of contaminants from the ground surface to the water table or between aquifers. To properly decommission a well, the preferred method is to completely remove the well casing and screen from the borehole, clean out the borehole, and backfill with a cement or bentonite grout, neat cement, or concrete. In order to comply with state well decommissioning requirements, the appropriate state agency should be notified (if applicable) of monitoring well decommissioning. However, some state requirements are not explicit, so a technically sound well abandonment method should be designed based on the site geology, well casing materials, and general condition of the well(s).

2.8.1 Decommissioning Procedures

As previously stated the preferred method should be to completely remove the well casing and screen from the borehole. This may be accomplished by augering with a hollow-stem auger over the well casing down to the bottom of the borehole, thereby removing the grout and filter pack materials from the hole. The well casing should then be removed from the hole with the drill rig. The clean borehole can then be backfilled with the appropriate grout material. The backfill material should be placed into the borehole from the bottom to the top by pressure grouting with the positive displacement method (tremie method). This abandonment method can be accomplished on small diameter (1-inch to 4-inch) wells without too much difficulty. With wells having 6-inch or larger diameters, the use of hollow-stem augers for casing removal is very difficult or almost impossible. Instead of trying to ream the borehole with a hollow-stem auger, it is more practical to force a drill stem with a tapered wedge assembly or a solid-stem auger into the well casing and extract it out of the borehole. Wells with little or no grouted annular space and/or sound well casings can be removed in this manner. However, old wells with badly corroded casings and/or thickly grouted annular space have a tendency to twist and/or break-off in the borehole. When this occurs, the well will have to be grouted with the remaining casing left in the borehole. The preferred method in this case should be to pressure grout the borehole by placing the tremie tube to the bottom of the well casing, which will be the well screen or the bottom sump area below the well screen. The pressurized grout will be forced out through the well screen into the filter material and up the inside of the well casing sealing holes and breaks that are present.

A PVC well casing may be more difficult to remove from the borehole than a metal casing, because of its brittleness. If the PVC well casing breaks during removal, the borehole should be cleaned out by using a drag bit or roller cone bit with the wet rotary method to grind the casing into small cuttings that will be flushed out of the borehole by water or drilling mud. Another method is to use a solid-stem auger with a carbide tooth pilot bit to grind the PVC casing into small cuttings that will be brought to the surface on the rotating flights. After the casing materials have been removed from the borehole, the borehole should be cleaned out and pressure grouted with the approved grouting materials.

Where state regulations and conditions permit, it may be permissible to grout the casing in place. This decision should be based on confidence in the original well construction practice, protection of drinking water aquifers, and anticipated future property uses. The pad should be demolished and the area around the casing excavated. The casing should be sawn off at a depth of three feet below ground surface. The screen and riser should be tremie grouted with a 30% solids bentonite grout in the saturated zone. The remaining riser may be grouted with a cement grout for long term resistance to dessication.

3 Temporary Monitoring Well Installation

3.1 Introduction

Five types of temporary monitoring well installation techniques have been demonstrated as acceptable. The type selected for a particular site is dependent upon site conditions. The project leader and site geologist should be prepared to test temporary well installations on site and select the best solution. Temporary wells are cost effective, may be installed quickly, and provide a synoptic picture of ground water quality.

Temporary monitoring well locations are not permanently marked, nor are their elevations normally determined. Sand pack materials may or may not be used, but typically there is no bentonite seal, grout, surface completion, or extensive development (as it normally applies to permanent monitoring wells). Temporary wells are generally installed, purged, sampled, removed, and backfilled in a matter of hours.

Due to the nature of construction, turbidity levels may initially be high. However, these levels may be reduced by low flow purging and sampling techniques as described in Section 7.2.4.

Temporary wells may be left overnight, for sampling the following day, but the well must be secured, both against tampering and against the fall hazard of the open annulus. If the well is not sampled immediately after construction, the well should be purged prior to sampling as specified in SESD Operating Procedure for Groundwater Sampling, SESDPROC-301.

3.2 Data Limitation

Temporary wells described in this section are best used for delineation of contaminant plumes at a point in time, and for some site screening purposes. They are not intended to replace permanent monitoring wells. Temporary wells can be used in conjunction with a mobile laboratory, where quick analytical results can be used to delineate contaminant plumes.

3.3 Temporary Well Materials

Materials used in construction of temporary monitoring wells are the same standard materials used in the construction of permanent monitoring wells. Sand used for the filter pack (if any) should be as specified in Section 2.5.3, Filter Pack Materials. The well screen and casing should be stainless steel for ruggedness and suitability for steam cleaning and solvent rinsing. Other materials may be acceptable, on a case by case basis. Some commercially available temporary well materials, pre-packed riser, screen and filter pack assemblies are available commercially; however, these pre-assembled materials cannot be cleaned. Appropriate QA/QC must be performed to assure there will be no introduction of contamination.

3.4 Temporary Monitoring Well Borehole Construction

Borehole construction for temporary wells is as specified in Section 2.3, using a drill rig. Alternatively, boreholes may be constructed using hand augers or portable powered augers (generally limited to depths of ten feet or less). If a drill rig is used to advance the borehole, the augers must be pulled back the length of the well screen (or removed completely) prior to sampling. When hand augers are used, the borehole is advanced to the desired depth (or to the point where borehole collapse occurs). In situations where borehole collapse occurs, the auger bucket is typically left in the hole at the point of collapse while the temporary well is assembled. When the well is completely assembled, a final auger bucket of material is quickly removed and the well is immediately inserted into the borehole, pushing, as needed, to achieve maximum penetration into the saturated materials.

3.5 Temporary Monitoring Well Types

Five types of monitoring wells which have been shown to be acceptable are presented in the order of increasing difficulty to install and increasing cost:

3.5.1 No Filter Pack

This is the most common temporary well and is very effective in many situations. After the borehole is completed, the casing and screen are simply inserted. This is the least expensive and fastest well to install. This type of well is extremely sensitive to turbidity fluctuations because there is no filter pack. Care should be taken to not disturb the casing during purging and sampling.

3.5.2 Inner Filter Pack

This type differs from the "No Filter Pack" well in that a filter pack is placed inside the screen to a level approximately 6 inches above the well screen. This ensures that all water within the casing has passed through the filter pack. For this type well to function properly, the static water level must be at least 6-12 inches above the filter pack. The screen slots may plug in some clayey environments with this construction method and others that use sand only inside the well screen.

3.5.3 Traditional Filter Pack

For this type of well, the screen and casing are inserted into the borehole, and the sand is poured into the annular space surrounding the screen and casing. Occasionally, it may be difficult to effectively place a filter pack around shallow open boreholes, due to collapse. This method requires more sand than the "inner filter pack" well, increasing material costs. As the filter pack is placed, it mixes with the muddy water in the borehole, which may increase the amount of time needed to purge the well to an acceptable level of turbidity.

3.5.4 Double Filter Pack

The borehole is advanced to the desired depth. As with the "inner filter pack" the well screen is filled with filter pack material and the well screen and casing inserted until the top of the filter pack is at least 6 inches below the water table. Filter pack material is poured into the annular space around the well screen. This type temporary well construction can be effective in aquifers where fine silts or clays predominate. This construction technique takes longer to implement and uses more filter pack material than others previously discussed.

3.5.5 Well-in-a-Well

The borehole is advanced to the desired depth. At this point, a 1-inch well screen and sufficient riser is inserted into a 2-inch well screen with sufficient riser, and centered. Filter pack material is then placed into the annular space surrounding the 1-inch well screen, to approximately 6 inches above the screen. The well is then inserted into the borehole.

This system requires twice as much well screen and riser, with attendant increases in assembly and installation time. The increased amount of well construction materials results in a corresponding increase in decontamination time and costs. The use of pre-packed well screens in this application will require rinse blanks of each batch of screens. Pre-pack Screen assemblies can not be decontaminated for reuse.

3.6 Decommissioning

Temporary well boreholes must be decommissioned after sampling and removal of the screen and riser. Backfilling the holes with cuttings may be acceptable practice for shallow holes in uniform materials with expected low contamination levels. Use of cuttings would not be an acceptable practice if waste materials were encountered or a confining layer was breached. Likewise, where the borehole is adjacent to, or downgradient of contaminated areas, the loose backfilled material could create a highly permeable conduit for contaminant migration. If the borehole will not be backfilled with the soil cuttings for this or other reasons, then SESD Operating Procedure for Management of Investigation Derived Waste, SESDPROC-202, should be referenced regarding disposal of the cuttings as IDW.

4 Temporary Monitoring Well Installation Using the Geoprobe® Screen Point 15/16 Groundwater Sampler

4.1 Introduction

The Geoprobe® Screen Point 15/16 Groundwater Sampler is a discrete interval ground water sampling device that can be pushed to pre-selected sampling depths in saturated, unconsolidated materials. Once the target depth has been reached, the screen is opened and groundwater can be sampled as a temporary monitoring well, which yields a representative, uncompromised sample from that depth. Using knock-out plugs, this method also allows for grouting of the push hole during sample tool retrieval.

The Screen Point® 15 sampler consist of four parts (drive point, screen, sampler sheath and drive head), with an assembled length of 52 inches (1321 mm) and a maximum OD of 1.5 inches (38 mm). When opened, it has an exposed screen length of 41 inches (1041 mm). It is typically pushed using 1.25-inch probe rod. The Screen Point® 16 consists of the same parts and works in the same fashion, the only differences being larger diameter and its use with 1.5" rods.

4.1.1 Assembly of Screen Point® 15/16 Groundwater Sampler

1. Install O-ring on expendable point and firmly seat in the angled end of the sampler sheath.

2. Place a grout plug in the lower end of the screen section. Grout plug material should be chosen with consideration for site specific Data Quality Objectives (DQOs).

3. When using stainless steel screen, place another O-ring* in the groove on the upper end of the screen and slide it into the sampler sheath.

4. Place an O-ring* on the bottom of the drive head and thread into the top of the sampler sheath.

5. The Screen Point® 15/16 Groundwater Sampler is now assembled and ready to push for sample collection.

   * It should be noted that O-ring use in steps 3 and 4 are optional.

4.1.2 Installation of Screen Point® 15/16 Groundwater Sampler

1. Attach drive cap to top of sampler and slowly drive it into the ground. Raise the hammer assembly, remove the drive cap and place an O-ring* in the top groove of the drive head. Add a probe rod and continue to push the rod string.

2. Continue to add probe rods until the desired sampling depth is reached.

3. When the desired sampling depth is reached, re-position the probe derrick and position either the casing puller assembly or the rod grip puller over the top of the top probe rod.

4. Thread a screen push adapter on an extension rod and attach sufficient additional extension rods to reach the top of the Screen Point® 15/16 sampler. Add an extension handle to the top of the string of extension rods and run this into the probe rod, resting the screen push adapter on top of the sampler.

5. To expose the screened portion of the sampler, exert downward pressure on the sampler, using the extension rod and push adapter, while pulling the probe rod upward. To expose the entire open portion of the screen, pull the probe rod upward approximately 41 inches.

6. At this point, the Screen Point® 15/16 Groundwater Sampler has been installed as a temporary well and may be sampled using appropriate ground water sampling methodology. If waters levels are less than approximately 25 feet, EIB personnel typically use a peristaltic pump, utilizing low-flow methods, to collect ground water samples from these installations. If water levels are greater than 25 feet, a manual bladder pump, a micro bailer, or other method may have to be utilized to collect the sample (SESD Operating Procedure for Groundwater Sampling, SESDPROC-301-R0) provides detailed descriptions of these techniques and methods).

4.1.3 Special Considerations for Screen Point® 15/16 Installations

<u>Decommissioning (Abandonment)</u>

In many applications, it may be appropriate to grout the abandoned probe hole where a Screen Point® 15/16 sampler was installed. This probe hole decommissioning can be accomplished through two methods which are determined by location and contamination risk. In certain non-critical areas, boreholes may be decommissioned by filling the saturated zone with bentonite pellets and grouting the vadose zone with neat cement poured from the surface or Bentonite pellets properly hydrated in place. Probe holes in areas where poor borehole sealing could present a risk of contaminant migration should be decommissioned by pressure grouting through the probe rod during sampler retrieval. To accomplish this, the grout plug is knocked out of the bottom of the screen using a grout plug push adapter and a grout nozzle is fed through the probe rod, extending just below the bottom of the screen. As the probe rod and sampler

are pulled, grout is injected in the open hole below the screen at a rate that just fills the open hole created by the pull. Alternatively, the screen can generally be pulled and the hole re-probed with a tool string to be used for through-the-rod grouting.

Screen Material Selection

Screen selection is also a consideration in sampling with the Screen Point® 15/16 sampler. The screens are available in two materials, stainless steel and PVC. Because of stainless steel's durability, ability to be cleaned and re-used, and overall inertness and compatibility with most contaminants, it is the material typically used during EIB investigations.

Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Management of Investigation Derived Waste**

Effective Date: November 1, 2007	**Number:** SESDPROC-202-R1

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Revision History

This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by the SESD Field Quality Manager.

History	Effective Date
SESDPROC-202-R1, *Management of Investigation Derived Waste*, replaces SESDPROC-202-R0. **General** Corrected any typographical, grammatical and/or editorial errors. **Title Page** Changed title for Antonio Quinones from Environmental Investigations Branch to Enforcement and Investigations Branch. Changed Bill Cosgrove's title from Acting Chief to Chief. **Section 1.3** Updated information to reflect that the procedure is located on the H: drive of the LAN. Clarified Field Quality Manager (FQM) responsibilities. **Section 1.4** Alphabetized and revised the referencing style for consistency. **Section 1.5.1** Corrected the title of the Safety, Health, and Environmental Management Program Procedures and Policy Manual.	November 1, 2007
SESDPROC-202-R0, Management of Investigation Derived Waste, Original Issue	February 05, 2007

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1 General Information

1.1 Purpose

This document describes general and specific procedures and considerations to be used and observed when managing investigation derived waste (IDW) generated during the course of hazardous waste site investigations.

1.2 Scope/Application

The procedures and management options for the different categories of IDW described in this document are to be used by SESD field personnel to manage IDW generated during site investigations. On the occasion that SESD field personnel determine that any of the procedures described in this section are inappropriate, inadequate or impractical and that another procedure must be used to manage IDW generated at a particular site, the variant procedure will be documented in the field log book, along with a description of the circumstances requiring its use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and have been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the H: drive of the SESD local area network. The Field Quality Manager (FQM) is responsible for ensuring the most recent version of the procedure is placed on the H: drive and for maintaining records of review conducted prior to its issuance.

1.4 References

SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205, Most Recent Version

United States Environmental Protection Agency (US EPA). 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Region 4 Science and Ecosystem Support Division (SESD), Athens, GA

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version

1.5 General Precautions

1.5.1 Safety

Proper safety precautions must be observed when managing IDW. Refer to the SESD Safety, Health and Environmental Management Program (SHEMP) Procedures and Policy Manual and any pertinent site-specific Health and Safety Plans (HASP) for guidelines on safety precautions. These guidelines, however, should only be used to complement the judgment of an experienced professional. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate.

1.5.2 Procedural Precautions

The following precautions should be considered when managing IDW:

- Due to time limitations and restrictions posed by RCRA regulations on storage of hazardous waste, accumulation start dates should be identified on all drums, buckets or other containers used to hold IDW so that it can be managed in a timely manner.
- During generation of both non-hazardous and hazardous IDW, keep hazardous IDW segregated from non-hazardous IDW to minimize the volume of hazardous IDW that must be properly managed.

2 Types of Investigation Derived Waste

Materials which may become IDW include, but are not limited to:

- Personnel protective equipment (PPE) - This includes disposable coveralls, gloves, booties, respirator canisters, splash suits, etc.

- Disposable equipment and items - This includes plastic ground and equipment covers, aluminum foil, conduit pipe, composite liquid waste samplers (COLIWASAs), Teflon® tubing, broken or unused sample containers, sample container boxes, tape, etc.

- Soil cuttings from drilling or hand augering.

- Drilling mud or water used for mud or water rotary drilling.

- Groundwater obtained through well development or well purging.

- Cleaning fluids such as spent solvents and wash water.

- Packing and shipping materials.

Table 1, found at the end of this procedure, lists the types of IDW commonly generated during field investigations and the current disposal practices for these materials.

For the purpose of determining the ultimate disposition of IDW, it is typically distinguished as being either hazardous or non-hazardous. This determination is based on either clear regulatory guidance or by subsequent analysis. This determination and subsequent management is the responsibility of the program site manager.

3 Management of Non-Hazardous IDW

Disposal of non-hazardous IDW should be addressed in the study plan or QAPP for the investigation. To reduce the volume of any IDW transported back to the Field Equipment Center (FEC), it may be necessary to compact the waste into a reusable container, such as a 55-gallon drum.

If the waste is from an active facility, permission should be sought from the operator of the facility to place the non-hazardous PPE, disposable equipment, and/or paper/cardboard into the facilities' dumpsters. If necessary, these materials may be placed into municipal dumpsters, with the permission of the owner. These materials may also be taken to a nearby permitted landfill. On larger studies, waste hauling services may be obtained and a dumpster located at the study site.

Disposal of non-hazardous IDW such as drill cuttings, purge or development water, decontamination wash water, drilling mud, etc., should be specified in the approved study plan or QAPP. It is recommended that these materials be placed into a unit with an environmental permit, such as a landfill or sanitary sewer. These materials must not be placed into dumpsters. If the facility at which the study is being conducted is active, permission should be sought to place these types of IDW into the facilities treatment system. It may be feasible to spread drill cuttings around the borehole, or, if the well is temporary, to place the cuttings back into the borehole. Non-hazardous monitoring well purge or development water may also be poured onto the ground down gradient of the monitoring well when site conditions permit. Purge water from private potable wells which are in service may be discharged directly onto the ground surface.

The minimum requirements for this subsection are:

- Non-hazardous liquid and soil/sediment IDW may be placed on the ground or returned to the source if doing so does not endanger human health or the environment or violate federal or state regulations. Under no circumstances, however, should monitoring well purge water be placed back into the well from which it came.
- Soap and water decontamination fluids and rinsates of such cannot be placed in any water bodies and must be collected and returned to the FEC for disposition.
- The collection, handling and proposed disposal method must be specified in the approved study plan or QAPP.

4 Management of Hazardous IDW

Disposal of hazardous or suspected hazardous IDW must be specified in the approved study plan or QAPP for the study or investigation. Hazardous IDW must be disposed as specified in USEPA regulations. If appropriate, these wastes may be placed back in an active facility waste treatment system. These wastes may also be disposed in the source area from which they originated if doing so does not endanger human health or the environment.

If on-site disposal is not feasible, and if the wastes are suspected to be hazardous, appropriate tests must be conducted to make that determination. If they are determined to be hazardous wastes, they must be properly contained and labeled. They may be stored on the site for a maximum of 90 days before they must be manifested and shipped to a permitted treatment or disposal facility. Generation of hazardous IDW must be anticipated, if possible, to allow arrangements for proper containerization, labeling, transportation and disposal/treatment in accordance with USEPA regulations.

The generation of hazardous IDW should be minimized to conserve Division resources. Most routine studies should not produce any hazardous IDW, with the possible exception of spent solvents and, possibly, purged groundwater. The use of solvents during field cleaning of equipment should be minimized by using solvent-free cleaning procedures for routine cleaning and decontamination (see SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205). If solvents are needed, the volume should be minimized by using only the amount necessary and by capturing the residual solvent separately from the aqueous decontamination fluids (detergent/wash water mixes and water rinses).

At a minimum, the requirements of the management of hazardous IDW are as follows:

- Spent solvents must be left on-site with the permission of site operator and proper disposal arranged.
- All hazardous IDW must be containerized. Proper handling and disposal should be arranged prior to commencement of field activities.

Table 1: Disposal of IDW

TYPE	HAZARDOUS	NON-HAZARDOUS
PPE-Disposable	Containerize in plastic 5-gallon bucket with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise return to FEC for proper disposal.	Place waste in trash bag. Place in dumpster with permission of site operator, otherwise return to FEC for disposal in dumpster.
PPE-Reusable	Decontaminate as per SESDPROC-205, if possible. If the equipment cannot be decontaminated, containerize in plastic 5-gallon bucket with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise return to FEC for proper disposal.	Decontaminate as per SESDPROC-205.
Spent Solvents	Containerize in original containers. Clearly identify contents. Leave on-site with permission of site operator and arrange for proper disposal.	N/A
Soil Cuttings	Containerize in DOT-approved container with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal.	Containerize in a 55-gallon steel drum with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal. **
Groundwater	Containerize in DOT-approved container with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal.	Containerize in an appropriate container with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal. **
Decontamination Water	Containerize in DOT-approved container with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal.	Containerize in an appropriate container with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal.
Disposable Equipment	Containerize in DOT-approved container or 5-gallon plastic bucket with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal.	Containerize in an appropriate container with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal.
Trash	N/A	Place waste in trash bag. Place in dumpster with permission of site operator, otherwise return to FEC for disposal in dumpster.

** These materials may be placed on the ground if doing so does not endanger human health or the environment or violate federal or state regulations.

Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Field Equipment Cleaning and Decontamination**

Effective Date: November 1, 2007	**Number:** SESDPROC-205-R1

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Revision History

This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by the SESD Field Quality Manager.

History	Effective Date
SESDPROC-205-R1, *Field Equipment Cleaning and Decontamination*, replaces SESDPROC-205-R0. **General** Corrected any typographical, grammatical and/or editorial errors. **Title Page** Changed title for Antonio Quinones from Environmental Investigations Branch to Enforcement and Investigations Branch. Changed Bill Cosgrove's title from Acting Chief to Chief. **Section 1.3** Updated information to reflect that the procedure is located on the H: drive of the LAN. Clarified Field Quality Manager (FQM) responsibilities. **Section 1.5** Alphabetized and revised the referencing style for consistency. **Section 1.6.1** Corrected the title of the Safety, Health, and Environmental Management Program Procedures and Policy Manual.	November 1, 2007
SESDPROC-205-R0, *Field Equipment Cleaning and Decontamination*, Original Issue	February 05, 2007

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Contents

1 General Information

1.1 Purpose

This document describes general and specific procedures, methods and considerations to be used and observed when cleaning and decontaminating sampling equipment during the course of field investigations.

1.2 Scope/Application

The procedures contained in this document are to be followed when field cleaning sampling equipment, for both re-use in the field, as well as used equipment being returned to the Field Equipment Center (FEC). On the occasion that SESD field investigators determine that any of the procedures described in this section are either inappropriate, inadequate or impractical and that other procedures must be used to clean or decontaminate sampling equipment at a particular site, the variant procedure will be documented in the field log book, along with a description of the circumstances requiring its use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and have been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the H: drive of the SESD local area network. The Field Quality Manager (FQM) is responsible for ensuring the most recent version of the procedure is placed on the H: drive and for maintaining records of review conducted prior to its issuance.

1.4 Definitions

Decontamination: The process of cleaning dirty sampling equipment to the degree to which it can be re-used, with appropriate QA/QC, in the field.

Field Cleaning: The process of cleaning dirty sampling equipment such that it can be returned to the FEC in a condition that will minimize the risk of transfer of contaminants from a site.

De-ionized water: Tap water that has been treated by passing through a standard de-ionizing resin column. At a minimum, the finished water should contain no detectable heavy metals or other inorganic compounds (i.e., at or above analytical detection limits)

as defined by a standard inductively coupled Argon Plasma Spectrophotometer (ICP) (or equivalent) scan. De-ionized water obtained by other methods is acceptable, as long as it meets the above analytical criteria. Organic-free water may be substituted for de-ionized water.

Organic-free water: Tap water that has been treated with activated carbon and de-ionizing units. At a minimum, the finished water must meet the analytical criteria of de-ionized water and it should contain no detectable pesticides, herbicides, or extractable organic compounds, and no volatile organic compounds above minimum detectable levels as determined by the Region 4 laboratory for a given set of analyses. Organic-free water obtained by other methods is acceptable, as long as it meets the above analytical criteria.

Soap: A standard brand of phosphate-free laboratory detergent, such as Luminox®.

Tap water: Water from any potable water supply. De-ionized water or organic-free water may be substituted for tap water.

Drilling Equipment: All power equipment used to collect surface and sub-surface soil samples or install wells. For purposes of this procedure, direct push is also included in this definition.

1.5 References

SESD Operating Procedure for Management of Investigation Derived Waste, SESDPROC-202, Most Recent Version

SESD Operating Procedure for Equipment Cleaning and Decontamination at the FEC, SESDPROC-206, Most Recent Version

United States Environmental Protection Agency (US EPA). 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Region 4 Science and Ecosystem Support Division (SESD), Athens, GA

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version

1.6 General Precautions

1.6.1 Safety

Proper safety precautions must be observed when field cleaning or decontaminating dirty sampling equipment. Refer to the SESD Safety, Health and Environmental Management Program (SHEMP) Procedures and Policy Manual and any pertinent site-specific Health and Safety Plans (HASPs) for guidelines on safety precautions. These guidelines, however, should only be used

to complement the judgment of an experienced professional. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate. At a minimum, the following precautions should be taken in the field during these cleaning operations:

- When conducting field cleaning or decontamination using laboratory detergent, safety glasses with splash shields or goggles, and latex gloves will be worn.

- No eating, smoking, drinking, chewing, or any hand to mouth contact should be permitted during cleaning operations.

1.6.2 Procedural Precaution

Prior to mobilization to a site, the expected types of contamination should be evaluated to determine if the field cleaning and decontamination activities will generate rinsates and other waste waters that might be considered RCRA hazardous waste or may require special handling.

2 Introduction to Field Equipment Cleaning and Decontamination

2.1 General

The procedures outlined in this document are intended for use by field investigators for cleaning and decontaminating sampling and other equipment in the field. These procedures should be followed in order that equipment is returned to the FEC in a condition that will minimize the risk of transfer of contaminants from a site.

Sampling and field equipment cleaned in accordance with these procedures must meet the minimum requirements for the Data Quality Objectives (DQOs) of the study or investigation. Site-specific alterations to these procedures should be documented in the study plan. Deviations from these procedures should be documented in the field records.

Cleaning procedures for use at the Field Equipment Center (FEC) are found in SESD Operating Procedure for Equipment Cleaning and Decontamination at the FEC (SESDPROC-206).

2.2 Handling and Containers for Cleaning Solutions

Improperly handled cleaning solutions may easily become contaminated. Storage and application containers must be constructed of the proper materials to ensure their integrity. Following are acceptable materials used for containing the specified cleaning solutions:

- Soap must be kept in clean plastic, metal, or glass containers until used. It should be poured directly from the container during use.

- Tap water may be kept in tanks, hand pressure sprayers, squeeze bottles, or applied directly from a hose.

- De-ionized water must be stored in clean, glass or plastic containers that can be closed prior to use. It can be applied from plastic squeeze bottles.

- Organic-free water must be stored in clean glass or Teflon® containers prior to use. It may be applied using Teflon® squeeze bottles, or with the portable system.

2.3 Disposal of Cleaning Solutions

Procedures for the safe handling and disposition of investigation derived waste (IDW); including used wash water and rinse water are in SESD Operating Procedure for Management of Investigation Derived Waste (SESDPROC-202).

2.4 Sample Collection Equipment Contaminated with Concentrated Materials

Equipment used to collect samples of concentrated materials from investigation sites must be field cleaned before returning from the study. At a minimum, this should consist of washing with soap and rinsing with tap water. When the above procedure cannot be followed, the following options are acceptable:

1. Leave with facility for proper disposal;

2. If possible, containerize, seal and secure the equipment and leave on-site for later disposal;

3. Containerize, bag or seal the equipment so that no odor is detected and return to the SESD.

It is the project leader's responsibility to evaluate the nature of the sampled material and determine the most appropriate cleaning procedures for the equipment used to sample that material.

2.5 Sample Collection Equipment Contaminated with Environmental Media

Equipment used to collect samples of environmental media from investigation sites should be field cleaned before returning from the study. Based on the condition of the sampling equipment, one or more of the following options must be used for field cleaning:

1. Wipe the equipment clean;

2. Water-rinse the equipment;

3. Wash the equipment in detergent and water followed by a tap water rinse.

4. For grossly contaminated equipment, the procedures set forth in Section 2.4 must be followed.

Under extenuating circumstances such as facility limitations, regulatory limitations, or during residential sampling investigations where field cleaning operations are not feasible, equipment can be containerized, bagged or sealed so that no odor is detected and returned to the FEC without being field cleaned. If possible, FEC personnel should be

notified that equipment will be returned without being field cleaned. It is the project leader's responsibility to evaluate the nature of the sampled material and determine the most appropriate cleaning procedures for the equipment used to sample that material.

2.6 Handling of Decontaminated Equipment

After decontamination, equipment should be handled only by personnel wearing clean gloves to prevent re-contamination. In addition, the equipment should be moved away (preferably upwind) from the decontamination area to prevent re-contamination. If the equipment is not to be immediately re-used it should be covered with plastic sheeting or wrapped in aluminum foil to prevent re-contamination. The area where the equipment is kept prior to re-use must be free of contaminants.

3 Field Equipment Decontamination Procedures

3.1 General

Sufficient equipment should be transported to the field so that an entire study can be conducted without the need for decontamination. When equipment must be decontaminated in the field, the following procedures are to be utilized.

3.2 Specifications for Decontamination Pads

Decontamination pads constructed for field cleaning of sampling and drilling equipment should meet the following minimum specifications:

- The pad should be constructed in an area known or believed to be free of surface contamination.
- The pad should not leak.
- If possible, the pad should be constructed on a level, paved surface and should facilitate the removal of wastewater. This may be accomplished by either constructing the pad with one corner lower than the rest, or by creating a sump or pit in one corner or along one side. Any sump or pit should also be lined.
- Sawhorses or racks constructed to hold equipment while being cleaned should be high enough above ground to prevent equipment from being splashed.
- Water should be removed from the decontamination pad frequently.
- A temporary pad should be lined with a water impermeable material with no seams within the pad. This material should be either easily replaced (disposable) or repairable.

At the completion of site activities, the decontamination pad should be deactivated. The pit or sump should be backfilled with the appropriate material designated by the site project leader, but only after all waste/rinse water has been pumped into containers for disposal. See SESD Operating Procedure for Management of Investigation Derived Waste (SESDPROC-202) for proper handling and disposal of these materials. If the decontamination pad has leaked excessively, soil sampling may be required.

3.3 "Classical Parameter" Sampling Equipment

"Classical Parameters" are analyses such as oxygen demand, nutrients, certain inorganics, sulfide, flow measurements, etc. For routine operations involving classical parameter analyses, water quality sampling equipment such as Kemmerers, buckets, dissolved oxygen dunkers, dredges, etc., may be cleaned with the sample water or tap water between sampling locations as appropriate.

Flow measuring equipment such as weirs, staff gages, velocity meters, and other stream gauging equipment may be cleaned with tap water between measuring locations, if necessary.

Note: The procedures described in Section 3.3 are not to be used for cleaning field equipment to be used for the collection of samples undergoing trace organic or inorganic constituent analyses.

3.4 Sampling Equipment used for the Collection of Trace Organic and Inorganic Compounds

For samples undergoing trace organic or inorganic constituent analyses, the following procedures are to be used for all sampling equipment or components of equipment that come in contact with the sample:

1. Clean with tap water and Luminox® soap using a brush, if necessary, to remove particulate matter and surface films. Equipment may be steam cleaned (Luminox® soap and high pressure hot water) as an alternative to brushing. Sampling equipment that is steam cleaned should be placed on racks or saw horses at least two feet above the floor of the decontamination pad. PVC or plastic items should not be steam cleaned.

2. Rinse thoroughly with tap water.

3. Rinse thoroughly with organic-free water and place on a clean foil-wrapped surface to air-dry.

4. All equipment must be wrapped with foil. If the equipment is to be stored overnight before it is wrapped in foil, it should be covered and secured with clean, unused plastic sheeting.

3.5 Well Sounders or Tapes

The following procedures are recommended for decontaminating well sounders (water level indicators) and tapes:

1. Wash with soap and tap water.

2. Rinse with tap water.

3. Rinse with de-ionized water.

3.6 Redi-Flo2® Pump

The Redi-Flo2® pump should be decontaminated prior to use and between each monitoring well. The following procedure is required:

CAUTION - Make sure the pump is not plugged in.

1. Using a brush, scrub the exterior of the pump, electrical cord and garden hose with soap and tap water. Do not wet the electrical plug.

2. Rinse with tap water.

3. Rinse with de-ionized water.

4. Place the equipment in a clean plastic bag.

To clean the Redi-Flo2® ball check valve:

1. Remove the ball check valve from the pump head. Check for wear and/or corrosion, and replace as needed.

2. Using a brush, scrub all components with soap and tap water.

3. Rinse with de-ionized water.

4. Replace the ball check valve to the Redi-Flo2® pump head.

3.7 Downhole Drilling Equipment

These procedures are to be used for drilling activities involving the collection of soil samples for trace organic and inorganic constituent analyses and for the construction of monitoring wells to be used for the collection of groundwater samples for trace organic and inorganic constituent analyses.

3.7.1 Introduction

Cleaning and decontamination of all equipment should occur at a designated area (decontamination pad) on the site. The decontamination pad should meet the specifications of Section 3.2 of this procedure.

Tap water brought on the site for drilling and cleaning purposes should be contained in a pre-cleaned tank.

A steam cleaner and/or high pressure hot water washer capable of generating a pressure of at least 2500 PSI and producing hot water and/or steam (200° F plus), with a soap compartment, should be obtained.

3.7.2 Preliminary Cleaning and Inspection

Drilling equipment should be clean of any contaminants that may have been transported from off-site to minimize the potential for cross-contamination. The drilling equipment should not serve as a source of contaminants. Associated drilling and decontamination equipment, well construction materials, and equipment handling procedures should meet these minimum specified criteria:

- All downhole augering, drilling, and sampling equipment should be sandblasted before use if painted, and/or there is a buildup of rust, hard or caked matter, etc., that cannot be removed by steam cleaning (soap and high pressure hot water), or wire brushing. Sandblasting should be performed <u>prior to arrival</u> on site, or well away from the decontamination pad and areas to be sampled.

- Any portion of the drilling equipment that is over the borehole (kelly bar or mast, backhoe buckets, drilling platform, hoist or chain pulldowns, spindles, cathead, etc.) should be steam cleaned (soap and high pressure hot water) and wire brushed (as needed) to remove all rust, soil, and other material which may have come from other sites before being brought on site.

- Printing and/or writing on well casing, tremie tubing, etc., should be removed before use. Emery cloth or sand paper can be used to remove the printing and/or writing. Most well material suppliers can provide materials without the printing and/or writing if specified when ordered. Items that cannot be cleaned are not acceptable and should be discarded.

- Equipment associated with the drilling and sampling activities should be inspected to insure that all oils, greases, hydraulic fluids, etc., have been removed, and all seals and gaskets are intact with no fluid leaks.

3.7.3 Drill Rig Field Cleaning Procedure

Any portion of the drill rig, backhoe, etc., that is over the borehole (kelly bar or mast, backhoe buckets, drilling platform, hoist or chain pulldowns, spindles, cathead, etc.) should be steam cleaned (soap and high pressure hot water) between boreholes.

3.7.4 Field Decontamination Procedure for Drilling Equipment

The following is the standard procedure for field cleaning augers, drill stems, rods, tools, and associated equipment. This procedure does not apply to well casings, well screens, or split-spoon samplers used to obtain samples for chemical analyses, which should be decontaminated as outlined in Section 3.4 of this procedure.

1. Wash with tap water and soap, using a brush if necessary, to remove particulate matter and surface films. Steam cleaning (high pressure hot water with soap) may be necessary to remove matter that is difficult to remove with the brush. Drilling equipment that is steam cleaned should be placed on racks or saw horses at least two feet above the floor of the decontamination pad. Hollow-stem augers, drill rods, etc., that are hollow or have holes that transmit water or drilling fluids, should be cleaned on the inside with vigorous brushing.

2. Rinse thoroughly with tap water.

3. Remove from the decontamination pad and cover with clean, unused plastic. If stored overnight, the plastic should be secured to ensure that it stays in place.

Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Groundwater Sampling**

Effective Date: November 1, 2007	**Number:** SESDPROC-301-R1

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Revision History

This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by the SESD Field Quality Manager.

History	Effective Date
SESDPROC-301-R1, *Groundwater Sampling*, replaces SESDPROC-301-R0. **General** Corrected any typographical, grammatical and/or editorial errors. **Title Page** Changed title for Antonio Quinones from Environmental Investigations Branch to Enforcement and Investigations Branch **Section 1.3** Updated information to reflect that the procedure is located on the H: drive of the LAN. Clarified Field Quality Manager (FQM) responsibilities. **Section 1.4** Updated referenced operating procedures due to changes in title names. Alphabetized and revised the referencing style for consistency. **Section 1.5.1** Corrected the title of the Safety, Health, and Environmental Management Program Procedures and Policy Manual. **Section 1.5.2, 4th bullet** Added references to the CFR and IATA's Dangerous Goods Regulations. **Section 2.5** Updated referenced operating procedures due to changes in title names.	November 1, 2007
SESDPROC-301-R0, Groundwater Sampling, Original Issue	February 05, 2007

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Contents

1 General Information

1.1 Purpose

This document describes general and specific procedures, methods and considerations to be used and observed when collecting groundwater samples for field screening or laboratory analysis.

1.2 Scope/Application

The procedures contained in this document are to be used by field personnel when collecting and handling groundwater samples in the field. On the occasion that SESD field personnel determine that any of the procedures described in this section are either inappropriate, inadequate or impractical and that another procedure must be used to obtain a groundwater sample, the variant procedure will be documented in the field log book, along with a description of the circumstances requiring its use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and have been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the H: drive of the SESD local area network. The Field Quality Manager (FQM) is responsible for ensuring the most recent version of the procedure is placed on the H: drive and for maintaining records of review conducted prior to its issuance.

1.4 References

International Air Transport Authority (IATA). Dangerous Goods Regulations, Most Recent Version

Puls, Robert W., and Michael J. Barcelona. 1989. Filtration of Ground Water Samples for Metals Analysis. Hazardous Waste and Hazardous Materials 6(4), pp.385-393.

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SESD Guidance Document, Design and Installation of Monitoring Wells, SESDGUID-001, Most Recent Version

SESD Operating Procedure for Control of Records, SESDPROC-002, Most Recent Version

SESD Operating Procedure for Sample and Evidence Management, SESDPROC-005, Most Recent Version

SESD Operating Procedure for Logbooks, SESDPROC-010, Most Recent Version

SESD Operating Procedure for Field Sampling Quality Control, SESDPROC-011, Most Recent Version

SESD Operating Procedure for Field pH Measurement, SESDPROC-100, Most Recent Version

SESD Operating Procedure for Field Specific Conductance Measurement, SESDPROC-101, Most Recent Version

SESD Operating Procedure for Field Temperature Measurement, SESDPROC-102, Most Recent Version

SESD Operating Procedure for Field Turbidity Measurement, SESDPROC-103, Most Recent Version

SESD Operating Procedure for Groundwater Level and Well Depth Measurement, SESDPROC-105, Most Recent Version

SESD Operating Procedure for Management of Investigation Derived Waste, SESDROC-202, Most Recent Version

SESD Operating Procedure for Pump Operation, SESDPROC-203, Most Recent Version

SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205, Most Recent Version

SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC, SESDPROC-206, Most Recent Version

SESD Operating Procedure for Potable Water Supply Sampling, SESDPROC-305, Most Recent Version

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US EPA. 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Region 4 Science and Ecosystem Support Division (SESD), Athens, GA

US EPA. Analytical Support Branch Laboratory Operations and Quality Assurance Manual. Region 4 SESD, Athens, GA, Most Recent Version

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version

1.5 General Precautions

1.5.1 Safety

Proper safety precautions must be observed when collecting groundwater samples. Refer to the SESD Safety, Health and Environmental Management Program (SHEMP) Procedures and Policy Manual and any pertinent site-specific Health and Safety Plans (HASP) for guidelines on safety precautions. These guidelines should be used to complement the judgment of an experienced professional. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate.

1.5.2 Procedural Precautions

The following precautions should be considered when collecting groundwater samples.

- Special care must be taken not to contaminate samples. This includes storing samples in a secure location to preclude conditions which could alter the properties of the sample. Samples shall be custody sealed during long-term storage or shipment.
- Always sample from the anticipated cleanest, i.e., least contaminated location, to the most contaminated location. This minimizes the opportunity for cross-contamination to occur during sampling.

- Collected samples must remain in the custody of the sampler or sample custodian until the samples are relinquished to another party.
- If samples are transported by the sampler, they will remain under his/her custody or be secured until they are relinquished.
- Shipped samples shall conform to all U.S. Department of Transportation (DOT) rules of shipment found in Title 49 of the Code of Federal Regulations (49 CFR parts 171 to 179), and/or International Air Transportation Association (IATA) hazardous materials shipping requirements found in the current edition of IATA's Dangerous Goods Regulations.
- Documentation of field sampling is done in a bound logbook.
- Chain-of-custody documents shall be filled out and remain with the samples until custody is relinquished.
- All shipping documents, such as air bills, bills of lading, etc., shall be retained by the project leader and placed in the project files.

2 Special Sampling Considerations

2.1 Volatile Organic Compounds (VOC) Analysis

Groundwater samples for VOC analysis must be collected in 40 ml glass vials with Teflon® septa. The vial may be either preserved with concentrated hydrochloric acid or they may be unpreserved. Preserved samples have a two week holding time, whereas unpreserved samples have only a seven day holding time. In the great majority of cases, the preserved vials are used to take advantage of the extended holding time. In some situations, however, it may be necessary to use the unpreserved vials. For example, if the groundwater has a high amount of dissolved limestone, i.e., is highly calcareous, there will most likely be an effervescent reaction between the hydrochloric acid and the water, producing large numbers of fine bubbles. This will render the sample unacceptable. In this case, unpreserved vials should be used and arrangements must be confirmed with the laboratory to ensure that they can accept the unpreserved vials and meet the shorter sample holding times.

The samples should be collected with as little agitation or disturbance as possible. The vial should be filled so that there is a meniscus at the top of the vial and absolutely no bubbles or headspace should be present in the vial after it is capped. After the cap is securely tightened, the vial should be inverted and tapped on the palm of one hand to see if any undetected bubbles are dislodged. If a bubble or bubbles are present, the vial should be topped off using a minimal amount of sample to re-establish the meniscus. Care should be taken not to flush any preservative out of the vial during topping off. If, after topping off and capping the vial, bubbles are still present, a new vial should be obtained and the sample re-collected.

Samples for VOC analysis must be collected using either stainless steel or Teflon® equipment, such as:

- Bailers must be constructed of stainless steel or Teflon®
- RediFlo2® submersible pumps used for sampling should be equipped with Teflon® sample delivery tubing
- Peristaltic pump/vacuum jug assemblies should be outfitted with Teflon® tubing from the water column to the transfer cap, which should also be constructed of Teflon®

2.2 Special Precautions for Trace Contaminant Groundwater Sampling

- A clean pair of new, non-powdered, disposable gloves will be worn each time a different location is sampled and the gloves should be donned immediately prior to sampling. The gloves should not come in contact

with the media being sampled and should be changed any time during sample collection when their cleanliness is compromised.

- Sample containers for samples suspected of containing high concentrations of contaminants shall be stored separately.
- Sample collection activities shall proceed progressively from the least suspected contaminated area to the most suspected contaminated area if sampling devices are to be reused. Samples of waste or highly contaminated media must not be placed in the same ice chest as environmental (i.e., containing low contaminant levels) or background samples.
- If possible, one member of the field sampling team should take all the notes and photographs, fill out tags, etc., while the other members collect the samples.
- Clean plastic sheeting will be placed on the ground at each sample location to prevent or minimize contaminating sampling equipment by accidental contact with the ground surface.
- Samplers must use new, verified certified-clean disposable or non-disposable equipment cleaned according to procedures contained in SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205) or SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC (SESDPROC-206) for collection of samples for trace metals or organic compound analyses.

2.3 Sample Handling and Preservation Requirements

1. Groundwater samples will typically be collected from the discharge line of a pump or from a bailer, either from the pour stream of an up-turned bailer or from the stream from a bottom-emptying device. Efforts should be made to reduce the flow from either the pump discharge line or the bailer during sample collection to minimize sample agitation.

2. During sample collection, make sure that the pump discharge line or the bailer does not contact the sample container.

3. Place the sample into appropriate, labeled containers. Samples collected for VOC analysis must not have any headspace (see Section 2.1, Volatile Organic Compound Analysis). All other sample containers must be filled with an allowance for ullage.

4. All samples requiring preservation must be preserved as soon as practically possible, ideally immediately at the time of sample collection. If preserved VOC vials are used, these will be preserved with concentrated hydrochloric acid by ASB personnel prior to departure for the field investigation. All other chemical preservatives required for the remaining suite of analytes will be supplied by ASB personnel and will be added to the samples by SESD field personnel or other

authorized persons. The adequacy of sample preservation will be checked after the addition of the preservative for all samples except for the samples collected for VOC analysis. Additional preservative should be added to achieve adequate preservation. Preservation requirements for groundwater samples are found in the USEPA Region 4 Analytical Support Branch Laboratory Operations and Quality Assurance Manual (ASBLOQAM), Most Recent Version.

2.4 Quality Control

If possible, a control sample should be collected from location not affected by the possible contaminants of concern and submitted with the other samples. This control sample should be collected as close to the sampled area as possible and from the same water-bearing formation. Equipment blanks should be collected if equipment is field cleaned and re-used on-site or if necessary to document that low-level contaminants were not introduced by pumps, bailers or other sampling equipment.

2.5 Records

Information generated or obtained by SESD personnel will be organized and accounted for in accordance with SESD records management procedures found in SESD Operating Procedure for Control of Records, SESDPROC-002. Field notes, recorded in a bound field logbook, will be generated, as well as chain-of-custody documentation in accordance with SESD Operating Procedure for Logbooks, SESDPROC-010 and SESD Procedure for Sample and Evidence Management, SESDPROC-005.

3 Groundwater Sampling Methods - Purging

3.1 General

3.1.1 Purging and Purge Adequacy

Purging is the process of removing stagnant water from a well, immediately prior to sampling, causing its replacement by ground water from the adjacent formation that is representative of actual aquifer conditions. In order to determine when a well has been adequately purged, field investigators should monitor the pH, specific conductance, temperature, and turbidity of the ground water removed during purging and, in the case of permanent monitoring wells, observe and record the volume of water removed.

Prior to initiating the purge, the amount of water standing in the water column (water inside the well riser and screen) should be determined, if possible. To do this, the diameter of the well should be determined and the water level and total depth of the well should be measured and recorded. Specific methodology for obtaining these measurements is found in SESD Operating Procedure for Groundwater Level and Well Depth Measurement (SESDPROC-105). Once this information is obtained, the volume of water to be purged can be determined using one of several methods. One is the equation:

$$V = 0.041\ d^2h$$

Where: h = depth of water in feet
d = diameter of well in inches
V = volume of water in gallons

Alternatively, the volume may be determined using a casing volume per foot factor for the appropriate diameter well, similar to that in Table 3.1.1. The water level is subtracted from the total depth, providing the length of the water column. This length is multiplied by the factor in the Table 3.1.1 which corresponds to the appropriate well diameter, providing the amount of water, in gallons, contained in the well, i.e., one well or water column volume. Other acceptable methods include the use of nomographs or other equations or formulae.

With respect to volume, an adequate purge is normally achieved when three to five well volumes have been removed. The field notes should reflect the single well volume calculations or determinations, according to one of the above methods, and a reference to the appropriate multiplication of that volume, i.e., a minimum three well volumes, clearly identified as a purge volume goal.

With respect to the ground water chemistry, an adequate purge is achieved when the pH, specific conductance, and temperature of the ground water have stabilized

TABLE 3.1.1
WELL CASING DIAMETER vs. VOLUME

WELL CASING DIAMETER (INCHES) vs. VOLUME (GALS.)/FEET of WATER	
CASING	GALLONS/FT
1	0.041
2	0.163
3	0.367
4	0.653
5	1.02
6	1.469
7	1.999
8	2.611
9	3.305
10	4.08
11	4.934
12	5.875

and the turbidity has either stabilized or is below 10 Nephelometric Turbidity Units (NTUs) (twice the Primary Drinking Water Standard of 5 NTUs). Although 10 NTUs is normally considered the minimum goal for most ground water sampling objectives, lower turbidity has been shown to be easily achievable in most situations and reasonable attempts should be made to achieve these lower levels. Stabilization occurs when, for at least three consecutive measurements, the pH remains constant within 0.1 Standard Unit (SU), specific conductance varies no more than approximately 10 percent, and the temperature is constant. There are no set criteria for establishing how many total sets of measurements are adequate to document stability of parameters. If the calculated purge volume is small, the measurements should be taken frequently enough to provide a sufficient number of measurements to evaluate stability. If the purge volume is large, measurements taken every 15 minutes, for example, may be sufficient. See the SESD Operating Procedure for Field pH Measurement (SESDPROC-100), SESD Operating Procedure for Field Specific Conductance Measurement (SESDPROC-101), SESD Operating Procedure for Field Temperature Measurement (SESDPROC-102) and SESD Operating Procedure for Field Turbidity Measurement (SESDPROC-103) for procedures for conducting these purge adequacy measurements.

If, after three well volumes have been removed, the chemical parameters have not stabilized according to the above criteria, additional well volumes (up to five well volumes), should be removed. If the parameters have not stabilized within five volumes, it is at the discretion of the project leader whether or not to collect a sample or to continue purging. If, after five well volumes, pH and conductivity have stabilized and the turbidity is still decreasing and approaching an acceptable level, additional purging should be considered to obtain the best sample possible, with respect to turbidity. The conditions of sampling should be noted in the field log.

In some situations, even with slow purge rates, a well may be pumped or bailed dry (evacuated). In these situations, this generally constitutes an adequate purge and the well can be sampled following sufficient recovery (enough volume to allow filling of all sample containers). ***It is not necessary that the well be evacuated three times before it is sampled***. The pH, specific conductance, temperature, and turbidity should be measured and recorded, during collection of the sample from the recovered volume, as the measurements of record for the sampling event.

For wells with slow recovery, attempts should be made to avoid purging them to dryness. This can be accomplished, for example, by slowing the purge rate. If a well is purged to dryness, it may result in the sample being comprised partially of water contained in the sand pack, which may be reflective, at least in part, of initial, stagnant conditions. Additionally, as water enters a well that has been purged to dryness, it may cascade down the sand pack and/or the well screen, stripping volatile organic constituents that may be present and/or introducing soil fines into the water column.

It is particularly important that wells be sampled as soon as possible after purging. If adequate volume is available immediately upon completion of purging, the well must be sampled immediately. If not, sampling should occur as soon as adequate volume has recovered. Sampling of wells which have a slow recovery should be scheduled so that they can be purged and sampled in the same day, after adequate volume has recovered. Wells of this type should not be purged at the end of one day and sampled the following day.

3.1.2 Equipment Considerations for Purging

Monitoring well purging is preferably accomplished by using in-place plumbing and dedicated pumps or by using portable pumps/equipment when dedicated systems are not present. The equipment utilized by Branch personnel will usually consist of peristaltic pumps and variable speed electric submersible pumps, but may also include bladder pumps or inertial pumps. The pump of choice is usually a function of the well diameter, the depth to water, the depth of the well and the amount of water that is to be removed during purging. Whenever the head difference between the sampling location and the water level is less than the limit of suction and the volume to be removed is reasonably small, a peristaltic pump

should be used for purging. For wells where the water level is below the limit of suction and/or there is a large volume of water to be purged, the variable speed electric submersible pump would be the pump of choice. SESD Operating Procedure for Pump Operation (SESDPROC-203) contains the use and operating instructions for all pumps commonly used during SESD ground water investigations.

Bailers may also be used for purging in appropriate situations, however, their use is discouraged. Bailers tend to disturb any sediment that may be present in the well, creating or increasing sample turbidity. If a bailer is used, it should be a closed-top Teflon® bailer.

3.2 Wells Without Plumbing or In-Place Pumps

For permanent monitoring wells, the depth to water (water level) and depth of the well (total depth) should be determined before purging. Caution should be exercised during this procedure to prevent cross-contamination between wells. This is a critical concern when samples for trace organic compounds or metals analyses are collected. See SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205**)** for cleaning procedures for well sounders. After cleaning, the well sounding device should be protected to keep it clean until its next use.

3.2.1 Purging with Pumps

3.2.1.1 Peristaltic Pumps

The following step-by-step procedures describe the process of purging with a peristaltic pump:

1. Cut a length of standard-cleaned (SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC (SESDPROC-206) Teflon® tubing, equal to the well depth plus an additional five to ten feet. Enough tubing is needed to run from the ground surface up to the top of the well casing and back down to the bottom of the well. This will allow for operation of the pump at all possible water level conditions in the well.

2. Place one end of the tubing into the vacuum side of the peristaltic pump head. Proper sizing of the Teflon® and Silastic® or Tygon® tubing should allow for a snug fit of the Teflon® tubing inside the flexible tubing mounted in the pump head.

3. Run a short section of tubing (does not have to be Teflon®) from the discharge side of the pump head to a graduated bucket.

4. Place the free end of the Teflon® tubing into the well until the end of the tubing is just below the surface of the water column.

5. Secure the Teflon® tubing to the well casing or other secure object using electrician's tape or other suitable means. This will prevent the tubing from being lost in the well should the tubing detach from the pump head.

6. Turn on the pump to produce a vacuum on the well side of the pump head and begin the purge. Observe pump direction to ensure that a vacuum is being applied to the purge line. If the purge line is being pressurized, either switch the tubing at the pump head or reverse the polarity of the cables on the pump or on the battery.

7. If the pumping rate exceeds the recovery rate of the well, continue to lower the tubing into the well, as needed, until the drawdown stabilizes or the well is evacuated to dryness. If the pump is a variable speed peristaltic pump, and the water level in the well is being drawn down, reduce the speed of the pump in an attempt to stabilize the drawdown. If the well can be purged without evacuating the well to dryness, a sample with greater integrity can be obtained.

8. For wells which are not evacuated to dryness, particularly those with recovery rates equal to or very nearly equal to the purge rate, there may not be a complete exchange and removal of stagnant water in that portion of the water column above the tubing intake. For this reason, it is important that the tubing intake be placed in the very uppermost portion of the water column while purging. Standard field measurements should frequently be taken during this process to verify adequacy of the purge and readiness for sampling, as described in Section 3.

3.2.1.2 Submersible Pumps

When a submersible pump is used for well purging, the pump itself is lowered into the water column. The pump must be cleaned as specified in SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205).

The pump/hose assembly used in purging should be lowered into the top of the standing water column and not deep into the column. This is done so that the purging will "pull" water from the formation into the screened area of the well and up through the casing so that the entire static volume can be removed. If the pump is placed deep into the water column, the water above the pump may not be removed, and the subsequent samples, particularly if collected with a bailer, may not be representative of the aquifer conditions. It is recommended that no more than three to five feet

of hose be lowered into the water column. If the recovery rate of the well is faster than the pump rate and no observable draw down occurs, the pump should be raised until the intake is within one foot of the top of the water column for the duration of purging. If the pump rate exceeds the recovery rate of the well, the pump will have to be lowered, as needed, to accommodate the drawdown. After the pump is removed from the well, the hose and the pump should be cleaned as outlined in SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205).

3.2.2 Purging With Bailers

Standard-cleaned (SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205) or SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC (SESDPROC-206) closed-top Teflon® bailers with Teflon® coated stainless steel leaders and new nylon rope are lowered into the top of the water column, allowed to fill, and removed. It is critical that bailers be slowly and gently immersed into the top of the water column, particularly during final stages of purging, to minimize turbidity and disturbance of volatile organic constituents. The use of bailers for purging and sampling is discouraged because the correct technique is highly operator dependent and improper use may result in an unrepresentative sample.

3.2.3 Field Care of Purging Equipment

New plastic sheeting should be placed on the ground surface around the well casing to prevent contamination of the pumps, hoses, ropes, etc., in the event they accidentally come into contact with the ground surface or, for some reason, they need to be placed on the ground during the purging event. It is preferable that hoses used in purging that come into contact with the ground water be kept on a spool or contained in a large wash tub lined with plastic sheeting, both during transportation and during field use, to further minimize contamination by the transporting vehicle or the ground surface.

Careful consideration shall be given to using submersible pumps to purge wells which are excessively contaminated with oily compounds, because it may be difficult to adequately decontaminate severely contaminated pumps under field conditions. When wells of this type are encountered, alternative purging methods, such as bailers, should be considered.

3.2.4 General Low Flow/Low Stress Method Preference

The device with the lowest pump or water removal rate and the least tendency to stress the well during purging should be selected for use. For example, if a bailer and a peristaltic pump both work in a given situation, the pump should be selected because it will greatly minimize turbidity, providing a higher quality sample (Sec.

3.4.2, Purging When Water Level Is Within Limit of Suction**,** contains a description of low flow purging and sampling with a peristaltic pump used in a temporary well).

3.2.5 Low Flow/Low Volume Purging Techniques/Procedures

An alternative to the low flow/low stress purging method is the low flow/low volume method, commonly referred to as the "micro-purge" method. The low flow/low volume purging method is a procedure developed and used to minimize purge water volumes. The pump intake is placed within the screened interval at the zone of sampling, preferably, the zone with the highest flow rate. Low flow rate purging is conducted after hydraulic conditions within the well have re-stabilized, usually within 24 to 48 hours. Flow rates should not exceed the recharge rate of the aquifer. This is monitored by measuring the top of the water column with a properly cleaned water level indicator or similar device while pumping. This method is not considered to be a standard method by the Branch and is only acceptable under certain hydraulic conditions. It's use must be evaluated on a case-by-case basis.

3.3 Wells With In-Place Plumbing

Wells with in-place plumbing are commonly found at municipal water treatment plants, industrial water supplies, private residences, etc. Many permanent monitoring wells at active facilities are also equipped with dedicated, in-place pumps. The objective of purging wells with in-place pumps is the same as with monitoring wells without in-place pumps, i.e., to ultimately collect a ground water sample representative of aquifer conditions. Among the types of wells identified in this section, two different approaches are necessary.

A permanent monitoring well with an in-place pump should, in all respects, be treated like a monitoring well without a pump. One limitation is that in most cases the in-place pump is "hard" mounted, that is, the pump is suspended in the well at a pre-selected depth and cannot be moved up or down during purging and sampling. In these cases, well volumes are calculated, parameters are measured and the well is sampled from the pump discharge, after volume removal and parameter conditions have been met.

In the case of the other types of wells, i.e., municipal, industrial and residential supply wells, however, not enough is generally known about the construction aspects of the wells to apply the same criteria as used for monitoring wells, i.e., 3 to 5 well volumes. The volume to be purged in these situations, therefore, depends on several factors: whether the pumps are running continuously or intermittently and whether or not any storage/pressure tanks are located between the sampling point and the pump. The following considerations and procedures should be followed when purging wells with in-place plumbing under the conditions described.

3.3.1 Continuously Running Pumps

If the pump runs more or less continuously, no purge (other than opening a valve and allowing it to flush for a few minutes) is necessary. If a storage tank is present, a spigot, valve or other sampling point should be located between the pump and the storage tank. If not, locate the valve closest to the tank. Measurements of pH, specific conductance, temperature, and turbidity are recorded at the time of sampling.

3.3.2 Intermittently or Infrequently Running Pumps

If the pump runs intermittently or infrequently, best judgment should be utilized to remove enough water from the plumbing to flush standing water from the piping and any storage tanks that might be present. Generally, under these conditions, 15 to 30 minutes will be adequate. Measurements of pH, specific conductance, temperature and turbidity should be made and recorded at intervals during the purge and the final measurements made at the time of sampling should be considered the measurements of record for the event.

3.4 Temporary Monitoring Wells

3.4.1 General Considerations

Procedures used to purge temporary ground water monitoring wells differ from permanent wells because temporary wells are installed for immediate sample acquisition. Wells of this type may include standard well screen and riser placed in boreholes created by hand augering, power augering, or by drilling. They may also consist of a rigid rod and screen that is pushed, driven, or hammered into place to the desired sampling interval, such as a direct push Wellpoint®, a Geoprobe® Screen Point 15 sampler or a Hydropunch® sampler. As such, the efforts to remove several volumes of water to replace stagnant water do not necessarily apply because stagnant water is not present. It is important to note, however, that the longer a temporary well is in place and not sampled, the more stagnant the water column becomes and the more appropriate it becomes to apply, to the extent possible, standard permanent monitoring well purging criteria to it to re-achieve aquifer conditions.

In cases where the temporary well is to be sampled immediately after installation, purging is conducted primarily to mitigate the impacts of installation. In most cases, temporary well installation procedures disturb the existing aquifer conditions, resulting primarily in increased turbidity. Therefore, the goal of purging is to reduce the turbidity and remove the volume of water in the area directly impacted by the installation procedure. Low turbidity conditions in these types of wells that are completed within the limit of suction are typically and routinely achieved by the use of low-flow/low stress purging techniques using variable speed peristaltic pumps.

3.4.2 Purging When Water Level Is Within Limit of Suction

In situations where the elevation of the top of the water column is within the limit of suction (no greater than about 25 feet head difference between the pump and the water level), a variable speed peristaltic pump may be used to purge temporary wells. Enough tubing is deployed to reach the bottom of the temporary well screen. At the onset of purging, the tubing is slowly lowered to the bottom of the screen and is used to remove any formation material which may have entered the well screen during installation. This is critical to ensuring rapid achievement of low turbidity conditions. After the formation material is removed from the bottom of the screen, the tubing is slowly raised through the water column to near the top of the column. The tubing can be held at this level to determine if the pump rate is drawing down the water level in the well. If the water level remains the same, secure the tubing at the surface to maintain this pumping level.

If drawdown is observed on initiation of pumping, reduce the pump speed and attempt to match the drawdown of the well. Sustained pumping at these slow rates will usually result in a relatively clear, low turbidity sample. If the drawdown stabilizes, maintain that level, however, if it continues to lower, "chase" the water column until the well is evacuated. In this case, the recovered water column may be relatively free of turbidity and can be sampled. It may take several episodes of recovery to provide enough volume for a complete sample.

3.4.3 Purging When Water Level Is Greater Than Limit of Suction

In situations where the elevation of the water table is greater than the limit of suction, peristaltic pumps cannot be used to purge temporary wells. If the temporary well is a ScreenPoint15® sampler with small diameter probe rod riser, the only practical choices for water removal are a small diameter bailer, a small diameter bladder pump or an inertial pump. If the well is to be used strictly for VOC screening, it may be acceptable to use the bailer to bail as much sediment from the well as possible prior to sampling. If metals are the analytes of concern, the bladder pump is the best choice for lowering the turbidity of the water column prior to sampling, followed next by the inertial pump. For larger diameter temporary wells, two-inch diameter or greater, bailers and the Grundfos® RediFlo2 may be used although excessive silt or other “fines” may present problems with the operation of the pump.

3.4.4 Considerations for Direct Push Groundwater Sampling

With many of the direct push sampling techniques, purging is either not practical or possible, therefore, no purging is conducted. The sampling device is simply pushed or driven to the desired depth and opened and the sample is collected and retrieved. As a result, some samples collected in this way may not be satisfactory

or acceptable for certain analyses, i.e., the subject procedure may yield a turbid sample that is not appropriate for metals analyses.

3.5 Investigation Derived Waste

Purging generates quantities of purge water or investigation derived waste (IDW), the disposition of which must be considered. See SESD Operating Procedure for Management of Investigation Derived Waste (SESDPROC-202) for guidance on management or disposal of this waste.

4 Groundwater Sampling Methods – Sampling

4.1 General

Sampling is the process of obtaining, containerizing, and preserving (if required) a ground water sample after the purging process is complete. Non-dedicated pumps for sample collection generally should not be used. Many pumps are made of materials such as brass, plastic, rubber, or other elastomer products which may cause chemical interferences with the sample. Their principle of operation may also render them unacceptable as a sample collection device. It is recognized that there are situations, such as industrial or municipal supply wells or private residential wells, where a well may be equipped with a dedicated pump from which a sample would not normally be collected. Discretion should always be used in obtaining a sample.

4.2 Sampling Wells With In-Place Plumbing

Samples should be collected following purging from a valve or cold water tap as near to the well as possible, preferably prior to any storage/pressure tanks or physical/chemical treatment system that might be present. Remove any hose that may be present before sample collection and reduce the flow to a low level to minimize sample disturbance, particularly with respect to volatile organic constituents. Samples should be collected directly into the appropriate containers as specified in the ASBLOQAM. It may be necessary to use a secondary container, such as a clean 8 oz. or similar size sample jar or a stainless steel scoop, to obtain and transfer samples from spigots with low ground clearance. Also, refer to the discussion in the SESD Operating Procedure for Potable Water Supply Sampling (SESDPROC-305), Sec. 4.2, Potable Water Samples Collected from Wells with In-Place Plumbing**.** Potable well measurements for pH, specific conductance, temperature, and turbidity should be recorded at the time of sample collection.

4.3 Sampling Wells without Plumbing, Within the Limit of Suction

4.3.1 Equipment Available

The pump of choice for sampling ground water within the limit of suction is the variable-speed peristaltic pump. Its use is described in the following sections. Other acceptable alternatives that may be used under these conditions are the RediFlo2® electric submersible pump (with Teflon® tubing) and a closed-top Teflon® bailer

4.3.1.1 Peristaltic Pump, Direct from Pump Head Tubing

Samples for some constituents, primarily inorganic analytes such as metals and cyanide, may be collected directly from the pump head tubing. This method is acceptable under the following conditions:

- The pump head tubing must be changed between sampling locations;
- The pump head tubing must be either be certified clean according to SESD's internal quality control program described in Section 3.2 of the SESD Operating Procedure for Field Sampling Quality Control (SESDPROC-011) or
- An equipment rinsate blank is collected by pumping de-ionized water through a piece of the tubing.

4.3.1.2 Peristaltic pump/vacuum jug

It is not acceptable to collect samples for organic compounds analyses through the flexible tubing used in the pump head. When collecting samples for organic compound analyses it is necessary to use a vacuum container, placed between the pump and the well for sample collection. The following step-by-step procedures describe the process of sampling with a peristaltic pump and vacuum jug (see note following these procedures for collection of VOC samples):

1. Disconnect the purge tubing from the pump. Make sure the tubing is securely attached to the protective casing or other secure object.

2. Insert the tubing into one of the ferrule nut fittings of a Teflon® vacuum container transfer cap assembly.

3. Place a suitable length of Teflon® tubing between the remaining transfer cap assembly ferrule nut fitting and the vacuum side of the flexible tubing in the peristaltic pump head. Securely hand-tighten both fittings.

4. Turn the pump on. Water should begin to collect in the transfer container (typically a 1-liter sample container) within a few minutes. If water does not begin to flow into the container within several minutes, check the transfer cap fittings and make sure the assembly is tightly attached to the container. It may be necessary to tighten the ferrule nuts with a wrench or pliers to achieve a vacuum in the system, particularly when approaching the maximum head difference between the pump and water table (limit of suction).

5. When the transfer container is nearly full, turn off the pump, remove the transfer cap assembly, and pour the sample into the appropriate containers. Because the 1-liter containers used by the Branch are rinsed with nitric acid during cleaning, they cannot be used for collecting samples to be analyzed for nitrogen sensitive parameters.

6. If additional sample volume is needed, replace the transfer cap assembly, turn the pump on, and collect additional volume. The use of Teflon® valves or ball check devices to retain the water column in the sample delivery tubing during the transfer phase, when large volumes of sample are required, is acceptable. These devices, however, must be constructed so that they may be completely disassembled and cleaned according to the procedures in SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205).

7. When sampling is completed, all Teflon® tubing should be discarded.

   NOTE: Samples for volatile organic compound analyses cannot be collected using this method. If samples for VOC analyses are required, they must be collected with a Teflon® or stainless steel bailer or by other approved methods, such as the "soda straw" method. The "soda straw" method involves allowing the tubing to fill, by either lowering it into the water column (A) or by filling it via suction applied by the pump head (B). If method (A) is used, the tubing is removed from the well after filling and the captured sample is allowed to drain into the sample vial. If method (B) is used, after running the pump and filling the tubing with sample, the pump speed is reduced and the direction reversed to push the sample out of the tubing into the vials. Avoid completely emptying the tubing when filling the sample vials when using method (B) to prevent introducing water that was in contact with the flexible pump head tubing. Either method is repeated, as necessary, until all vials are filled.

4.3.1.3 RediFlo2® Electric Submersible Pump (with Teflon® tubing)

After purging has been accomplished with RediFlo2® electric submersible pump, the sample may be obtained directly from the pump discharge, provided that Teflon® tubing was used for the sample delivery line. The discharge rate of the pump should be reduced during volatile organic compound sample collection to minimize sample disturbance. Note, if the RediFlo2® electric submersible pump is used for sampling, the water in the cooling chamber must be replaced with organic-free water between each well and the pump must undergo a full external and internal cleaning. In addition, pump rinsate blanks must be collected, at the appropriate frequency, to demonstrate that the pump has been adequately cleaned between wells.

4.3.1.4 Bailers

New bailer rope should be attached to the bailer via a Teflon® coated stainless steel wire. (If a bailer was used to purge the well, it may also be used to sample the well and new bailer rope is not required between purging and sampling). The bailer should be gently immersed in the top of the water column until just filled. At this point, the bailer should be slowly removed and the contents emptied into the appropriate sample containers.

4.4 Sampling Wells without Plumbing, Exceeding the Limit of Suction

All methods described previously in Section 4.3.2.1.3, RediFlo2® Electric Submersible Pumps, and Section 4.3.2.1.4, Bailers, are suitable sample methods where the water table is too deep to consider the use of a peristaltic pump for sampling.

4.5 Sample Preservation

After sample collection, all samples requiring preservation must be preserved as soon as practical. Consult the ASBLOQAM for the correct preservative for the particular analytes of interest. All samples preserved using a pH adjustment (except VOCs) must be checked, using pH strips, to ensure that they were adequately preserved. This is done by pouring a small volume of sample over the strip. Do not place the strip in the sample. Samples requiring reduced temperature storage should be placed on ice immediately.

4.6 Special Sample Collection Procedures

4.6.1 Trace Organic Compounds and Metals

Special sample handling procedures should be instituted when trace contaminant samples are being collected. All sampling equipment, including pumps, bailers, water level measurement equipment, etc., which comes into contact with the water in the well must be cleaned in accordance with the cleaning procedures described in the SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205 or SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC (SESDPROC-206). Pumps should not be used for sampling unless the interior and exterior portions of the pump and the discharge hoses are thoroughly cleaned. Blank samples should be collected to determine the adequacy of cleaning prior to collection of any sample using a pump other than a peristaltic pump.

4.6.2 Order of Sampling with Respect to Analytes

In many situations when sampling permanent or temporary monitoring wells, an adequate purge, with respect to turbidity, is often difficult to achieve. Removal

and insertion of equipment after the purge and prior to actual sampling may negate the low turbidities achieved during purging and elevate turbidity back to unacceptable levels. For this reason, it is important that special efforts be used to minimize any disturbance of the water column after purging and to collect the aliquot for metals first. Therefore, the preferred order of sampling is metals first, followed by other inorganic analytes, extractable organic compounds and volatile organic compounds.

4.6.3 Filtering

As a standard practice, ground water samples will not be filtered for routine analysis. Filtering will usually only be performed to determine the fraction of major ions and trace metals passing the filter and used for flow system analysis and for the purpose of geochemical speciation modeling. Filtration is not allowed to correct for improperly designed or constructed monitoring wells, inappropriate sampling methods, or poor sampling technique.

When samples are collected for routine analyses and are filtered, both filtered and non-filtered samples will be submitted for analyses. Samples for organic compounds analysis should not be filtered. Prior to filtration of the ground water sample for any reason other than geochemical speciation modeling, the following criteria must be demonstrated to justify the use of filtered samples for inorganic analysis:

1. The monitoring wells, whether temporary or permanent, have been constructed and developed in accordance with the SESD Guidance Document, Design and Installation of Monitoring Wells (SESDGUID-001).

2. The ground water samples were collected using sampling techniques in accordance with this section, and the ground water samples were analyzed in accordance with USEPA approved methods.

3. Efforts have been undertaken to minimize any persistent sample turbidity problems. These efforts may consist of the following:

- Redevelopment or re-installation of permanent ground water monitoring wells.
- Implementation of low flow/low stress purging and sampling techniques.

4. Turbidity measurements should be taken during purging and sampling to demonstrate stabilization or lack thereof. These measurements should be documented in the field notes. If the ground water sample appears to have either a chemically-induced elevated turbidity, such as would occur with precipitate formation, or a naturally elevated colloid or fine, particulate-related turbidity, filtration will not be allowed.

If filtration is necessary for purposes of geochemical modeling or other **pre-approved** cases, the following procedures are suggested:

1. Accomplish in-line filtration through the use of disposable, high capacity filter cartridges (barrel-type) or membrane filters in an in-line filter apparatus. The high capacity, barrel-type filter is preferred due to the higher surface area associated with this configuration. If a membrane filter is utilized, a minimum diameter of 142 mm is suggested.

2. Use a 5 µm pore-size filter for the purpose of determining the colloidal constituent concentrations. A 0.1 µm pore-size filter should be used to remove most non-dissolved particles.

3. Rinse the cartridge or barrel-type filter with 500 milliliters of the solute (ground water to be sampled) prior to collection of sample. If a membrane filter is used, rinse with 100 milliliters of solute prior to sample collection.

Potential differences could result from variations in filtration procedures used to process water samples for the determination of trace element concentrations. A number of factors associated with filtration can substantially alter "dissolved" trace element concentrations; these include filter pore size, filter type, filter diameter, filtration method, volume of sample processed, suspended sediment concentration, suspended sediment grain-size distribution, concentration of colloids and colloidally-associated trace elements, and concentration of organic matter. Therefore, consistency is critical in the comparison of short-term and long-term results. Further guidance on filtration may be obtained from the following: 1) Metals in Ground Water: Sampling Artifacts and Reproducibility; 2) Filtration of Ground Water Samples for Metals Analysis; and 3) Ground Water Sampling - A Workshop Summary. See Section 1.4, References, for complete citation for these documents.

Bacterial Sampling

Whenever wells (normally potable wells) are sampled for bacteriological parameters, care must be taken to ensure the sterility of all sampling equipment and all other equipment entering the well. Further information regarding bacteriological sampling is available in the following: 1) Sampling for Organic Chemicals and Microorganisms in the Subsurface; 2) Handbook for Evaluating Water Bacteriological Laboratories; and 3) Microbiological Methods for Monitoring the Environment, Water and Wastes. See Section 1.4, References, for complete citation for these documents.

4.7 Specific Sampling Equipment Quality Assurance Techniques

All equipment used to collect ground water samples shall be cleaned as outlined in the SESD Operating Procedure for Field Equipment Cleaning and Decontamination

(SESDPROC-205) or SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC (SESDPROC-206) and repaired, if necessary, before being stored at the conclusion of field studies. Cleaning procedures utilized in the field or field repairs shall be thoroughly documented in field records.

4.8 Auxiliary Data Collection

During ground water sample collection, it is important to record a variety of ground water related data. Included in the category of auxiliary data are water levels measured according to the SESD Operating Procedure for Groundwater Level and Well Depth Measurement (SESDPROC-105), well volume determinations (Section 3.1.1, Purging and Purge Adequacy), pumping rates during purging (see below), and occasionally, drillers or boring logs. This information should be documented in the field records.

4.8.1 Well Pumping Rate - Bucket/Stop Watch Method

The pumping rate for a pump can be determined by collecting the discharge from the pump in a bucket of known volume and timing how long it takes to fill the bucket. The pumping rate should be in gallons per minute. This method shall be used primarily with pumps with a constant pump rate, such as gasoline-powered or electric submersible pumps. Care should be taken when using this method with some battery-powered pumps. As the batteries' charge decreases, the pump rate also decreases so that pumping rate calculations using initial, high pump rates may be erroneously high. If this method is used with battery-powered pumps, the rate should be re-checked frequently to ensure accuracy of the pumping rate calculations.

APPENDIX C

Standard Label and Chain-of-Custody Record

Project Name: _____ Project No: _____

Sample ID: _____

Sample Date: _____ Sample Time: _____

Sampler(s): _____

Analyses: _____

Preservatives: _____

AGVIQ CH2M HILL
1000 Abernathy Road, Suite 1600
Atlanta, GA 30328
Tel No: (770) 604-9182
Fax No: (770) 604-9183

CHAIN-OF-CUSTODY RECORD

[1] COC NUMBER: **378718-063009-01**

[2] PROJECT NAME:	[5] PROJECT NUMBER:	[8] LAB NAME AND CONTACT:	[11] FAX AND MAIL REPORTS/EDD TO:: RECIPIENT 1 (Name and Company)	[14] RECIPIENT 1 (Address, Tel No. , and Fax No.):
Naval Activity Puerto Rico	**378718.10.02.01.07**	**Empirical Laboratories**	**Tom Beisel/CH2M HILL**	**1000 Abernathy Road, Atlanta GA 30328. 678.530.4033/770.604.9183**
[3] PROJECT PHASE/SITE/TASK:	[6] CTO OR DO NUMBER:	[9] LAB PO NUMBER:	[12] FAX AND MAIL REPORTS/EDD TO:: RECIPIENT 2 (Name and Company)	[15] RECIPIENT 2 (Address, Tel No. , and Fax No.):
SWMU 7/8 - Test Pit Waste Characterization	**N62470-08-D-1006**	**30024338**	**Bryan Burkingstock/CH2M HILL**	**1000 Abernathy Road, Atlanta GA 30328. 678.530.4060/770.604.9183**
[4] PROJECT CONTACT:	[7] PROJECT TEL NO AND FAX NO:	[10] LAB TEL NO AND FAX NO:	[13] FAX AND MAIL REPORTS/EDD TO:: RECIPIENT 3 (Name and Company)	[16] RECIPIENT 3 (Address, Tel No. , and Fax No.):
Tom Beisel	**770.604.9182**	**615.345.1115/615.345.5426**		

[25] ANALYSES REQUIRED (Include Method Numbers)

[17] ITEM	[18] SAMPLE IDENTIFIER	[19] SAMPLE DESCRIPTION/LOCATION	[20] MATRIX (see codes on SOP)	[21] DATE COLLECTED	[22] TIME COLLECTED	[23] DATA PKG LEVEL (see codes on SOP)	[24] TAT (calendar days)	Bottle Type / Number of Bottles	G TCLP VOCs - 1311/8260B	G TCLP SVOCs - 1311/8270C	G TCLP Pesticides - 1311/8081A	G TCLP Herbicides - 1311/8151A	G TCLP Metals - 1311/6010B/7470A	G Ignitability - 1010	G Corrosivity - 9045	G Reactivity- Ch 7.3	G PCBs - 8082		[26] SAMPLE TYPE (see codes on SOP)	[27] COMMENTS/ SCREENING READINGS	[28] LAB ID (for lab's use)
1	**JM04-TP-IDW-1-063009**	**Test Pit IDW #1**	**SO**	**06/30/09**		**B/III**	**14**	**5**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**		**N**		
2																					
3																					
4																					
5																					
6																					
7																					
8																					
9																					
10																					

[29] SAMPLER(S) AND COMPANY: (please print)	[30] COURIER AND SHIPPING NUMBER:	[31] SAMPLES TEMPERATURE AND CONDITION UPON RECEIPT (for lab's use):
Andrew O'Conor/CH2M HILL **Lauren Petty/CH2M HILL**		

[32] RELINQUISHED BY	DATE	TIME	[33] RECEIVED BY	DATE	TIME
Printed Name and Signature:			Printed Name and Signature:		
Printed Name and Signature:			Printed Name and Signature:		
Printed Name and Signature:			Printed Name and Signature:		

Distribution: [ ] **Original** - Laboratory (To be returned with Analytical Report); [ ] **Copy 1** - Project File; [ ] **Copy 2** - PMO

Form CCI001, Rev 06/00

Appendix B
Quality Control Attachments

SMALL BUSINESS RAC AGVIQ CH2M HILL	PREPARATORY PHASE REPORT	REPORT NO:	REPORT DATE: REVISION NO: REVISION DATE:
PROJECT NO:	DEFINABLE FEATURE OF WORK:	SITE/ACTIVITY:	

PERSONNEL PRESENT

NAME	POSITION	COMPANY/GOVERNMENT

SUBMITTALS

REVIEW SUBMITTALS AND/OR SUBMITTAL REGISTER.

HAVE ALL SUBMITTALS BEEN APPROVED? YES ☐ NO ☐

IF NO, WHAT ITEMS HAVE NOT BEEN SUBMITTED?

ARE ALL MATERIALS ON HAND? YES ☐ NO ☐

IF NO, WHAT ITEMS ARE MISSING?

CHECK APPROVED SUBMITTALS AGAINST DELIVERED MATERIAL. (THIS SHOULD BE DONE AS MATERIAL ARRIVES).

COMMENTS:

MATERIAL STORAGE

ARE MATERIALS STORED PROPERLY? YES ☐ NO ☐

IF NO, WHAT ACTION IS TAKEN?

SPECIFICATIONS

REVIEW EACH PARAGRAPH OF SPECIFICATIONS.

DISCUSS PROCEDURE FOR ACCOMPLISHING THE WORK.

CLARIFY ANY DIFFERENCES.

PRELIM WORK & PERMITS

ENSURE PRELIMINARY WORK IS CORRECT AND PERMITS ARE ON FILE.

IF NO, WHAT ACTION IS TAKEN?

CH2M HILL **RAC 4**	**PREPARATORY PHASE REPORT**	REPORT NO:	REPORT DATE: REVISION NO: REVISION DATE:
PROJECT NO:	DEFINABLE FEATURE OF WORK:	SITE/ACTIVITY:	

TESTING

IDENTIFY TEST TO BE PERFORMED, FREQUENCY, AND BY WHOM.

TEST	FREQUENCY	PERFORMER

WHEN REQUIRED?

WHERE REQUIRED?

REVIEW TESTING PLAN.

HAVE TEST FACILITIES BEEN APPROVED?

TEST FACILITY	APPROVED?
	YES ☐ NO ☐
	YES ☐ NO ☐

SAFETY

ACTIVITY HAZARD ANALYSIS APPROVED? YES ☐ NO ☐

REVIEW APPLICABLE PORTION OF EM 385-1-1 AND AHA.

MEETING COMMENTS

NAVY/ROICC COMMENTS DURING MEETING.

OTHER ITEMS OR REMARKS

OTHER ITEMS OR REMARKS:

QC REPRESENTATIVE'S NAME	QC REPRESENTATIVE'S SIGNATURE		DATE	

AGVIQ CH2M HILL **Small Business RAC** **N62470-08-D-1006**	**CONTRACTOR PRODUCTION REPORT** (ATTACH ADDITIONAL SHEETS IF NECESSARY)	DATE OF REPORT: REVISION NO: REVISION DATE:

CTO NO:	PROJECT NAME/LOCATION:		REPORT NO:
PROJECT NO:	SUPERINTENDENT:	SITE H&S SPECIALIST:	
AM WEATHER:	PM WEATHER:	MAX TEMP: F	MIN TEMP: F

SUMMARY OF WORK PERFORMED TODAY

JOB SAFETY

Was A Job Safety Meeting Held This Date?	☐ Yes ☐ No	**TOTAL WORK HOURS ON JOB SITE THIS DATE** (Including Continuation Sheets)	
Were there any lost-time accidents this date? (If Yes, attach copy of completed OSHA report)	☐ Yes ☐ No	CH2MHILL On-Site Hours	
Was a Confined Space Entry Permit Administered This Date? (If Yes, attach copy of each permit)	☐ Yes ☐ No	AGVIQ On-Site Hours	
Was Crane/Manlift/Trenching/Scaffold/HV Elec/High Work/Hazmat Work Done?? (If Yes, attach statement or checklist showing inspection performed)	☐ Yes ☐ No	Subcontractor On-Site Hours	
		Total On-Site Hours This Date	
Was Hazardous Material/Waste Released into the Environment? (If Yes, attach description of incident and proposed action)	☐ Yes ☐ No	Cumulative Total of Work Hours From Previous Report	
		Total Work Hours From Start of Construction	

SAFETY ACTIONS TAKEN TODAY/SAFETY INSPECTIONS CONDUCTED (Include Safety Violations, Corrective Instructions Given, Corrective Actions Taken, and Results of Safety Inspections Conducted):

EQUIPMENT/MATERIAL RECEIVED TODAY TO BE INCORPORATED IN JOB

DESCRIPTION OF EQUIPMENT/MATERIAL RECEIVED	MAKE/ MODEL/ MANUFACTURER	EQUIPMENT/ LOT NUMBER	INSPECTION PERFORMED BY	NUMBER/ VOLUME/ WEIGHT

EQUIPMENT USED ON JOB SITE TODAY.

EQUIPMENT DESCRIPTION	EQUIPMENT MAKE/MODEL	SAFETY CHECK PERFORMED BY	NUMBER OF HOURS		
			USED	IDLE	REPAIR

CHANGED CONDITIONS/DELAY/CONFLICTS ENCOUNTERED (List any conflicts with the delivery order [i.e., scope of work and/or drawings], delays to the project attributable to site and weather conditions, etc.)**:**

VISITORS TO THE SITE:

LIST OF ATTACHMENTS (OSHA report, confined space entry permit, incident reports, etc.):

SAFETY REQUIREMENTS HAVE BEEN MET ☐

SUPERINTENDENT'S SIGNATURE DATE

AGVIQ-CH2M HILL **Small Business RAC** **N62470-08-D-1006**	**CONTRACTOR PRODUCTION REPORT** (ATTACH ADDITIONAL SHEETS IF NECESSARY)	DATE OF REPORT: REVISION NO: REVISION DATE:
CTO NO:	PROJECT NAME/LOCATION:	REPORT NO:
PROJECT NO:	SUPERINTENDENT: / SITE H&S SPECIALIST:	

WORK PERFORMED TODAY

EMPLOYEE	WORK PERFORMED	EMPLOYER	FEMALE?	MINORITY?	TITLE/TRADE	HRS

INCLUDE ALL PERSONNEL WORK HOURS IN THE TOTAL WORK HOURS ON JOB SITE

SAFETY REQUIREMENTS HAVE BEEN MET ☐

SUPERINTENDENT'S SIGNATURE _____ DATE _____

AGVIQ CH2M HILL **Small Business RAC** **N62470-08-D-1006**	**CONTRACTOR QUALITY CONTROL REPORT** (ATTACH ADDITIONAL SHEETS IF NECESSARY)	REPORT DATE: REVISION NO: REVISION DATE:
CTO NO:	PROJECT NAME/LOCATION:	REPORT NO:
PROJECT NO:	PROJECT QC MANAGER:	SITE H&S SPECIALIST:

SAFETY MEETINGS AND INSPECTIONS

WAS A SAFETY MEETING HELD THIS DAY?	☐ YES	☐ NO	IF YES, ATTACH SAFETY MEETING MINUTES
WAS CRANE USED ON THE SITE THIS DAY?	☐ YES	☐ NO	IF YES, ATTACH DAILY CRANE REPORT OF INSPECTION AND CONTRACTOR CRANE OPERATION CHECKLIST

DEFINABLE FEATURES OF WORK STATUS

DFOW No.	Definable Feature Of Work	Preparatory	Initial	Follow-Up
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
10		☐	☐	☐
11		☐	☐	☐
12		☐	☐	☐
13		☐	☐	☐
14		☐	☐	☐
15		☐	☐	☐

PREPARATORY

WAS PREPARATORY PHASE WORK PERFORMED TODAY? ☐ YES ☐ NO

IF YES, FILL OUT AND ATTACH SUPPLEMENTAL PREPARATORY PHASE CHECKLIST.

DFOW No.(from list above).	TASK/ACTIVITY	PREPARATORY PHASE REPORT NO.

INITIAL AND FOLLOW-UP FEATURE OF WORK COMMENTS

DFOW No.(from list above)	Phase	Comment/Finding/Action
	Initial ☐ Follow up ☐	
	Initial ☐ Follow up ☐	
	Initial ☐ Follow up ☐	
	Initial ☐ Follow up ☐	
	Initial ☐ Follow up ☐	
	Initial ☐ Follow up ☐	
	Initial ☐ Follow up ☐	
	Initial ☐ Follow up ☐	
	Initial ☐ Follow up ☐	
	Initial ☐ Follow up ☐	
	Initial ☐ Follow up ☐	

REWORK ITEMS IDENTIFIED TODAY (NOT CORRECTED BY CLOSE OF BUSINESS)			**REWORK ITEMS CORRECTED TODAY (FROM REWORK ITEMS LIST)**	
TASK/ACTIVITY	DATE ISSUED	DESCRIPTION	TASK/ACTIVITY	CORRECTIVE ACTION(S) TAKEN

AGVIQ-CH2M HILL **Small Business RAC** **N62470-08-D-1006**	**CONTRACTOR QUALITY CONTROL REPORT** (ATTACH ADDITIONAL SHEETS IF NECESSARY)	REPORT DATE: REVISION NO: REVISION DATE:
CTO NO:	PROJECT NAME/LOCATION:	REPORT NO:
PROJECT NO:	PROJECT QC MANAGER:	SITE H&S SPECIALIST:

SAMPLING/TESTING PERFORMED

SAMPLING/TESTING PERFORMED	SAMPLING/TESTING COMPANY	SAMPLING/TESTING PERSONNEL

MATERIALS/EQUIPMENT INSPECTION (Materials received and inspected against specifications)

MATERIAL/EQUIPMENT DESCRIPTION	SPECIFICATION	MATERIAL ACCEPTED?	COMMENT/REASON/ACTION
		YES ☐ NO ☐	
		YES ☐ NO ☐	
		YES ☐ NO ☐	
		YES ☐ NO ☐	
		YES ☐ NO ☐	
		YES ☐ NO ☐	
		YES ☐ NO ☐	

SUBMITTALS INSPECTION / REVIEW

SUBMITTAL NO	SUBMITTAL DESCRIPTION	SPEC/PLAN REFERENCE	SUBMITTAL APPROVED?	COMMENT/REASON/ACTION
			YES ☐ NO ☐	
			YES ☐ NO ☐	
			YES ☐ NO ☐	
			YES ☐ NO ☐	

OFF-SITE SURVEILLANCE ACTIVITIES, INCLUDING ACTIONS TAKEN:

ACCUMULATION/STOCKPILE AREA INSPECTION

INSPECTION PERFORMED BY:				SIGNATURE OF INSPECTOR:			
ACCUMULATION/ STOCKPILE AREA LOCATION							
NO OF CONTAINERS:		NO OF TANKS:		NO OF ROLL-OFF BOXES:		NO OF DRUMS:	

INSPECTION RESULTS:

TRANSPORTATION AND DISPOSAL ACTIVITIES/SUMMARY/QUANTITIES:

GENERAL COMMENTS (rework, directives, etc.):

LIST OF ATTACHMENTS (examples, as applicable: preparatory phase checklist, QC meeting minutes, safety meeting minutes, crane inspections, crane operation checklist, COCs, weight tickets, manifests, profiles, rework item list, testing plan and log, etc.):

On behalf of the contractor, I certify that this report is complete and correct and equipment and material used and work performed during this reporting period is in compliance with the contract drawings and specifications to the best of my knowledge except as noted in this report.

PROJECT QC MANAGER'S SIGNATURE DATE

On behalf of the contractor, I attest that the work for which payment is requested, including stored material, is in compliance with contract requirements.

PROJECT QC MANAGER'S SIGNATURE DATE

Testing Plan and Log

Contract No.: N62470-08-D-1006		TO No.: JM04	TO Title: MNA Groundwater Study at SWMU 7/8				Location: Ceiba, Puerto Rico		Contractor: AGVIQ CH2M HILL	
A	B	C	D	E	F	G	H	I	J	K
Spec Section and Paragraph	Test Required	Proposed Lab	Sampled By	Tested By	Test Location	Frequency	Date Test Made	Test Results	Date Results Forwarded	Remarks

Submittal Register

Contract Number: N62470-08-D-1006	TO No.: JM04	TO Title: MNA Groundwater Study at SWMU 7/8	Location: Ceiba, Puerto Rico	Contractor: AGVIQ CH2M HILL

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Spec Section	Item Description	Para. Number	Approving Authority	Other Reviewers	Submittal Number	Scheduled Submission Date	CCI Review Date	CCI Disposition	CCI Transmit Date	QC Admin Received Date	QC Disposition	QC Admin Transmit Date	Contracting Officer Received	Contracting Officer Disposition	Contracting Officer Return	Remarks
	SD-01 **Data**															
	SD- Work Plan (WMP, EPP,Quality Plan, Schedule, HSP)															
	SD- Environmental Survey															
	SD- Environmental Conditions Report															
	SD-															
	SD-															
	SD-02 **Manufacturer's Catalog Data**															
	SD-															
	SD-															
	SD-															
	SD-04 **Drawings**															
	SD- Sampling Maps															
	SD- Well Construction Diagrams															
	SD-															
	SD-															
	SD-09 **Reports**															
	SD- Laboratory Analytical Data															
	SD- Quarterly Reports															
	SD-															
	SD-															
	SD-															
	SD-12 **Field Test Reports**															
	SD-															
	SD-															
	SD-															
	SD-13 **Certificates**															
	SD- Analytical Laboratory															
	SD-															
	SD-															
	SD-															
	SD-															
	SD-18 **Records**															
	SD- Waste Manifests															
	SD- Certificate of Disposal/Recycling															
	SD- Instrument Calibration Data															
	SD- Waste Disposal Log															
	SD- Contractor Production Report															
	SD- Contract Quality Control Report															
	SD- Rework Items List															
	SD- Photo Log															
	SD- Photographs															
	SD- Testing Plan and Log															
	SD- Monthly Summary of Field Tests															

Submittal Register

Contract Number: N62470-08-D-1006	TO No.: JM04	TO Title: MNA Groundwater Study at SWMU 7/8	Location: Ceiba, Puerto Rico	Contractor: AGVIQ CH2M HILL

A	B		C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Spec Section	Item Description		Para. Number	Approving Authority	Other Reviewers	Submittal Number	Scheduled Submission Date	CCI Review Date	CCI Disposition	CCI Transmit Date	QC Admin Received Date	QC Disposition	QC Admin Transmit Date	Contracting Officer Received	Contracting Officer Disposition	Contracting Officer Return	Remarks
	SD-	Weight Tickets															
	SD-	Meeting Minutes															
	SD-	Navy Environmental Data Transfer Standards (NEDTS) Deliverables															
	SD-	Laboratory Electronic Data Deliverables (EDDs) in NIRIS Electronic Data Deliverable (NEDD) Format															
	SD-	Living CD															
	SD-	Permits															
	SD-	Emergency and Hazardous Chemical Inventory Forms															
	SD-	Contractor and Subcontractor Personnel List															
	SD-	MSDS Sheets															
	SD-	Chemical Inventory															
	SD-																
	SD-																
	SD-20	**Closure Report**															
	SD-	MNA Evaluation Report															
	SD-																
	SD-																
	SD-																
	SD-21	**Sampling and Analysis Plan**															
	SD-	Sample Log															
	SD-	UFP-SAP															

Appendix C
Appointment Letters for Quality Control Manager

November 4, 2009

Ms. Alicia Nobles
CH2M HILL, Inc.
1000 Abernathy Road
Suite 1600
Atlanta, Georgia

RE: Contract No. N62470-08-D-1006
Task Order No. JM04
Naval Activity (NA) Puerto Rico – Ceiba, Puerto Rico
Project Quality Control Manager Letter of Appointment

Dear Ms. Nobles:

Herein describes the responsibilities and authority delegated to you in your capacity as the Project QC Manager at the Naval Activity Puerto Rico, Task Order (TO) No. JM04 under the Navy LANT Small Business (SB) RAC Contract No. N62470-08-D-1006.

In this position, you assist and represent the QC Program Manager in continued implementation and enforcement of the Project QC Plans. Your primary role is to ensure all requirements of the contract are met. Consistent with this responsibility, you will: (i) implement the QC program as described in the Navy LANT SB RAC contract; (ii) manage the site-specific QC requirements in accordance with the Project QC Plans; (iii) attend the coordination and mutual understanding meeting; (iv) conduct QC meetings; (v) oversee implementation of the three phases of control; (vi) perform submittal review and approval; (vii) ensure testing is performed; (viii) prepare QC certifications and documentation required in the Navy LANT SB RAC Contract; and, (ix) furnish a Completion Certificate to the Contracting Officer or designated representative, upon completion of work under a contract task order , attesting that "the work has been completed, inspected, and tested, and is in compliance with the contract."

Your responsibilities further include identifying and reporting quality problems, rejecting nonconforming materials, initiating corrective actions, and recommending solutions for nonconforming activities.

You have the authority to control or stop further processing, delivery, or installation activities until satisfactory disposition and implementation of corrective actions are achieved. You have the authority to direct the correction of non-conforming work. All work requiring corrective action will be documented on daily reports, and, in the event non-conforming work is not immediately corrected you are required to submit a non-conformance report to the PM and

copy the QC Program Manager. A status log will be kept of all non-conforming work. You shall immediately notify the QC Program Manager in the event of any stop work order.

It is imperative that you comply with all terms of the basic contract. In particular, Section C, Paragraph 6.5.2, which states:

> "No work or testing may be performed unless the QC Program Manager or Project QC Manager is on the work site."

In the event that you are not able to be at the work site when work or testing is to be performed, it is your responsibility to inform the QC Program Manager and Project Manager, in advance, so that other arrangements can be made.

Further, if you are requested to perform the duties of the Site Supervisor, it is your responsibility to inform the QC Program Manager so that approval can be obtained in advance from the Contracting Officer or designated representative, in accordance with Section C Paragraph 6.6.2.1 of the contract.

You are a key member of the Project Manager's team. You ensure that work meets the specific requirements and intent of the work plan, the Navy's scope of work and the basic contract. Should you have any questions regarding this role, you should immediately contact the QC Program Manager, Theresa Rojas. Your day-to-day activities on the site should be coordinated with all site personnel and the Project Manager. In event of any deficient items, the Superintendent and Project Manager should be advised immediately so they have opportunity to remedy the situation.

Sincerely,

CH2M HILL Constructors, Inc.

Michael Halil
Deputy Program Manager

cc: Project File No. 378718

September 11, 2009

Mr. Andrew O'Conor
CH2M HILL Constructors, Inc.
1000 Abernathy Road, Suite 1600
Atlanta, Georgia 30328

RE: Contract No. N62470-08-D-1006
Task Order No. JM04
Naval Activity (NA) Puerto Rico – Ceiba, Puerto Rico
Alternate Project Quality Control Manager Letter of Appointment

Dear Mr. O'Conor:

Herein describes the responsibilities and authority delegated to you in your capacity as the alternate Project QC Manager at NA Puerto Rico, Task Order (TO) No. JM04 under the Navy Atlantic Small Business (SB) RAC Contract No. N62470-08-D-1006.

In this position, you assist and represent the Project QC Manager in the event that she is not on the project site and the Program QC Manager in continued implementation and enforcement of the Project QC Plans. Your primary role is to ensure all requirements of the contract are met. Consistent with this responsibility, you will: (i) implement the QC program as described in the Navy LANT SB RAC; (ii) manage the site-specific QC requirements in accordance with the Project QC Plans; (iii) attend the coordination and mutual understanding meeting; (iv) conduct QC meetings; (v) oversee implementation of the three phases of control; (vi) perform submittal review and approval; (vii) ensure testing is performed; (viii) prepare QC certifications and documentation required in the Navy LANT SB RAC Contract; and, (ix) furnish a Completion Certificate to the Contracting Officer or designated representative, upon completion of work under a contract task order , attesting that "the work has been completed, inspected, and tested, and is in compliance with the contract."

Your responsibilities further include identifying and reporting quality problems, rejecting nonconforming materials, initiating corrective actions, and recommending solutions for nonconforming activities.

You have the authority to control or stop further processing, delivery, or installation activities until satisfactory disposition and implementation of corrective actions are achieved. You have the authority to direct the correction of non-conforming work. All work requiring corrective action will be documented on daily reports, and, in the event non-conforming work is not immediately corrected you are required to submit a non-conformance report to the PM and

copy the Program QC Manager. A status log will be kept of all non-conforming work. You shall immediately notify the Program QC Manager in the event of any stop work order.

It is imperative that you comply with all terms of the basic contract. In particular, Section C, Paragraph 6.5.2, which states:

> "No work or testing may be performed unless the QC Program Manager or Project QC Manager is on the work site."

In the event that you are not able to be at the work site when work or testing is to be performed, it is your responsibility to inform the Program QC Manager and Project Manager, in advance, so that other arrangements can be made.

Further, if you are requested to perform the duties of the Site Supervisor, it is your responsibility to inform the Program QC Manager so that approval can be obtained in advance from the Contracting Officer or designated representative, in accordance with Section C Paragraph 6.6.2.1 of the contract.

You are a key member of the Project Manager's team and ensure that work meets the specific requirements and intent of the work plan, the Navy's scope of work and the basic contract. Should you have any questions regarding this role, you should immediately contact the Program QC Manager, Theresa Rojas. Your day-to-day activities on the site should be coordinated with all site personnel and the Project Manager. In event of any deficient items, the Superintendent and Project Manager should be advised immediately so they have opportunity to remedy the situation.

Sincerely,

CH2M HILL Constructors, Inc.

Michael Halil
Deputy Program Manager

cc: Project File No. 378718