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FINAL SAMPLING AND ANALYSIS PLAN (FIELD SAMPLING PLAN AND QUALITY
ASSURANCE PROJECT PLAN) SITE 1 PRE FEASIBILITY STUDY INVESTIGATION NWS
YORKTOWN VA
3/1/2013
CH2MHILL

SAP Worksheet #1—Title and Approval Page

Final

Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan) Site 1 Pre-Feasibility Study Investigation

**Naval Weapons Station Yorktown
Yorktown, Virginia**

Contract Task Order WE35

March 2013

Prepared for

**Department of the Navy
Naval Facilities Engineering Command
Mid-Atlantic Division**

Under the

**NAVFAC CLEAN 8012 Program
Contract N62470-11-D-8012**

Prepared by:



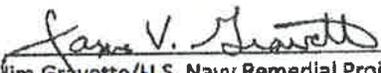
Virginia Beach, Virginia

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Approval Signatures

The following person(s) hereby state that they have reviewed this document and approved this document.

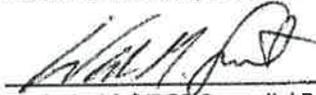
Approval Signatures:

 3/20/13

Jim Gravette/U.S. Navy Remedial Project Manager/Date

 3/24/13

Moshood Oduwole/USEPA Remedial Project Manager/Date

 03/20/2013

Wade Smith/VDEQ Remedial Project Manager/Date

Navy Quality Assurance Officer/Date

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Executive Summary

This Sampling and Analysis Plan (SAP) is being submitted to provide a systematic data collection and analysis structure for a field investigation to be completed in preparation for the Feasibility Study (FS) for Site 1 at Naval Weapons Station (WPNSTA) Yorktown, Yorktown, Virginia. In accordance with the *Uniform Federal Policy for Quality Assurance Project Plans* (UFP-QAPP) (USEPA, 2005), this United States Department of the Navy (Navy)-specific SAP includes 37 worksheets that detail various aspects of the environmental investigation process and serve as guidelines for the field work and data quality. The site-specific field standard operating procedures (SOPs), laboratory accreditation letters, and the Navy Comprehensive Long-term Environmental Action—Navy (CLEAN) Data Management Plan are located in **Appendices A, B, and C** of this SAP, respectively.

The Naval Facilities Engineering Command (NAVFAC), Mid-Atlantic, is conducting this Pre-FS investigation under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). CERCLA work is being conducted with the United States Environmental Protection Agency (USEPA) Region 3 as the lead regulatory agency. The Virginia Department of Environmental Quality (VDEQ) is the State regulatory agency. Together, these three entities form the stakeholder agencies for this project. Representatives from each of these entities form the WPNSTA Yorktown Partnering Team.

This document will help ensure that environmental data collected or compiled are scientifically sound, of known and documented quality, and suitable for intended uses. The laboratory information cited in this SAP is for the analytical laboratories that are currently contracted to provide analytical services for this investigation. The analytical services for this investigation will be provided by ENCO Laboratories of Orlando, Florida; Microbial Insights of Rockford, Tennessee; Kemron; and ALS of Rochester, New York. Additionally, data validation services will be provided by CH2M HILL.

A number of previous investigations and evaluations have been conducted at Site 1 from 1984 through 2012 to assess potential releases associated with landfilling activities. The most recent investigation (Phase II Remedial Investigation [RI]) identified chlorinated volatile organic compounds (VOCs) and metals as primary contaminants in groundwater. The landfill waste, possible dense non-aqueous phase liquid (DNAPL), and sorbed contaminant mass in fine-grained soil of the Yorktown-Eastover confining unit were identified as potential continuing sources of contamination. Unacceptable risks to future human receptors were identified due to potential exposure to contamination in groundwater due to tetrachloroethene (PCE), trichloroethene (TCE), 1,2-dichloroethene (DCE), and vinyl chloride. However, during review of the Phase II Groundwater RI report, a number of data gaps were identified which would not likely impact the risk assessment conclusions or the conclusions of the RI, but which were believed to potentially affect the identification and evaluation of remedial alternatives in the upcoming FS. As a result, the WPNSTA Yorktown Partnering Team agreed to finalize the RI report with recommendation to perform additional investigation in support of the FS. Therefore, the purpose of the investigation detailed in this SAP is to:

- Confirm the lateral extent of landfill waste and vertical and horizontal extent of the soil cover over the landfill since the landfilled waste is a potential continuing source of groundwater contamination and any groundwater remedy to be implemented will consider addressing contamination beyond the point of compliance (landfill boundary).
- Determine the concentrations of VOCs and metals in groundwater at the newly installed wells.
- Determine the potential for and rate of natural attenuation of site-related contaminants in groundwater at the site to support potential consideration as part of remedial alternatives evaluated in the FS.
- Refine the understanding of vertical and horizontal groundwater flow at the site to assist with determining the components of discharge to each of the surface water bodies.

- Better quantify the concentrations of elevated VOCs, previously determined via membrane interface probe (MIP), potentially present along the southern perimeter of the site in order to allow for contaminant mass concentration approximations in support of the FS.
- Determine if there are seeps that are impacted by contaminated groundwater in order to assist in determining if this groundwater to surface water pathway warrants consideration in the FS.
- Determine the presence or absence of the emerging contaminant 1,4-dioxane in groundwater, surface water, seeps, sediment, and sediment pore water at the site since it has not been previously evaluated but is potentially present. 1,4-dioxane is a solvent stabilizer which was previously used to stabilize 1,1,1-trichloroethane (TCA). Low concentrations of 1,1,1-TCA and its daughter products were detected during historical sampling.
- Confirm the RI findings associated with the surface water bodies to ensure that no significant impacts from groundwater discharge are occurring and this pathway does not need to be considered in the FS.

The following activities are proposed to meet the previously listed objectives:

- Eighteen test pits will be completed with a contingency to collect up to seven additional locations if necessary to confirm the lateral extent of waste and the thickness and extent of the landfill soil cover. Prior to test pitting, a field survey will be conducted to identify any visual indications of historic landfilling operations and activity (e.g., hummocky terrain). If additional ground surface evidence of possible waste is identified then these areas will also be investigated or test pits may be biased towards these areas.
- Five new monitoring wells will be installed (two shallow and deep well pairs and one deep well to be paired with an existing shallow well). The two new well pairs will be installed in areas where uncertainty currently exists related to vertical gradient and the presence of contamination was indicated by MIP data. The remaining deep well will assist in determining vertical gradient in the vicinity of Indian Field Creek
- Collection of groundwater from existing monitoring wells for site-related VOCs and 1,4-dioxane.
- Collection of groundwater from newly installed monitoring wells for Target Compound List (TCL) VOCs, 1,4-dioxane, and metals.
- Collection of groundwater from all new and existing monitoring wells for natural attenuation parameters, and collection of microbial population data at locations with the highest concentrations of VOCs.
- Groundwater level survey.
- Collection of surface water, sediment, seep, and sediment pore water samples for TCL VOCs, 1,4-dioxane, metals, and appropriate geochemical parameters to support ecological risk assessments.

The data will be summarized and evaluated in a Pre-FS Investigation Technical Memorandum and will be used to support the completion of the proposed FS for Site 1. If data collected indicate considerable degradation of contaminants to levels below project action levels (PALs), or a significant increase (one order of magnitude or higher) in concentrations of constituents is identified, the quantitative risk assessment from the RI will be revised to determine if unacceptable risks are still present at the site and, if so, their magnitude. If no unacceptable risks are identified, no FS will be necessary and a no further action Record of Decision (ROD) for groundwater will be prepared.

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- A Field Standard Operating Procedures
- B Department of Defense Laboratory Accreditation Letter
- C Navy CLEAN Data Management Plan

Tables

- 1 Previous Investigations/Actions
- 2 Problem Definition/Objectives, Environmental Questions, and Project Quality Objectives
- 3 Project Indicator Levels
- 4 Test Pit Locations
- 5 Sampling Design and Rationale

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- 2 Site 1 Layout
- 3 Previous Investigation Sample Locations
- 4 Hydrogeologic Units in York County
- 5 Site Location and Major Geologic Features
- 6 Site 1 Conceptual Hydrogeologic Cross Section A-A'
- 7 Site 1 Groundwater Elevation Contour Map – Columbia Aquifer
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- 9 Proposed Test Pit Locations and Approach
- 10 Site 1 Proposed Groundwater Sample Locations
- 11 Site 1 TCE Isoconcentrations Cross Section A-A'
- 12 Proposed Surface Water, Sediment, and Sediment-Pore Water Sample Locations

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Abbreviations and Acronyms

°C	degree Celsius
µg/L	microgram per liter
µm	micrometer
3R	Recognize, Retreat, and Respond
AM	Activity Manager
AQM	Activity Quality Manager
ASTM	American Society for Testing and Materials
AVS	acid volatile sulfide
AWQC	ambient water quality criteria
bgs	below ground surface
BTAG	Biological Technical Assistance Group
CA	corrective action
CAS	Chemical Analytical Service
CCC	calibration check compound
CCV	continuing calibration verification
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CLEAN	Comprehensive Long-term Environmental Action—Navy
CNNS	chloride, nitrate, nitrite, sulfate
COC	constituent of concern
CSM	conceptual site model
CTO	Contract Task Order
CVAA	cold vapor atomic absorption
DCE	dichloroethene
DHC	dehalococcoides sp.
DL	detection limit
DNA	deoxyribonucleic acid
DNAPL	dense non-aqueous phase liquid
DO	dissolved oxygen
DoD	Department of Defense
DPT	direct push technology
DQO	data quality objective
DRMO	Defense Recycling Material Office
ELAP	Environmental Laboratory Accreditation Program
EM	electromagnetic
ERA	Ecological Risk Assessment
ERD	enhanced reductive dechlorination
ERP	Environmental Restoration Program
ESV	ecological screening value
ETSG	Ecological Technical Support Group
FID	flame ionization detector
FRG	final remediation goal
FS	Feasibility Study
FTL	Field Team Leader

g	gram
GC	gas chromatography
GC-MS	gas chromatography mass spectroscopy
GPR	ground penetrating radar
GPS	Global Positioning System
H&S	health and safety
HASP	Health and Safety Plan
HDPE	high-density polyethylene
HHRA	Human Health Risk Assessment
HQ	hazard quotient
HS&E	health, safety, and environment
HSO	Health and Safety Officer
IAS	Initial Assessment Study
ICAL	initial calibration
ICP	inductively coupled plasma
ICP-AES	inductively coupled plasma atomic emission spectroscopy
ICP-MS	inductively coupled plasma mass spectroscopy
ICS	Interference check solution
ICV	initial calibration verification
ID	identification
IDW	investigation-derived waste
IS	internal standard
L	liter
LCL	lower control limit
LCS	Laboratory Control Sample
LIMS	Laboratory Information Management Systems
LOD	limit of detection
LOQ	limit of quantitation
LTM	long-term monitoring
LUC	land use control
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
MEE	methane, ethane, ethene
mg/kg	milligram per kilogram
mg/L	milligram per liter
MIP	membrane interface probe
mL	milliliter
mm	millimeter
MPC	Measurement Performance Criteria
MRL	Method Reporting Limit
MS	matrix spike
MSD	matrix spike duplicate
N/A	not applicable
NA	not analyzed
NAVFAC	Naval Facilities Engineering Command
Navy	Department of the Navy
NC	no criterion

ND	not detected
NIRIS	Navy Installation Restoration Information System
NTU	nephelometric turbidity unit
ORP	oxidation-reduction potential
OU	Operable Unit
oz	ounce
PAH	polycyclic aromatic hydrocarbon
PAL	project action level
PC	Project Chemist
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PID	photoionization detector
PIL	project indicator limit
PM	Project Manager
POC	point of contact
PPE	personal protective equipment
ppm	part per million
PQL	project quantitation limit
PQO	project quality objective
PVC	polyvinyl chloride
QA	quality assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	quality control
QL	quantitation limit
qPCR	quantitative polymerase chain reaction
QSM	Quality Systems Manual
RA	remedial action
RAA	remedial action alternative
RAO	remedial action objective
RD	remedial design
RF	response factor
RI	Remedial Investigation
RL	reporting limit
ROD	Record of Decision
RPD	relative percent difference
RPM	Remedial Project Manager
RRT	relative retention time
RSL	Regional Screening Level
SAP	Sampling and Analysis Plan
SCV	second source calibration verification
SEM	simultaneously extractable metals
SOP	standard operating procedure
SPCC	system performance check compound
STC	Senior Technical Consultant
TAL	Target Analyte List
TBD	to be determined

TCA	trichloroethane
TCD	thermal conductivity detection
TCE	trichloroethene
TCL	Target Compound List
TDS	total dissolved solids
TNT	trinitrotoluene
TOC	total organic carbon
tpy	ton per year
UCL	upper control limit
UFP-QAPP	Uniform Federal Policy for Quality Assurance Project Plans
UFP-SAP	Uniform Federal Policy for Sampling Analysis Plans
USEPA	United States Environmental Protection Agency
UTL	upper tolerance limit
VDEQ	Virginia Department of Environmental Quality
VOA	volatile organic analyte
VOC	volatile organic compound
WPNSTA	Naval Weapons Station

SAP Worksheet #2—SAP Identifying Information

Site Name/Number: Site 1, Naval Weapons Station (WPNSTA) Yorktown, Yorktown, Virginia
Former Operable Unit(s): Operable Unit (OU) VIII – soil, OU I - groundwater
Contractor Name: CH2M HILL
Contract Number: N62470-11-D-8012, Contract Task Order (CTO)-WE35
Contract Title: Comprehensive Long-term Environmental Action—Navy (CLEAN) 8012

1. This Sampling and Analysis Plan (SAP) was prepared in accordance with the requirements of:

- Department of the Navy (Navy) Uniform Federal Policy-Sampling and Analysis Plan (UFP-SAP) Template (Navy, 2008)
- Guidance on Systematic Planning Using the Data Quality Objectives (DQOs) Process (USEPA, 2006)
- Uniform Federal Policy for Quality Assurance Project Plans (USEPA, 2005)
- Guidance for Quality Assurance Project Plans, United States Environmental Protection Agency (USEPA) QA/G-5, QAMS (USEPA, 2002)

2. Regulatory program:

- Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)

3. This SAP is project-specific.

4. Scoping Sessions:

Scoping Session	Date
Internal Scoping Session	August 1, 2012
Team Scoping Session	August 15, 2012

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

CH2M HILL, 2008. *Phase II Remedial Investigation Work Plan for Groundwater at Sites 1, 3, and 6 and Long-term Monitoring at Site 7*. Naval Weapons Station Yorktown, Yorktown, Virginia. December.

6. List organizational partners (stakeholders) and connection with lead organization:

- **Lead Organization:** Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic Division
- **Land Owner:** Department of Defense (DoD)
- **Lead Regulatory Agency:** USEPA Region 3
- **State Regulatory Agency:** Virginia Department of Environmental Quality (VDEQ)

7. If any required SAP elements or required information are not applicable to the project or are provided elsewhere, then note the omitted SAP elements and provide an explanation for their exclusion below:

- All SAP elements required for this project are described herein on the 37UFP-SAP Worksheets. Therefore, the crosswalk table is not necessary for this project.

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SAP Worksheet #3—Distribution List

Name of SAP Recipients	Title/Role	Organization	Telephone Number	E-mail Address or Mailing Address	Document Control Number
Jim Gravette	Remedial Project Manager (RPM)	NAVFAC Mid-Atlantic	(757) 341-0477	james.gravette@navy.mil	An Administrative Record number will be assigned when the final document is being prepared.
Donna Caldwell	Navy Technical Support	NAVFAC Atlantic	(757) 322-4816	Donna.caldwell@navy.mil	
Janice Nielsen	Quality Assurance Officer	NAVFAC Atlantic	(757) 322-8339	Janice.nielsen@navy.mil	
Moshood Oduwole	RPM	USEPA Region 3	(215) 814-3362	Oduwole.Moshood@epamail.epa.gov	
Wade Smith	RPM	VDEQ	(804) 698-4125	wade.smith@deq.virginia.gov	
John McCloskey	Biological Technical Assistance Group (BTAG)	USEPA	(804) 693-6694 x108	john_mccloskey@fws.gov	
Bonnie Capito	Librarian	NAVFAC Atlantic	(757) 322-4785	bonnie.capito@navy.mil	
Bill Friedmann	Activity Manager (AM)	CH2M HILL	(757) 671-6223	william.friedmann@ch2m.com	
Linda Saksvig	Project Manager (PM)	CH2M HILL	(804) 477-6112	Linda.Saksvig@ch2m.com	
Herb Kelly	Contractor Data Validator	CH2M HILL	(352) 384-7100	Herb.kelly@ch2m.com	
Marcia Colon	Laboratory PM	ENCO Laboratories	(407) 826-5314	mcolon@encolabs.com	
Deb Patton	Third-tier Laboratory PM	ALS-Rochester	(585) 672-7473	dpatton@caslab.com	
Tommy Jordan	Third-tier Laboratory PM	Kemron	(404) 516-3172	tjordan@kemron.com	
Anita Biernacki	Microbial Laboratory PM	Microbial Insights	865) 573-8188	abiernacki@microbe.com	

SAP Worksheet #3—Distribution List (continued)

The following people may receive copies of the SAP, subsequent SAP revisions, addenda, and amendments provided by people/organizations listed above.

Name of SAP Recipients	Title/Role	Organization	Telephone Number	E-mail Address or Mailing Address	Document Control Number
Roni Warren	Navy CLEAN Human Health Risk Assessor	CH2M HILL	(814) 364-2454	roni.warren@ch2m.com	An Administrative Record number will be assigned when the final document is being prepared.
William Kappleman	Navy CLEAN Ecological Risk Assessor	CH2M HILL	(703) 376-5152	william.kappleman@ch2m.com	
Clairette Campbell	Project Chemist (PC)	CH2M HILL	(757) 671-6335	clairette.campbell@ch2m.com	
Laura Cook	Senior Technical Consultant (STC)	CH2M HILL	(757) 671-6214	laura.cook@ch2m.com	
Doug Bitterman	Activity Quality Manager (AQM)	CH2M HILL	(757) 671-6209	doug.bitterman@ch2m.com	
Brian Wachter	Field Team Leader (FTL)	CH2M HILL	(757) 671-6289	Brian.Wachter@ch2m.com	
To be determined (TBD)	Field Team Members	CH2M HILL	TBD	TBD	

SAP Worksheet #4—Project Personnel Sign-Off Sheet

The following is a list of people who are responsible for ensuring overall implementation of the SAP:

Name	Organization/ Title/Role	Telephone Number	Signature/E-mail Receipt	SAP Section Reviewed	Date SAP Read
Jim Gravette	NAVFAC Mid-Atlantic RPM	(757) 341-0477			
Moshood Oduwole	USEPA RPM	(215) 814-3362			
Wade Smith	VDEQ RPM	(804) 698-4125			
Paul Favara	CH2M HILL SAP Quality Reviewer	(352) 384-7067			
Bill Friedmann	CH2M HILL AM	(757) 671-6223			
Anita Dodson	CH2M HILL Navy CLEAN Program Chemist	(757) 671-6218			
Laura Cook	CH2M HILL STC	(757) 671-6214			
Doug Bitterman	CH2M HILL AQM	(757) 671-6209			
Linda Saksvig	CH2M HILL PM	(804) 477-6112			

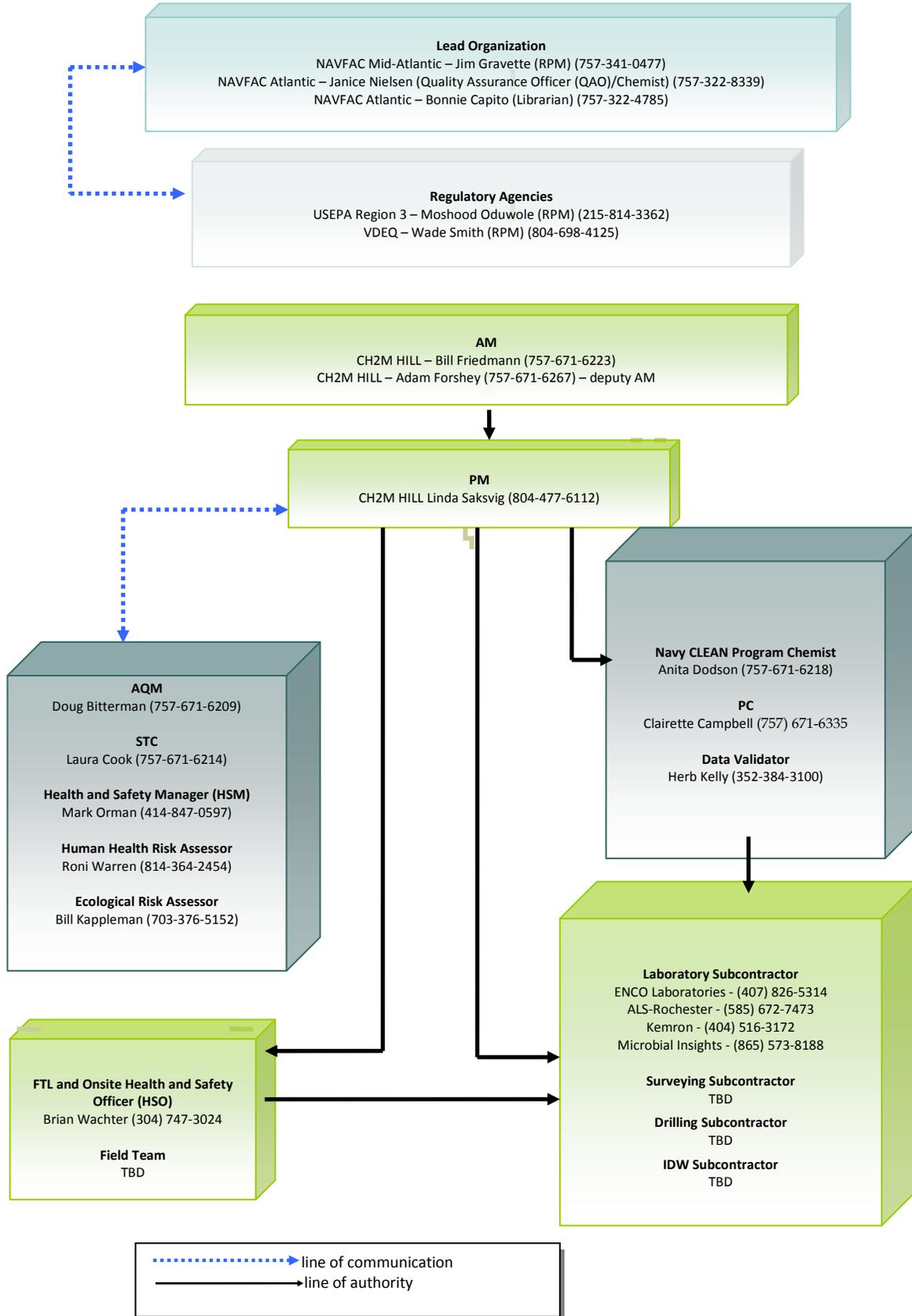
SAP Worksheet #4—Project Personnel Sign-Off Sheet (continued)

The following is a list of people who may provide input and therefore review portions or all of the SAP:

Name	Organization/Title/ Role	Telephone Number	Signature/ E-mail Receipt	SAP Section Reviewed	Date SAP Read
Donna Caldwell	NAVFAC Atlantic Technical Support	(757) 322-4816			
Janice Nielsen	NAVFAC Atlantic Quality Assurance Officer	(757) 322-8339			
Bonnie Capito	NAVFAC Atlantic Librarian	(757) 322-4785			
Clairette Campbell	CH2M HILL PC	(757) 671-6335			
Roni Warren	CH2M HILL Human Health Risk Assessor	(814) 364-2454			
William Kappleman	CH2M HILL Ecological Risk Assessor	(703) 376-5152			
Brian Wachter	CH2M HILL FTL	(757) 671-6289			
TBD	CH2M HILL Field Team Members	TBD			
Herb Kelly	CH2M HILL Data Validator	(352) 384-3100			
Marcia Colon	ENCO Laboratory PM	(407) 826-5314			
Deb Patton	ALS-Rochester Laboratory PM	(585) 672-7473			
Tommy Jordan	Kemron Laboratory PM	(404) 516-3172			
Anita Biernacki	Microbial Insights Laboratory PM	(865) 573-8188			

Once this worksheet has been completed and signed it will be maintained in the project files by the PM.

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
Point of contact (POC) with USEPA Region 3 and VDEQ PMs	RPM, NAVFAC Mid-Atlantic	Jim Gravette	(757) 341-0477	All materials and information pertaining to the project will be forwarded to Moshood Oduwole and Wade Smith within 2 business days by the RPM following review.
Oversight on all projects at WPNSTA Yorktown; AM	CH2M HILL AM	Bill Friedmann	(757) 671-6223	Issues are to be reported to the RPM immediately and followed up in writing within 2 business days.
Implement SAP and manage all phases of this project	CH2M HILL PM	Linda Saksvig	(804) 477-6112	Communicate directly (verbal and/or in writing) with the AM and NAVFAC as necessary.
SAP changes in the field	CH2M HILL FTL	Brian Wachter	(757) 671-6289	Communicate directly (verbal and/or in writing) with CH2M HILL AM or PM with daily meetings. Documentation of deviations from the UFP-SAP made in field logbooks; deviations made only with approval of PM, who will communicate with the AM, Navy, and regulators. The FTL will ensure SAP requirements are met by field staff.
Significant Laboratory Issues	CH2M HILL PM	Linda Saksvig	(804) 477-6112	The PM will notify the Navy RPM in writing of any significant laboratory issues. The Navy RPM will then report these issues to NAVFAC LANT for evaluation of the potential impact to other projects.
Data tracking from collection through upload to database	CH2M HILL PC	Clairette Campbell	(757) 671-6335	The PC tracks the data and informs the PM and program chemist of potential problems or issues. The PM and AM are informed within 24 hours to pass on communications to Navy and regulators as appropriate.
Reporting Data Validation Issues	CH2M HILL Data Validator	Herb Kelly	(352) 384-3100	All completeness and data issues will be addressed with the laboratory. The Data Validator should copy the CH2M HILL PC on all communications to the laboratory. The validated data package will be due within 14 calendar days of data receipt by the validator.
Reporting Analytical Laboratory Data Quality Issues	Laboratory PM	Marcia Colon Deb Patton Tommy Jordan Anita Biernacki	(407) 826-5314 (585) 672-7473 (404) 516-3172 (865) 573-8188	All quality assurance (QA)/quality control (QC) issues with project field samples will be reported by the subcontracted laboratory, who will relay them to the PC and Contractor Quality Assurance Officer (QAO) within 2 days of discovery.
Field and Analytical Corrective Actions (CAs)	CH2M HILL Program Chemist PC FTL	Anita Dodson Clairette Campbell Brian Wachter	(757) 671-6218 (757) 671-6335 (757) 671-6289	The need for CA for field and analytical issues will be determined by the FTL, PC, senior support staff, and/or Contractor QAO as necessary. The senior support will ensure Quality Assurance Project Plan (QAPP) requirements are met by field staff. The PC will ensure QAPP requirements are met by the laboratory. The FTL will notify the PM of any needed field CAs. The PM will have 24 hours to respond to the request for field CA. CA with laboratories will be coordinated by PC. The PC will notify the Program Chemist, who will in turn notify the Navy Chemist of any lab issues that render DQOs unattainable or cause delivery issues such that project schedule cannot be met.

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SAP Worksheet #7—Personnel Responsibilities and Qualifications Table

Name	Organization/Title	Responsibilities	Qualifications	
			Education	Years of Applicable Experience
Jim Gravette	NAVFAC Mid-Atlantic RPM	Coordinates all environmental activities at WPNSTA Yorktown.	1992 BS Geological Sciences 1997 Geology MS	16
Donna Caldwell	NAVFAC Atlantic	Provides technical support to the Navy RPM.	1978 BS Geology 1981 Graduate Studies Geology	
Moshood Oduwole	USEPA Region 3 RPM	Manages all aspects of project to confirm Federal regulations and requirements are met.	2002 BS Geology 2009 Masters Program, Environmental Geology	5
Wade Smith	VDEQ RPM	Manages all aspects of project to confirm State regulations and requirements are met.	1995 BS Earth Science 1998 MS Environmental Engineering	12
Bonnie Capito	NAVFAC Mid-Atlantic Librarian	Responsible for document tracking and filing.	MSLS Library and Information Science	30
Bill Friedmann, P.G.	CH2M HILL AM	Responsible for support to Navy to implement CERCLA Environmental Restoration Program (ERP) at WPNSTA Yorktown	1989 BS Geology	21
Linda Saksvig, P.E.	CH2M HILL PM	Day-to-day project management to implement SAP. Directs and oversees staff; health, safety, and environment (HS&E). Contractor POC for decision-making. Conducts data usability assessment.	1983 BS Mining Engineering	21
Douglas Bitterman, P.G.	CH2M HILL AQM	Provides activity-level quality review and guidance	1985 BS Geology 1989 MS Civil Engineering	22
Laura Cook, P.G.	CH2M HILL STC	Provides senior technical oversight.	1998 BS Geological and Environmental Sciences	13
William Kappleman	CH2M HILL Senior Ecological Risk Assessor	Conducts Ecological Risk Assessment (ERA) to determine any impacts to ecological receptors	1983 BS Wildlife Biology 1991 MS Wildlife Biology	23
Roni Warren, P.E.	CH2M HILL Human Health Risk Assessor	Responsible for performing the Human Health Risk Assessment (HHRA)	1988 BS Computer Science 1990 MS Environmental Engineering	20

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

Name	Organization/Title	Responsibilities	Qualifications	
			Education	Years of Applicable Experience
Anita Dodson	CH2M HILL Program Chemist	Provides program level review of the UFP-SAP	1994 BS Chemistry	17
Clairette Campbell	CH2M HILL PC	Performs oversight of laboratory and data validators, and evaluates usability of data. Also manages sample tracking.	2008 BS Chemistry	3
Brian Wachter	CH2M HILL FTL	Supervises field sampling and coordinates all field activities	2006 BS Geology 2008 MS Geology	6
Herb Kelly	CH2M HILL Data Validator	Responsible for the analytical data review and validation	1982 BS Chemistry	26
Mark Orman, CSP, CHMM, ARM	CH2M HILL Health and Safety Officer (HSO)	Oversees health and safety (H&S) for CLEAN Program	1992 BS Environmental Science	16
Marcia Colon	ENCO Laboratory PM	Provides analytical laboratory services for ENCO laboratories	1993 BS Geology	14
Deb Patton	ALS-Rochester Laboratory PM	Provides analytical laboratory services for ALS-Rochester	1995 BS Environmental Forest Biology	17
Tommy Jordan	Kemron Laboratory PM	Provides geotechnical laboratory services for Kemron	TBD	TBD
Anita Biernacki	Microbial Insights	Provides microbial laboratory services for Microbial Insights	TBD	TBD
TBD	Drilling Subcontractor	TBD	TBD	TBD

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
All site activities	Recognize, Retreat, and Respond ("3R") Training for explosives	Munitions Response Personnel	Personnel files	FTL, field team members, and Site Safety Coordinator (SSC)	FTL, SSC, and field team members from CH2M HILL	CH2M HILL, NAVFAC, regulatory agency, or subcontractor Human Resources Department

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SAP Worksheet #9-1—Project Scoping Session Participants Sheet Summary

Project Name: Yorktown Site 1 Pre-Feasibility Study (FS) SAP Projected Date(s) of Sampling: Winter 2012/Spring 2013 PM: Linda Saksvig				Site Name: Site 1 Site Location: WPNSTA Yorktown, Virginia	
Date of Sessions: August 1, 2012 Scoping Session Purpose: Internal meeting to discuss the sampling approach for the Site 1 Pre-FS SAP					
Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Bill Friedmann	AM	CH2M HILL	(757) 671-6223	William.Friedmann@ch2m.com	Overseeing project delivery, technical support
Rebekah Klyukin	Task Manager	CH2M HILL	(757) 671-8311	Rebekah.Klyukin@ch2m.com	Lead author of UFP-SAP
Jim Gravette	RPM	NAVFAC Mid-Atlantic	(757) 341-0477	James.gravette@navy.mil	Representative of lead agency responsible for overseeing execution of projects
Donna Caldwell	Technical Support	NAVFAC	(757) 322-4816	Donna.caldwell@navy.mil	Navy technical support

Background

During review of the Phase II Groundwater Remedial Investigation (RI) report, which was finalized in June 2012, a number of data gaps were identified which would not likely impact the risk assessment conclusions or the conclusions of the RI, but which were believed to potentially affect the identification and evaluation of remedial alternatives in the upcoming FS. As a result, the RI report was finalized and the WPNSTA Yorktown Partnering Team agreed to conduct additional investigation in preparation for drafting the FS. This scoping session was intended to support the planning for the pre-FS investigation.

Comments/Decisions:

The team discussed the data gaps identified as potentially impacting the development of the FS, but not likely to change the risk assessment or RI conclusions. These data gaps include:

- Any future FS will address remediation of groundwater contamination beyond the point of compliance of the landfill, which is considered the extent of waste. However, the existing data collected during the previous RI field events does not provide adequate resolution to plan for a remedy along the point of compliance. As a result, further evaluation of the extent of landfill waste (lateral) and the soil cover (lateral extent of the cover and cover thickness) is needed to better assess leaching potential and the boundary along which the groundwater remedy must be implemented.
- The groundwater flow direction beneath the landfill was identified in the RI as moving to the east and south in the Columbia aquifer toward Indian Field Creek and its unnamed tributary. Additionally, existing data indicate deeper groundwater flows predominantly to the east toward Indian Field Creek. However monitoring well pairs are needed at the site to allow for accurate calculations of the vertical groundwater gradient to help with the components of discharge to each surface water body.
- The vertical and horizontal extent of contamination along the estimated boundary of the landfill have been delineated by membrane interface probe (MIP) data. However, there are no monitoring wells present in some key locations adjacent to the tributary to Indian Field Creek to allow for quantification of the qualitative MIP data. Laboratory analytical concentrations in these areas are needed to adequately generate viable remedial alternatives.

SAP Worksheet #9-1—Project Scoping Session Participants Sheet Summary (continued)

- Groundwater was last sampled at Site 1 in March 2009. Most site-related contaminants may naturally attenuate over time; therefore, additional groundwater data would be valuable to determine current concentrations at the site and to further evaluate the potential for natural attenuation at the site.
- Seeps are believed to be present at the site, but have not been sampled. Seeps data may assist with determining any contribution of groundwater contamination to surface water and allow for this pathway to be addressed in the FS.

Sediment, surface water and pore water samples have been collected during multiple phases of the RI at the site and have not indicated significant contamination migrating to the adjacent surface water bodies. However, there were locations at which no surface water was present during the Phase II groundwater RI, and the lack of obvious base flow casts some doubt on whether the moisture in the water bodies was due to previous overland storm water flow or groundwater discharge. In order to ensure no significant impacts from groundwater discharge are occurring and nothing further needs to be completed to address this pathway in the FS, the Partnering team recommended one additional round of data collection for these media.

The scoping session further discussed the sampling approach for the Site 1 Pre-FS SAP. The following investigation activities were discussed and agreed upon:

- Test Pitting will be conducted to verify the lateral extent of the landfill, the thickness of the soil cover, and the lateral extent of the soil cover. Eighteen initial test pit locations within Site 1 were selected based on the presence of waste discovered during historical investigation activities. Additional test pitting will be conducted based on the results of the initial locations to delineate the extent of the landfill and cover over the landfill. Test pits will be excavated to 8 feet below ground surface (bgs) (11 feet in the vicinity of 1GW18), unless waste is identified at shallower depths. Prior to test pitting, a field survey will be conducted to identify any visual indications of historic landfilling operations and activity (e.g., hummocky terrain). If additional ground surface evidence of possible waste is identified then these areas will also be investigated or test pits may be biased towards these areas. Soil samples will not be collected during this investigation.
- Five additional monitoring wells will be installed at Site 1. Three deep monitoring wells extending into the Eastover-Calvert Confining Unit will be installed and screened just above the confining unit. Two of the three deep wells will be paired with a new shallow well. The third deep well will be paired with an existing shallow well. These wells will be used to assist with comparing MIP results to actual analytical data and determining vertical gradient.
- Groundwater samples will be collected from all of the existing and newly-installed wells at Site 1. All of the wells will be sampled for the parameters that were agreed upon with the Partnering Team during the finalization of the Sites 1 and 3 RI. The partnering team agreed during the Phase II RI comment resolution process that full suite Target Compound List (TCL) volatile organic compounds (VOCs) and Target Analyte List (TAL) metals would be analyzed for in the newly installed monitoring wells proposed in the conclusions of the RI. Although it is anticipated that there will not be a concern with metals, the regulators have requested an additional round of metals sampling to support a more robust CSM. However, only one additional round of sampling will be collected for metals. In addition, monitoring well 3GW29 located across Indian Field Creek will be sampled, but will only be analyzed for VOCs. These data will be used to determine natural attenuation rates at the site.
- A groundwater elevation survey will be conducted at all new and existing wells to allow for confirmation of the groundwater flow direction and determination of vertical gradients.

SAP Worksheet #9-1—Project Scoping Session Participants Sheet Summary (continued)

- Five co-located surface water, sediment, and sediment pore water samples will be collected from new locations determined in the field based on field observations and assistance from BTAG. Surface water, sediment, and sediment-pore water samples collected during the previous RI investigation will be repeated and collected from the same locations. All of the surface water, sediment, and sediment-pore water samples will be analyzed for VOCs, metals, and geochemical parameters as appropriate.
- If observed in the field, seep samples will be collected at locations identified with assistance from BTAG. A request will be sent to BTAG to conduct a site visit with the field team to identify seeps, and if seeps are identified, samples will be collected during that time and analyzed for VOCs. For the purpose of the SAP, it is estimated that 3 seeps will be found and 3 samples will be collected.

Action Items: In addition, any supporting documentation that identifies where the landfill cover soil came from, and supports that the material was tested and documented to be “clean,” will be included in the SAP. If supporting documentation cannot be found, the team will discuss potentially collecting a few soil samples during this investigation.

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SAP Worksheet #9-2—Project Scoping Session Participants Sheet Summary

Project Name: Yorktown Site 1 Pre-FS SAP Projected Date(s) of Sampling: Winter 2012/Spring 2013 PM: Linda Saksvig				Site Name: Site 1 Site Location: WPNSTA Yorktown, Virginia	
Date of Sessions: August 15, 2012 Scoping Session Purpose: Partnering Team meeting to review and discuss the sampling approach for the Site 1 Pre-FS SAP					
Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Bill Friedmann	AM	CH2M HILL	(757) 671-6223	William.Friedmann@ch2m.com	Overseeing project delivery, technical support
Adam Forshey	Deputy AM	CH2M HILL	(757) 671-6267	adam.forshey@ch2m.com	Assists AM in overseeing project delivery and technical support
Jim Gravette	RPM	NAVFAC Mid-Atlantic	(757) 341-0477	James.gravette@navy.mil	Representative of lead agency responsible for overseeing execution of projects
Donna Caldwell	Technical Support	NAVFAC	(757) 322-4816	Donna.caldwell@navy.mil	Navy technical support
Wade Smith	RPM	VDEQ	(804) 698-4125	wade.smith@deq.virginia.gov	Lead representative of VDEQ, responsible for review of documents and ensure that appropriate regulations are applied
Moshood Oduwole	RPM	USEPA	(215) 814-3362	Oduwole.Moshood@epamail.epa.gov	Lead representative of USEPA, responsible for review of documents and ensure that appropriate regulations are applied
Nancy Rouse	Facilitator	Management Edge	(760) 470-0751	nvrouse@gmail.com	Provides facilitation support to the Navy, USEPA, VDEQ, and Navy Contractor during Tier I Partnering Meetings
Bruce Beach	Tier II	USEPA	(215) 814-3364	Beach.bruce@epa.gov	One of several Tier II links that participate during Tier I Partnering meetings. Shares information on Tier I requirements and policy work being discussed within Tier II.
Herminio Concepcion	Technical Support	USEPA	(215) 814-3115	Concepcion.herminio@epa.gov	Provides technical support to the USEPA RPM on matters related to groundwater.
Peter Knight	Technical Support	BTAG	(215) 814-3321	Peter.knight@noaa.gov	USEPA ecological technical support
Kyle Newman	Ecological Technical Support Group (ETSG)	VDEQ	(804) 698-4452	kyle.newman@deq.virginia.gov	Ecological support from VDEQ
Bill Kappleman	ETSG	CH2M HILL	(703) 376-5652	william.kappleman@ch2m.com	Ecological support from CH2M HILL
Bruce Pluta	BTAG	USEPA	(215) 814-2380	Pluta.bruce@epa.gov	Provides technical support to the USEPA RPM on matters related to ecological risks.
Dawn Iovan	USEPA Toxicologist	USEPA	(215) 814-3320	loven.dawn@epa.gov	Provides technical support to the USEPA RPM on matters related to human health and toxicology.

SAP Worksheet #9-2—Project Scoping Session Participants Sheet Summary (continued)

Comments/Decisions

A scoping session was held on August 15, 2012, during the WPNSTA Yorktown Partnering Team meeting to review and discuss the sampling approach for the Site 1 Pre-FS SAP. To review, a summary of the site history and previous contamination identified was provided.

The discussion started with an overview of the data gaps identified during the Phase II RI for Site 1 that were discussed during the first scoping session.

The Navy summarized the activities that are planned as part of the Site 1 Pre-FS investigation and specified the proposed locations. The following monitoring well pairs are proposed:

- A pair in the location of MIP 17, one screened at the top of the Yorktown-Eastover aquifer and the other at the bottom of the same unit
- A pair located downgradient of 1GW22 by the ephemeral feeder stream to the unnamed tributary to Indian Field Creek (shallow well screened at the top of the Yorktown-Eastover and deep well screened at the bottom of the same unit)
- One deep well adjacent to 1GW24 to evaluate the vertical gradient adjacent to Indian Field Creek

The sample locations for surface water, sediment, and sediment pore water were presented to the team.

The team discussed parameters to be sampled in for various media. While metals were not previously identified as constituents of concern (COCs) in any media at this site, concentration of metals in groundwater are greater than background. The team discussed the potential for metals to impact surface water under different discharge conditions than those evaluated during the Phase II RI. Therefore, in order to address regulatory concerns related to contaminants not previously identified as COCs, surface water, sediment, and the newly installed monitoring well samples will be analyzed for all constituents previously determined to be site-related. The USEPA stated that, for the most part, the investigation activities proposed addressed their concerns; however, BTAG was concerned that only VOCs were being analyzed in pore water, when VOCs and metals are being analyzed in sediment and surface water. VDEQ pointed out that sampling the pore water for metals may save the team from going back out for additional samples later, and BTAG reiterated that metals should be considered as an analyte for pore water samples. However, the Navy elected to keep the seeps analysis as VOCs only as the groundwater plume at Site 1 is a VOC plume. Therefore, the primary COCs to sediment pore water are VOCs. Additionally, it was noted that coordination with BTAG was requested for the purposes of identifying potential seeps.

Action Items

The Navy reviewed the proposed schedule for activities at Site 1, and will work to get the draft SAP to the Team around October.

Additional Post Scoping Session Discussion

Because 1,4-dioxane is an emerging contaminant, the team evaluated the potential for it to be present at Site 1. 1,4-dioxane is a solvent stabilizer which was previously used to stabilize 1,1,1-trichloroethane (TCA). Low concentrations of 1,1,1-TCA and its daughter products were detected during historical sampling rounds at levels not posing risk. Therefore, it is not believed that significant levels of 1,4-dioxane will be present at the site. However, the team agreed to analyze for this constituent to ensure it is not present.

SAP Worksheet #10—Conceptual Site Model

WPNSTA Yorktown History and Location

WPNSTA Yorktown is a 10,624-acre installation located on the Virginia Peninsula in York and James City Counties Virginia (**Figure 1**). WPNSTA Yorktown is bounded to the northwest by Cheatham Annex, to the northeast by the York River and the Colonial National Historic Parkway, to the southwest by Route 143 and Interstate 64, and to the southeast by Route 238 and the town of Lackey.

Originally named the United States Mine Depot, WPNSTA Yorktown was established in 1918 to support the laying of mines in the North Sea during World War I. For 20 years after World War I, the depot continued to receive, reclaim, store, and issue mines, depth charges, and related materials. During World War II, the facility was expanded to include three trinitrotoluene (TNT) loading plants and new torpedo overhaul facilities. A research and development laboratory for experimentation with high explosives was established in 1944. In 1947, a quality evaluation laboratory was developed to monitor special tasks assigned to the facility which included the design and development of depth charges and advanced underwater weapons. On August 7, 1959, the depot was renamed the United States WPNSTA. Today, the primary mission of WPNSTA Yorktown is to provide ordnance, technical support, and related services to sustain the war-fighting capability of the armed forces in support of national military strategy.

Site 1 History and Location

Site 1, the Dudley Road Landfill, is a 10-acre landfill located in the northern portion of WPNSTA Yorktown, west of Indian Field Creek and north of an unnamed tributary to the creek (**Figure 2**). Site 1 is grassy and generally flat. The topography gently slopes downward to the east, with more pronounced slopes east and south toward Indian Field Creek and its unnamed tributary. The area surrounding the soil-covered landfill is wooded and acts as a riparian buffer for the adjacent Indian Field Creek.

According to the *Round One Remedial Investigation Report: Site 1-9, 11, 12, 16-19, and 21* (Baker & Weston, 1993), the landfill at Site 1 was operated under a VDEQ Conditional Permit (No. 287) and used from approximately 1965 to 1979 for solid waste disposal; however, one area continued to be used for the disposal of plastic lens grinding waste until 1983. Historical documentation indicates that the landfill did not receive additional wastes from 1983 through 1985, when the landfill was officially closed. There is an abandoned sand reclamation pit on the eastern edge of the site, and a pond exists in the western portion of the site. Wastes disposed of at the site are reported to have included asbestos from steam pipe insulation; empty oil, grease, paint, and solvent containers (possibly including trichloroethene (TCE), TCA, methylene chloride, acetone, and cyclohexanol); explosives-contaminated carbon; household appliances; scrap metal banding; construction rubble; plastic lens grinding wastes; tree limbs; lumber; packaging wastes; electrical wires; and waste oil. Waste quantities were estimated at 17 tons per year (tpy) for approximately 15 years, for an approximate total waste disposal of 255 tons over the landfill operation period (C.C. Johnson, 1984). The landfill was covered by a 2-foot soil cover and the sand reclamation pit was covered with 8 feet of soil.

Additional document review indicated that the landfill area was reportedly excavated as borrow pits to approximately 20 feet deep prior to waste disposal. Waste material was then brought to the site and dumped into the borrow pit area and covered with 4 to 6 inches of soil. In 1977, two excavations were discovered where oil was being discarded. When the landfill was initially closed, it was covered with 2 feet of earth, graded, and reseeded. The cover material for the initial landfill cover was obtained from the immediate area, across the entry road from the main landfill, where a pond now exists. The sand borrow pit at Site 1 was reportedly filled with leftover soil excavated during a railroad track widening project being conducted on base (Baker, 1991).

SAP Worksheet #10—Conceptual Site Model (continued)

The *Round Two Remedial Investigation Report* (Baker, 1997a) provided additional information related to waste disposal practices at the site and identified Site 1 as a landfill consisting of two sand borrow pits that were later used for waste disposal. The first pit is located within the eastern portion of the site and is currently vegetated with loblolly pine. The second borrow pit is located within the southwest portion of the site, and it accumulates surface water runoff, varying seasonally, from a few inches to 2 feet deep. Wastes were reportedly disposed in both borrow pits. Despite the review of available historical documentation and the evaluation of aerial photographic data, significant uncertainty remains as to the history and limits of landfilling and the extent of the soil cover on the landfill at Site 1.

In 1999, surface metal debris was removed from the site and recycled and 413 tons of arsenic-contaminated waste/soil was disposed off site. The old landfill area was regraded, covered with 18 inches of backfill and 6 inches of topsoil, and seeded (OHM, 2001). **Figure 2** depicts the approximate locations of the arsenic removal and the area that was covered with additional soil.

The most recent investigation (Phase II RI) identified tetrachloroethene (PCE), TCE, cis-1,2-dichloroethene (DCE), and vinyl chloride as COCs for groundwater (combined Columbia and Yorktown Eastover aquifers) at Site 1 (CH2M HILL, 2012).

Previous Investigations

Investigations and evaluations were conducted from 1984 through 2012 to assess potential releases associated with landfilling activities at Site 1. **Table 1** presents a timeline and summary of the previous investigations and actions. **Figure 3** present the locations of historical samples from the various investigations at Site 1.

SAP Worksheet #10—Conceptual Site Model (continued)

TABLE 1
 Previous Investigations/Actions

Previous Investigations/Actions	Date	Description	Results/Recommendations
Initial Assessment Study (NEESA, 1984)	1984	The Initial Assessment Study (IAS) was conducted to identify potentially hazardous sites at WPNSTA Yorktown. A review of historical data, field inspections, and personnel interviews identified Site 1 as warranting further investigation to assess potential long-term impacts.	Concluded that potential migration pathways were present and Site 1 required further investigation.
Confirmation Study Step IA, Round One (Dames & Moore, 1986)	1986	A confirmation study was initiated to assess the presence of suspected contamination at Site 1. Monitoring wells were installed, and groundwater, surface water, and sediment was sampled and analyzed.	A second round of sampling was recommended.
Confirmation Study Step IA, Round Two (Dames & Moore, 1988)	1988	A second round of groundwater, surface water, and sediment samples were collected and analyzed for VOCs, pesticides/polychlorinated biphenyls (PCBs), inorganic constituents, and explosives.	No constituents were detected above Maximum Contaminant Levels (MCLs), ambient water quality criteria (AWQC) or Virginia Groundwater Standards in groundwater. Inorganics were detected in both sediment and surface water, with some exceeding Virginia Water Quality Standards, and it was noted that downgradient concentrations in surface water were generally higher than upgradient concentrations. No further investigation was recommended.
Final Remedial Investigation Interim Report (Versar, 1991)	1989-1991	Reviewed and evaluated existing data for Site 1.	Recommended a risk assessment, hydrogeologic investigation, site survey, and additional sampling of groundwater, surface water and sediment.
Final Round One Remedial Investigation Report for Sites 1-9, 11, 12, 16-19, and 21 (Baker and Weston, 1993)	1992-1993	Additional groundwater monitoring wells were installed at Site 1, and groundwater, surface soil, subsurface soil, surface water, and sediment samples were collected and analyzed. A groundwater elevation survey and soil cover survey was conducted.	Results indicated concentrations of chlorinated VOCs, in particular PCE, TCE, and 1,2-DCE in groundwater at Site 1. Methylphenol, pentachlorophenol, and phenol were detected in sediment, and several inorganics were detected in sediment and surface water. Recommended further investigation to identify and delineate potential source areas, and define the boundaries of waste disposal.

SAP Worksheet #10—Conceptual Site Model (continued)

TABLE 1
 Previous Investigations/Actions

Previous Investigations/Actions	Date	Description	Results/Recommendations
Final Round Two Remedial Investigation Report for Sites 1 and 3 (Baker, 1997a)	1996	Additional groundwater monitoring wells were installed and test pits were excavated to delineate the extent of waste disposal. Surface soil, subsurface soil, sediment, surface water, and groundwater samples were collected and analyzed.	Polycyclic aromatic hydrocarbons (PAHs) and pesticides were detected in both surface and subsurface soils at Site 1; however, these concentrations did not exceed base-wide background concentrations. Potential risks to human health were identified based on exposure to arsenic, beryllium, and iron in surface and subsurface soil. The highest metals concentrations were detected in the vicinity of monitoring well 1GW12A, including a maximum arsenic concentration of 126 milligrams per kilogram (mg/kg) in subsurface soil sample 1SB12A. Chlorinated VOCs TCE and cis-1,2-DCE, and several inorganics were detected in groundwater in both the Columbia and Yorktown-Eastover aquifers. Non-carcinogenic and carcinogenic risks for potential future adult and child residents were identified for groundwater. Potential risk to the aquatic environment was identified due to several inorganics in sediment and surface water. Recommended that land use controls (LUCs) be implemented to restrict groundwater as a source of potable water.
Final Focused Feasibility Study for Sites 1 and 3 (Baker, 1997b)	1997	Eighteen additional soil samples were collected as part of the “hot spot” investigation to delineate elevated levels of arsenic at Site 1. A final remediation goal (FRG) of 63 mg/kg of arsenic was established and remedial action alternatives (RAAs) were identified. RAAs were proposed in the FS.	The remedial action objective (RAO) identified was to mitigate the potential for direct contact of arsenic contaminated soils exceeding the FRG. Alternative 3 was identified as the preferred alternative, which included soil cover, surface debris removal, and excavation with offsite disposal.
Final v2 Proposed Remedial Action Plan for Sites 1 and 3 (Baker, 1998)	1998	Released to the public, identifying Alternative 3 as the proposed RAA at Site 1.	A Record of Decision (ROD) document will be prepared to document the chosen remedial action.
Final Record of Decision (Baker, 1999)	1999	Documented the selected RAA for Site 1.	The remedial action (RA) was conducted following the finalization of the ROD. The ROD was signed in June 1999, and the RA began in July 1999. The RA included removing and transporting metal debris to the Defense Recycling Material Office (DRMO), removing arsenic-contaminated waste and disposing of it off-site, placing additional soil cover over the landfill area, placing borrow soil in the excavated/backfilled area to provide graded slopes, and restoring the site with upland grasses. Eighteen inches of cover, followed by 6 inches of topsoil, were placed on the landfill for a total of 2 feet of soil cover.

SAP Worksheet #10—Conceptual Site Model (continued)

TABLE 1
 Previous Investigations/Actions

Previous Investigations/Actions	Date	Description	Results/Recommendations
Final Long-term Monitoring, Site 1, Site 3, and Site 7 (Baker and CH2M HILL, 2006)	2000, 2004, 2005	Long-term monitoring (LTM) began in 2000 to ensure the protectiveness of the RA, and included installation of additional wells and groundwater, surface water, and sediment sampling. Subsequent rounds of sampling were conducted in September/October 2004, February 2005, May 2005, and August 2005.	Following collection of initial LTM samples, it was determined that data gaps were present and LTM was ceased. It was recommended to continue investigating groundwater through an RI.
Phase I Remedial Investigation Report for Groundwater at Site 1, 3, 6, 7, 11, 17, 24, and 25 (CH2M HILL, 2007)	2004-2007	Additional groundwater monitoring wells were installed, and groundwater samples were collected. Chlorinated VOCs TCE and its daughter products were detected.	Chlorinated VOCs (TCE and its daughter products) were identified as primary contaminants at Site 1. It was concluded that contaminants in groundwater migrate vertically downward and toward Indian Field Creek; however, the extent of chlorinated VOC contamination was not fully delineated. The Phase I RI recommended additional investigation, including conducting a MIP investigation, groundwater/surface water interface samples, further investigation of the aquifers at Site 1, and quantifying potential risks.
Phase II Remedial Investigation Report for Groundwater at Sites 1 and 3 (CH2M HILL, 2012)	2009-2012	An MIP investigation was conducted to delineate the extent of chlorinated VOCs at Site 1, and direct-push technology (DPT) groundwater samples were collected to confirm the MIP results. Additional monitoring wells were installed and soil, groundwater, surface water, sediment, and sediment pore water samples were collected. The results were used to quantify and assess the potential human health and environmental risks associated with exposure to different media at Site 1.	Chlorinated VOCs and metals were identified as primary contaminants in groundwater. The landfill waste, possible dense non-aqueous phase liquid (DNAPL), and sorbed contaminant mass in fine-grained soil of the Yorktown-Eastover confining unit were identified as potential continuing sources of contamination. Unacceptable risks to future human receptors were identified due to potential exposure to contamination in groundwater due to PCE, TCE, 1,2-DCE, and vinyl chloride. While the data collected were determined to be adequate for the purpose of the risk assessment, further investigation was recommended to support the FS. Report conclusions indicated data gaps with regards to VOC concentrations in areas where the plume was delineated only with MIP and components of discharge to surface water bodies under potentially varying base flow conditions. Therefore, the report recommended a pre-FS investigation prior to evaluating remedial alternatives.

SAP Worksheet #10—Conceptual Site Model (continued)

Hydrogeological Setting

WPNSTA Yorktown

WPNSTA Yorktown is situated within the Virginia Coastal Plain Physiographic Province, which is characterized by unconsolidated sediments several thousand feet in thickness (Meng and Harsh, 1988). Deposition and erosion associated with fluctuating sea levels resulted in terraces that decrease in topographic elevation in a stair-step pattern as well as scarps, oriented north to south, delineating the eroded shoreline along the toe of each terrace. Two terraces (Lackey Plain and Croaker Flat) are divided by one scarp (the Camp Peary Scarp) within the boundaries of WPNSTA Yorktown.

As illustrated in **Figure 4**, the following five hydrogeologic units make up the York County Shallow Aquifer System at WPNSTA Yorktown (in descending order):

1. Columbia aquifer (consisting of the Windsor through Tabb Formations)
2. Cornwallis Cave confining unit (consisting of the Bacons Castle Formation)
3. Cornwallis Cave aquifer (consisting of the upper Moore House Member of the Yorktown Formation and the Sedley Formation)
4. Yorktown confining unit (consisting of the upper Morgarts Beach and lower Moore House Members of the Yorktown Formation)
5. Yorktown-Eastover aquifer (consisting of the Cobham Bay through Rushmere Members of the Yorktown Formation)

Site-specific

Site 1 is situated along Indian Field Creek and its unnamed tributary. The southwestern branch of Indian Field Creek lies north of the Camp Peary Scarp on Croaker Flat (**Figure 5**). Indian Field Creek is a tidally-influenced tributary to the York River, and the surface water flow direction reverses diurnally due to tidal fluctuations.

In the vicinity of Site 1 and within the Croaker Flat, the Camp Peary Scarp truncates the Cornwallis Cave confining unit and the Cornwallis Cave aquifer. Consequently, the first three hydrogeologic units encountered with increasing depth are the Columbia aquifer, Yorktown confining unit and Yorktown-Eastover aquifer.

The Columbia aquifer is only encountered within the topographically higher areas beneath Site 1, and is composed of mostly silts and fine- to coarse-grained sands. The Columbia aquifer is unconfined and its thickness is controlled by the presence of the underlying Yorktown confining unit. The Columbia aquifer has been eroded away and is not present in some parts of the southern, eastern, and northeastern portions of the site, along the steeper slopes of the unnamed tributary and Indian Field Creek (**Figure 6**). Where present, the thickness of the Columbia aquifer at Site 1 ranges from 10 to 18 feet.

Within the topographically higher areas, the clays of the Yorktown confining unit separate the Columbia aquifer from the Yorktown-Eastover aquifer. The Yorktown confining unit is generally approximately 20 feet thick and the top of the unit is encountered at a maximum depth of 20 feet bgs. The Yorktown confining unit has also been eroded away and is not present within the southern, eastern, and northeastern portions of the site. Consequently, in areas where the Columbia aquifer materials are still present and the confining unit materials were eroded away, the overlying Columbia aquifer is hydraulically connected to the underlying Yorktown aquifer.

The Yorktown-Eastover aquifer consists of silty, fine-to coarse-grained sands and shell hash. The aquifer is confined where it underlies the Yorktown confining unit, and is unconfined where it is the first encountered groundwater within the topographically lower areas in the southern, eastern, and northeastern portions of the site. The thickness of the aquifer beneath Site 1 is unknown, as no monitoring wells extend to the top of the

SAP Worksheet #10—Conceptual Site Model (continued)

underlying Eastover-Calvert confining unit. However, based on the *Geohydrology of the Shallow Aquifer System, Naval Weapons Station Yorktown* (Brockman et al., 1997), the aquifer is approximately 80 feet thick in the vicinity of Site 1. The underlying Eastover-Calvert confining unit is approximately 100 to 200 feet thick. Due to the thickness of this confining unit, it is unlikely that deeper aquifers have been impacted by historical releases at WPNSTA, which have consequently not been investigated.

Based on data collected in previous investigations, groundwater flow within the Columbia aquifer mimics the surface topography and flows in a radial direction from the western portion of the site (**Figure 7**). Yorktown-Eastover groundwater flows generally southeastward towards Indian Field Creek (**Figure 8**). However, uncertainty exists with regards to vertical groundwater flow in the vicinity of the unnamed tributary and Indian Field Creek (south eastern edge of site) and potentially varying flow conditions due to seasonal changes. These data gaps are a result of a lack of paired shallow and deep wells in the southern and southeastern perimeters of the site and the absence of surface water, sediment, sediment pore water, and seeps data under obvious groundwater influence ¹

¹ Surface water and sediment were collected during the Phase II Groundwater RI; however, lack of base flow during the time of that investigation casts doubt on whether the moisture in the surface water bodies was due to previous overland storm water flow or groundwater discharge.

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

Problem Definition, Environmental Questions, and Project Quality Objectives

The problem definitions, environmental questions, and project quality objectives (PQOs) are described in **Table 2**.

TABLE 2
 Problem Definition/Objective, Environmental Questions, and Project Quality Objectives

Problem Definition/Objective	Environmental Question	General Investigation Approach	PQO
Confirm the lateral extent of landfill waste and vertical and horizontal extent of the soil cover over the landfill since the landfilled waste is a potential continuing source of groundwater contamination and any groundwater remedy to be implemented will consider addressing contamination beyond the point of compliance (landfill boundary)	Is the landfill waste (potential continuing source of contamination) sufficiently covered?	Test pits will be excavated to confirm the lateral extent of the landfill and the vertical and horizontal extent of the soil cover. Prior to test pitting, a field survey will be conducted to identify any visual indications of historic landfilling operations and activity (e.g., hummocky terrain). If additional ground surface evidence of possible waste is identified then these areas will also be investigated or test pits biased toward these areas.	If the landfill waste is not sufficiently covered, then the FS will evaluate remedial alternatives that address the uncovered waste as a potential continuing source of contamination to groundwater and alternatives which reduce infiltration into waste will be considered. If the landfill waste is sufficiently covered, then the FS will not consider alternatives to address waste and will not consider alternatives which reduce infiltration into waste.
	What is the point of compliance at which a groundwater remedy is needed at the site?	Test pits will be excavated to confirm the lateral extent of the landfill and the vertical and horizontal extent of the soil cover.	The FS will evaluate remedial alternatives for groundwater that only address contamination beyond the point of compliance.
Determine the concentrations of VOCs and metals in groundwater at the newly installed wells.	Are concentrations of VOCs and metals in the newly installed monitoring wells comparable to Phase II RI data such that the conclusions drawn in the RI are still applicable?	One round of groundwater samples will be collected from newly installed monitoring wells and analyzed for full suite TCL VOCs and TAL metals. Although it is anticipated that there will not be a concern with metals, the regulators have requested an additional round of metals sampling to support a more robust CSM.	If data collected are comparable to previously collected data, the nature and extent have been confirmed and the new data will be used with the existing well data to develop potential remedial alternatives and the FS will be completed as planned. If data are not comparable to previously collected data and exceed risk-based screening values, then additional data may need to be collected to fill those data gaps prior to proceeding to the FS stage or a risk assessment will be performed.
Determine the potential for and rate of natural attenuation of site-related contaminants in groundwater at the site to support potential consideration as part of the remedial alternatives evaluated in the FS	Is natural attenuation occurring or does natural attenuation have the potential to occur such that natural attenuation or an enhancement of the natural processes should be considered viable, at least as part of a remedy?	Existing monitoring wells historically shown to have high concentrations of chlorinated VOCs and newly installed wells anticipated to have high concentrations will be analyzed for microbial count. Additionally, monitoring wells will be analyzed for geochemical parameters to determine if groundwater conditions are favorable for natural attenuation. One round of groundwater samples will be collected.	If natural attenuation is not occurring and does not have the potential to occur or be effectively stimulated, then the FS would evaluate remedial alternatives that do not consider natural attenuation. If natural attenuation is occurring, the FS will evaluate potential remedial alternatives that include natural attenuation, at least as part of the remedy. If natural attenuation is not occurring at a rate reasonable to allow for its use as a remedy, but has the potential to occur with some enhancements, then the FS will evaluate remedial alternatives that can enhance the natural attenuation potential of the site.

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

TABLE 2
 Problem Definition/Objective, Environmental Questions, and Project Quality Objectives

Problem Definition/Objective	Environmental Question	General Investigation Approach	PQO
<p>Refine the understanding of vertical and horizontal groundwater flow at the site to assist with determining the components of discharge to surface water bodies</p>	<p>Do the vertical and horizontal groundwater flow characteristics at the site indicate that contaminated groundwater is or could discharge to surface water bodies (unnamed tributary and Indian Field Creek)?</p>	<p>Install additional shallow-deep paired monitoring wells in the southern and southeastern perimeter of the site. Collect groundwater survey measurements at all wells to refine groundwater flow understanding.</p>	<p>If the vertical and horizontal groundwater gradient and direction are such that there is no discharge of contaminated groundwater to the unnamed tributary and/or Indian Field Creek, then this pathway will not be evaluated as part of the remedial alternatives in the FS.</p> <p>If the vertical and horizontal groundwater gradient and direction in the vicinity of the tributary indicate there is a component of contaminated groundwater discharge into the unnamed tributary and/or Indian Field Creek, the FS will consider alternatives that address this potential discharge. This is especially important because barrier alternatives such as permeable reactive barriers and biobarriers will be screened for potential applicability in the FS.</p>
<p>Better quantify the concentrations of elevated VOCs, previously determined via MIP, potentially present along the southern perimeter of the site in order to allow for contaminant mass concentration approximations in support of the FS</p>	<p>What are concentrations of VOCs qualitatively evaluated using MIP and what is the contaminant mass which must be addressed by FS alternatives?</p>	<p>Install two sets of new shallow-deep monitoring well pairs in the southern perimeter of the site in areas where MIP data had previously been collected. Collect one round of groundwater samples and analyze for TCL VOCs and compare to project action levels (PALs).</p>	<p>Quantitative data collected from the newly installed monitoring wells will be utilized to estimate contaminant mass in order to generate FS alternatives.</p>
<p>Determine if there are seeps that are impacted by contaminated groundwater in order to assist in determining if this groundwater to surface water pathway warrants consideration in the FS.</p>	<p>Are seeps present and if so, is contamination entering surface water/sediment via groundwater seeps?</p>	<p>Conduct a seep survey with BTAG and collect seep samples if present and analyze for TCL VOCs, 1,4-dioxane, and metals.</p>	<p>If no seeps exist or if contamination is below screening values, then FS alternatives will not consider the contaminant transport pathway through seeps.</p> <p>If seeps are present and groundwater contamination is discharging to seeps at levels above screening values, then the FS alternatives will consider the discharge of contaminants through the seeps.</p>

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

TABLE 2
 Problem Definition/Objective, Environmental Questions, and Project Quality Objectives

Problem Definition/Objective	Environmental Question	General Investigation Approach	PQO
<p>Determine the presence/absence of the emerging contaminant 1,4-dioxane in groundwater, surface water, seep, sediment, and sediment pore water at the site since it has not been previously evaluated but is potentially present. 1,4-dioxane is a solvent stabilizer which was previously used to stabilize 1,1,1-TCA. Low concentrations of 1,1,1-TCA and its daughter products were detected during historical sampling.</p>	<p>Does 1,4-dioxane exist at levels exceeding screening criteria?</p>	<p>Collect one round of groundwater (at all existing and newly installed monitoring wells), surface water, seep, sediment, and sediment pore water samples and analyze for 1,4-dioxane.</p>	<p>If 1,4-dioxane is not detected at levels exceeding risk-based screening levels in groundwater, then no further evaluation will be necessary for this constituent and remedial alternatives evaluated in the FS will not consider this constituent.</p> <p>If 1,4-dioxane is detected at levels exceeding risk-based screening values in groundwater, the need for additional risk assessment will be discussed with the partnering team. If the partnering team determines that exceedances of risk-based screening values are insignificant enough that no risk assessment is necessary, then the FS will not consider remediation of 1,4-dioxane.</p> <p>If a risk assessment determines there is no unacceptable risk associated with 1,4-dioxane, then no additional evaluation will be necessary for this constituent and remedial alternatives evaluated in the FS will not consider this constituent. If unacceptable risk is found to be associated with 1,4-dioxane, then the remedial alternatives evaluated in the FS will address this constituent.</p>
<p>Confirm the RI findings associated with the surface-water bodies to ensure that no significant impacts from groundwater discharge are occurring and this pathway does not need to be considered in the FS.²</p>	<p>Are concentrations of VOCs and metals comparable to previously collected data such that the conclusions drawn in the RI are still applicable?</p>	<p>Collect surface water, seep, sediment, and sediment pore water samples and analyze for VOCs and metals. Metals were added for surface water and sediment since other potential transport pathways (e.g., surface runoff) may be relevant for this analytical group.</p>	<p>If data collected are comparable to previously collected data, the nature and extent have been confirmed and the new data will be used to develop potential remedial alternatives and the FS will be completed as planned.</p> <p>If data are not comparable to previously collected data, then additional data may need to be collected to fill those data gaps prior to proceeding to the FS stage or a risk assessment will be performed to determine if risks associated with surface water and sediment exist.</p>

² Surface water and sediment were collected during the Phase II Groundwater RI; however, lack of base flow during the time of that investigation casts doubt on whether the moisture in the surface water bodies was due to previous overland storm water flow or groundwater discharge.

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

What are the Project Action Levels?

PALs are media-specific standards and criteria chosen for evaluation to help provide a conservative assessment of site conditions and determine if action is needed to address concentrations of chemicals present at the site and if so what remedial alternative(s) are potentially appropriate. The following list presents a summary of the PALs for each medium. **Worksheets #15-1** through **#15-12** provide a list of the PALs for each constituent in each medium. If there are exceedances of PALs in any samples, results will also be screened against data collected during the Phase II Groundwater RI to see if results are comparable. If results are determined to be comparable, no additional risk assessment activities will be completed. However, if data collected indicate considerable degradation of contaminants to levels below PALs, or a significant increase (one order of magnitude or higher) in concentrations of constituents is identified, the quantitative risk assessment from the RI will be revised to identify any new COCs and/or the magnitude of existing risks at the site. This process will not be followed for 1,4-dioxane, because it was not previously analyzed at the site. If concentrations of 1,4-dioxane exceed risk-based screening values, the need for additional risk assessment will be discussed with the partnering team. If the partnering team determines that exceedances of risk-based screening values are insignificant enough that no risk assessment is necessary, then the FS will not consider remediation of 1,4-dioxane. However, if significant unacceptable risk associated with 1,4-dioxane is identified, then the remedial alternatives evaluated in the FS will address this constituent.

- **Groundwater** data will be screened against the following PALs:
 - **Human Health** - MCLs, USEPA residential tapwater Regional Screening Levels (RSLs) from May 2012 (adjusted for a hazard quotient [HQ] of 0.1 for non-carcinogens), Yorktown Background upper tolerance limits (UTLs)
- **Surface Water and Seeps** data will be screened against the following PALs:
 - **Human Health** - the adjusted tapwater RSLs, released by USEPA in May 2012, multiplied by 10 in order to account for exposure. Note: the adjusted tapwater RSLs were calculated by dividing the RSLs based on non-carcinogenic effects by 10 to account for exposure to multiple constituents that may affect the same target organ. Consequently, PALs based on human health risk for non-carcinogens are the RSLs because the adjustments for exposure counter the adjustment for cumulative effects.
 - **Ecological** - screening values are derived from multiple sources compiled for use at WPNSTA Yorktown (multiple sources accepted for other Yorktown Site ERAs)
- **Sediment Pore Water** data will be screened against the following PALs:
 - **Ecological** - there are no established PALs specifically for sediment pore water. The sediment pore water analytical data will be screened against the surface water ecological screening values for Site 1 and used to help evaluate groundwater transport to Indian Field Creek.
- **Sediment** data will be screened against the following PALs:
 - **Human Health** - the adjusted Residential soil RSLs, released by USEPA in May 2012, multiplied by 10 in order to account for exposure. Note: the adjusted Residential soil RSLs were calculated by dividing the RSLs based on non-carcinogenic effects by 10 to account for exposure to multiple constituents that may affect the same target organ. Consequently, PALs based on human health risk for non-carcinogens are the RSLs because the adjustments for exposure counter the adjustment for cumulative effects.
 - **Ecological** - screening values are derived from multiple sources compiled for use at WPNSTA Yorktown (multiple sources accepted for other Yorktown Site ERAs)

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

In addition to PALs, project indicator limits (PILs) for groundwater were established to better determine the extent to which natural attenuation is occurring at the site. In order for geochemical parameter data to be meaningful, typically, more than one round of data is necessary. Therefore, it is anticipated that the most thorough evaluation will be of the results for the nineteen existing wells that have been sampled previously. However, data from the five new wells may also be used in future evaluations. PILs will be evaluated as a whole, as no individual parameter represents a definitive summary of site conditions. The parameters, their associated PILs, and explanations for inclusion are shown in **Table 3**.

TABLE 3
 Project Indicator Levels

Parameter	PIL	Justification
Dehalococcoides sp. (DHC)	>103 cells per milliliter (mL)	A result of >103 cells per mL is indicative of conditions optimal for remedial design (RD); however, the presence (detection) of DHC can indicate conditions favorable for slower rates of natural attenuation or conditions favorable for enhanced reductive dechlorination (ERD).
Hardness	0-75 milligrams per liter (mg/L), 75-150 mg/L, 150-300 mg/L, and 300 & up	Hardness data will be used to adjust the freshwater ecological screening values for certain metals to reflect site-specific conditions. Additionally, classification of water hardness content is based on the values presented from soft to very hard.
Total dissolved solids (TDS)	> 10,000 mg/L	Elevated levels of TDS indicate salt water conditions and the inability to use groundwater as potable water source.
pH	6 - 8.5	A pH value ranging from 6 - 8.5 is ideal for supporting microbial populations needed for natural attenuation.
Methane	> 0.5 mg/L	Elevated methane levels are expected to be seen under highly reducing conditions as a byproduct of degradation by methanogenic bacteria and are a positive indicator that degradation of VOCs and some explosives can occur.
Ferrous Iron	> 1 mg/L	Elevated concentrations indicate the activity of iron-reducing bacteria and are a positive indication that reductive dechlorination of VOCs may be occurring.
Sulfate	< 20 mg/L	If sulfur compounds are present in the aquifer, higher concentrations of sulfate may compete with the reductive dechlorination pathway. Therefore, ideal conditions will maintain low sulfate levels.
Sulfide	> 1 mg/L	If sulfur compounds are present in the aquifer, higher concentrations of sulfide are more favorable to reductive dechlorination. Therefore, ideal conditions will maintain higher sulfide levels.
Total organic carbon (TOC)	> 20 mg/L	TOC is an indicator of the total amount of organic matter available to microbial communities to use as a carbon source in the degradation of VOCs. Increasing TOC concentrations are a positive indicator of natural attenuation potential.
Nitrate	Baseline value to later determine decreasing trend	Nitrate data will be collected in the event that a natural attenuation or enhanced biological remedy is later needed for the site. Enhanced biological treatment methods that reduce aquifer conditions are generally expected to result in decreasing concentrations of nitrate.
Nitrite	Baseline value to later determine increasing trend	Nitrite data will be collected in the event that a natural attenuation or enhanced biological remedy is later needed for the site. Enhanced biological treatment methods which reduce aquifer conditions are generally expected to result in increasing concentrations of nitrite.
Chloride	Baseline value to later determine increasing trend	Chloride data will be collected in the event that a natural attenuation or enhanced biological remedy is later needed for the site. Enhanced biological treatment methods which reduce aquifer conditions are generally expected to result in increasing concentrations of chloride, if chlorinated compounds are being degraded.
Alkalinity	> 50 mg/L	A measurement of the available buffering capacity against pH change, which can affect the rate of degradation of chemicals. Decreasing alkalinity may indicate that pH conditions are becoming less optimal for reductive dechlorination.

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

What will the data be used for?

The data will be used to:

- Confirm the lateral extent of landfill waste and vertical and horizontal extent of the soil cover over the landfill since the landfilled waste is a potential continuing source of groundwater contamination and any groundwater remedy to be implemented will consider addressing contamination beyond the point of compliance (landfill boundary).
- Determine the concentrations of VOCs and metals in groundwater at the newly installed wells. Although it is anticipated that there will not be a concern with metals, the regulators have requested an additional round of metals sampling to support a more robust CSM. However, only one additional round of sampling will be collected for metals.
- Determine the potential for and rate of natural attenuation of site-related contaminants in groundwater at the site to support potential consideration as part of remedial alternatives evaluated in the FS.
- Refine the understanding of vertical and horizontal groundwater flow at the site to assist with determining the components of discharge to each of the surface water bodies.
- Better quantify the concentrations of elevated VOCs, previously determined via MIP, potentially present along the southern perimeter of the site in order to allow for contaminant mass concentration approximations in support of the FS.
- Determine if there are seeps that are impacted by contaminated groundwater in order to assist in determining if this groundwater to surface water pathway warrants consideration in the FS.
- Determine the presence or absence of the emerging contaminant 1,4-dioxane in groundwater, surface water, seep, sediment, and sediment pore water at the site since it has not been previously evaluated but is potentially present. 1,4-dioxane is a solvent stabilizer which was previously used to stabilize 1,1,1-trichloroethane (TCA). Low concentrations of 1,1,1-TCA and its daughter products were detected during historical sampling.
- Confirm the RI findings associated with the surface water bodies to ensure that no significant impacts from groundwater discharge are occurring and this pathway does not need to be considered in the FS. Ultimately, all of the previously described data uses will help support the development and evaluation of viable remedial alternatives in the subsequent FS.

What types of data are needed?

The types of data needed for this investigation are included in this section; the details and rationale for the investigation are included in the “How Much Data Are Needed” section, specifically **Table 5**. The COCs in groundwater at Site 1 are PCE, TCE, cis-1,2-DCE, and vinyl chloride. However, in areas where groundwater conditions have not been sufficiently assessed (i.e., where new wells will be installed), a broader suite of analytes is warranted due to the potential heterogeneity of the landfilled waste. Similarly, where historical data are to be confirmed to ensure the associated conclusions are still applicable (i.e., surface water bodies), a suite of analyses comparable to that collected in the past is warranted.

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

A survey of the landfill waste (lateral extent) and soil cover (lateral and vertical extent) is necessary to confirm the extent of the landfill and the thickness of the soil cover in order to ensure the potential for leaching to groundwater (i.e., continuing source) is controlled concurrent with any groundwater RA. Test pits will be excavated and soils will be characterized and logged based on visual observations (**Figure 9**). Prior to test pitting, a field survey will be conducted to identify any visual indications of historic landfilling operations and activity (e.g., hummocky terrain). If additional ground surface evidence of possible waste is identified then these areas will also be investigated or test pit locations biased toward these areas.

The investigation will collect data to provide additional information within the boundary of Site 1, the unnamed tributary south of Site 1, and the ephemeral stream leading to the unnamed tributary, to help refine the understanding of groundwater flow and discharge and better determine the potential for natural attenuation. New monitoring wells (**Figures 10 and 11**) are needed to assist with determination of groundwater flow and vertical gradients and to assess potential contaminant transport to adjacent surface water bodies. Groundwater sampling at all new and existing monitoring wells for site-related contaminants (including emerging contaminant 1,4-dioxane) and natural attenuation parameters is warranted to help evaluate the natural attenuation conditions, microbial population, and quantify contaminant concentrations in the elevated MIP data area.

Surface water, sediment, and sediment pore water samples are needed to determine if groundwater to surface water/sediment impacts exist under conditions where base flow is present. Additionally, seep samples will be collected (if observed during a visual reconnaissance) to aid in determining if a contaminated groundwater to surface water pathway exists.

Are there any special data quality needs, field or laboratory, in order to support environmental decisions?

The off-site laboratory analytical data will be of the quantity and quality necessary to provide technically sound and defensible assessments with respect to the aforementioned project objectives. QC sample requirements are detailed in **Worksheet #20**. For action decisions, the laboratory will follow the Measurement Performance Criteria (MPC) in **Worksheet #12** for field QC samples and **Worksheets #24 and #28** for laboratory QC samples. These MPC are consistent with the DoD Quality Systems Manual (QSM) as applicable and laboratory in-house limits where the QSM does not apply.

In the instance that the laboratory limit of detection (LOD) for a specific constituent is greater than the corresponding PAL, any detection of this constituent above a corresponding 95 percent background UTL will be considered potentially site-related. In those cases where this specific constituent is not detected above the LOD, the analyte will be considered not present.

In efforts to reach lower limits, the laboratory will report concentrations between the limit of quantitation (LOQ) and detection limit (DL) as estimated. These results will have a J qualifier applied to them indicating that they are quantitative estimates.

With the exception of geochemical and geotechnical data, data will be validated by CH2M HILL using the procedures listed in **Worksheet #36**. A full level IV equivalent data package and QC sampling are required for these data. A Level IV equivalent data package includes a case narrative, all field sample results, QC forms, and raw data.

Where, when, and how should the data be collected/generated?

The data will be collected and generated in accordance with the standard operating procedures (SOPs) contained in this SAP. The first phase of the fieldwork is tentatively scheduled to begin in winter 2012. Data will be validated by CH2M HILL and available for use approximately 7 weeks after the laboratory receives the last samples.

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

Who will use the data?

The data will be used by the Navy, its contractors, and the other stakeholder agencies to fill identified data gaps from previous investigations, complete data evaluation, and support the anticipated FS. If appropriate, the information will be used to evaluate actions to be taken to provide adequate protection of human health and the environment. Engineers and scientists will evaluate the data for decision making and a chemist will evaluate laboratory data quality. Once published in the Administrative Record, the data will be available to the public.

How much data are needed? (number of samples for each analytical group, matrix, and concentration)

Test Pitting Activities

Waste delineation activities, including test pitting and a cover depth survey, will be performed to confirm the lateral extent of the landfill wastes and vertical and horizontal extent of the soil cover over the landfill since the landfill waste is a potential continuing source of groundwater contamination and any groundwater remedy to be implemented will consider addressing contamination beyond the point of compliance. Prior to test pitting, a field survey will be conducted to identify any visual indications of historic landfilling operations and activity (e.g., hummocky terrain). If additional ground surface evidence of possible waste is identified then these areas will also be investigated or test pit locations may be biased towards these areas. It is assumed for the purposes of the SAP that 25 test pit locations will be investigated. Eighteen “start” points have been selected to initiate test pitting. Based on visual observations from these test pits, additional locations (north, south, east, and/or west) may be selected as appropriate. Each test pit will be excavated to a maximum depth as identified in **Table 4**, as follows; however, once waste is encountered in a test pit, no deeper excavation will be made at that test pit location. The 18 initial test pit locations are identified in **Figure 9**. Additionally, the field team will walk the southern perimeter of the site and make visual observations as to any waste that may be present within the ravine. For the purpose of the SAP, it is assumed that approximately 25 test pit locations will be investigated. Locations of test pits were selected based on historical data (including geophysical data and aerial photography) indicating where possible waste and landfilling activities occurred. The number of samples was selected to provide adequate spatial coverage of the site.

TABLE 4
 Test Pit Locations

Test Pit Number	Location (Figure 9)	Max Depth	Purpose/Rationale
1	Within main body of landfill, under 2001 "cover area"	8 feet bgs	Confirm thickness of cover; confirm presence/absence of waste. Previous test pits in this area identified waste in the 7 to 8 feet bgs range.
2	Within main body of landfill	8 feet bgs	Confirm thickness of cover; confirm presence/absence of waste. Previous test pits in this area identified waste in the 7 to 8 feet bgs range.
3	Within main body of landfill	8 feet bgs	Confirm thickness of cover; confirm presence/absence of waste. Previous test pits in this area identified waste in the 7 to 8 feet bgs range.
4	Former sand reclamation area	8 feet bgs	Confirm presence/absence of waste. Confirm thickness of cover if waste identified in area.
5	Northern edge of "main landfill," north of road	8 feet bgs	Confirm presence/absence of waste. Verify that main body of landfill ceases south of road (formerly based on TP1...which did not identify waste down to 5 feet bgs). Verify potential waste presence from ground penetrating radar (GPR) and electromagnetic (EM) studies. Confirm thickness of cover if waste identified in area.

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

TABLE 4
 Test Pit Locations

Test Pit Number	Location (Figure 9)	Max Depth	Purpose/Rationale
6	Northern edge of "main landfill," north of road	8 feet bgs	Confirm presence/absence of waste. Verify that main body of landfill ceases south of road (formerly based on TP1, which did not identify waste down to 5 feet bgs). Verify potential waste presence from GPR and EM studies. Confirm thickness of cover if waste identified in area.
7	Northern edge of "main landfill," north of road	8 feet bgs	Confirm presence/absence of waste. Verify that main body of landfill ceases south of road (formerly based on TP1, which did not identify waste down to 5 feet bgs). Verify potential waste presence from GPR and EM studies. Confirm thickness of cover if waste identified in area.
8	Southern edge of "main landfill," along tree line	8 feet bgs	Confirm presence/absence of waste along southern edge of site. Confirm thickness of cover if waste identified in area.
9	Southern edge of "main landfill," along tree line	8 feet bgs	Confirm presence/absence of waste along southern edge of site. Confirm thickness of cover if waste identified in area.
10	Southern edge of "main landfill," along tree line	8 feet bgs	Confirm presence/absence of waste along southern edge of site. Confirm thickness of cover if waste identified in area.
11	Southern edge of "main landfill," along tree line	8 feet bgs	Confirm presence/absence of waste along southern edge of site. Confirm thickness of cover if waste identified in area.
12	Western edge of "main landfill," just west of GW018	11 feet bgs	Confirm presence/absence of waste along western edge of site. Depth based on waste found at 10 feet bgs at 1GW18. Confirm thickness of cover if waste identified in area.
13	Northern cleared area	8 feet bgs	Confirm presence/absence of waste. Confirm thickness of cover if waste identified in area.
14	Area of potential anomaly from GPR and EM study	8 feet bgs	Confirm presence/absence of waste. Confirm thickness of cover if waste identified in area.
15	Northern cleared area	8 feet bgs	Confirm presence/absence of waste. Confirm thickness of cover if waste identified in area.
16	Former Sand Reclamation Area Border	8 feet bgs	Confirm presence/absence of waste. Confirm thickness of cover if waste identified in area.
17	Area of potential anomaly from GPR and EM study	8 feet bgs	Confirm presence/absence of waste. Confirm thickness of cover if waste identified in area.
18	Area of potential anomaly from GPR and EM study	8 feet bgs	Confirm presence/absence of waste. Confirm thickness of cover if waste identified in area.

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

Monitoring Well Installation and Groundwater Sampling

Five new monitoring wells (**Figures 10** and **11**) will be installed at Site 1 as follows:

- A shallow/deep pair in the location of MIP 17, one screened at the top of the Yorktown-Eastover aquifer and the other at the bottom of the same unit
- A shallow/deep pair located downgradient of 1GW22 by the ephemeral feeder stream to the unnamed tributary to Indian Field Creek (shallow well screened at the top of the Yorktown-Eastover and deep well screened at the bottom of the same unit)
- One deep well adjacent to shallow monitoring well 1GW24 to evaluate the vertical gradient adjacent to Indian Field Creek

All newly installed and existing site monitoring wells (including 3GW29) will be sampled (excluding well 1GW12B which will not be sampled because it is screened in a non-water bearing unit) using a peristaltic or submersible pump and disposable tubing following low-flow sampling protocol. All groundwater samples from existing monitoring wells will be analyzed for select TCL VOCs (PCE, TCE, cis-1,2-DCE, and vinyl chloride), chloride, nitrate, nitrite, sulfate (CNNS), sulfide, TOC, alkalinity, methane, ethane, ethene (MEE), and 1,4-dioxane. The VOC parameters are consistent with COCs identified during the groundwater RI; the others are pertinent natural attenuation parameters for these COCs. Additionally, 1,4-dioxane will be analyzed as an emerging contaminant in accordance with team agreement since historical use of the site and analytical data suggest it could be present.

The newly-installed monitoring wells will be analyzed for full suite TCL VOCs and TAL total and dissolved metals (including total cyanide) to ensure that these areas are not more contaminated than those areas previously evaluated at the site since the site is a landfill and the waste (and therefore the potential contaminants) is heterogenous. Although it is anticipated that there will not be a concern with metals, the regulators have requested an additional round of metals sampling to support a more robust CSM. However, only one additional round of sampling will be collected for metals.

Five groundwater samples (1GW12, 1GW12A, 1GW22, 1GW26, and 1GW26A) will also be analyzed for DHC and functional genes. The microbial parameters are needed to help identify contaminant degradation potential.

All groundwater samples will be field-analyzed for the following water quality parameters prior to sampling: dissolved oxygen (DO), oxidation-reduction potential (ORP), specific conductance, pH, turbidity, temperature, and salinity. These parameters will help to ensure the water sampled is representative of aquifer conditions (not standing water in the wells) and will assist in the natural attenuation evaluation.

The rationale for collecting specific samples and details of the parameters to be analyzed for collecting specific samples is included in **Table 5**.

**SAP Worksheet #11—Project Quality Objectives/
 Systematic Planning Process Statements (continued)**

TABLE 5
 Sampling Design and Rationale

Matrix	Depth to Sample	Analysis	Number of Samples	Station ID	Rationale	*Sampling Strategy
Groundwater	Samples will be collected two feet above the bottom of the well	PCE, TCE, cis-1,2-DCE, vinyl chloride	19 (all existing wells)	All existing Site 1 wells (and 3 GW29)	<p>Previously existing wells will be sampled for the COCs identified during the Phase II RI (PCE, TCE, cis-1,2-DCE, and vinyl chloride) and geochemical parameters in order to evaluate the potential for natural attenuation at the site. Additionally 1,4-dioxane (emerging contaminant) will be collected as requested by the partnering team.</p> <p>Five additional samples will be collected from the newly installed wells and sampled for full-suite VOCs and TAL total and dissolved metals. The dissolved metals will be compared to the total results to help determine whether the total results are influenced by turbidity. This data will be used to ensure that no other constituents need to be considered COCs at the site since the landfill is made up of heterogeneous waste. Although it is anticipated that there will not be a concern with metals, the regulators have requested an additional round of metals sampling to support a more robust CSM.</p> <p>While the vertical and horizontal extent of contamination along the estimated boundary of the landfill have been delineated by MIP data; there are no monitoring wells present in some key locations adjacent to the tributary to Indian Field Creek to allow for quantification of the qualitative MIP data. Additionally, shallow/deep pairs are needed along the southern and southeastern perimeters of the site to determine if groundwater discharge is occurring into the surface water bodies or flowing underneath them. Laboratory analytical concentrations in these areas are needed to adequately generate viable remedial alternatives.</p> <p>Proposed deep well GW24A will be installed as a pair with existing well GW24 to help define the vertical gradient of groundwater at the southeastern perimeter of the site and determine if groundwater contamination is discharging to Indian Field Creek or underneath it.</p> <p>Proposed shallow/deep well pair GW26/GW26A will be installed downgradient of GW22 (historically highest concentration of COCs) and in the vicinity of the ephemeral stream where uncertainty exists with regards to groundwater flow and contaminant mass.</p> <p>Proposed shallow/deep well pair GW27/GW27A will be installed near former MIP 17 where uncertainty exists with regards to groundwater flow and contaminant mass.</p>	1 existing well (3GW29) across Indian Field creek, 4 existing wells installed within the landfill, 9 existing wells along the perimeter of the landfill, 5 existing wells downgradient of the landfill, and 5 newly installed wells downgradient of the landfill as shown in Figures 10 and 11. 1 Yorktown-Eastover aquifer shallow/deep well pair will be installed downgradient of 1GW22. The deep well will be installed within the first few feet of the Eastover-Calvert confining unit. 1 Yorktown-Eastover aquifer shallow/deep well pair will be installed in the vicinity of former MIP location #17. The deep well will be installed within the first few feet of the Eastover-Calvert confining unit. 1 Yorktown-Eastover aquifer deep well will be installed east of 1GW24. This well will be installed within the first few feet of the Eastover-Calvert confining unit. All newly installed deep wells will be screened just above the Eastover-Calvert confining unit.
		TCL VOCs	5 (newly installed wells)	1GW24A, 1GW26, 1GW26A, 1GW27, 1GW27A		
		alkalinity	24 (19 existing, 5 new); including 3GW29	All Site 1 wells		
		chloride, nitrate, nitrites, sulfate,	24 (19 existing, 5 new); including 3GW29			
		sulfide	24 (19 existing, 5 new); including 3GW29			
		TOC	24 (19 existing, 5 new); including 3GW29			
		MEE	24 (19 existing, 5 new); including 3GW29			
		1,4-Dioxane	24 (19 existing, 5 new); including 3GW29			
		TAL metals (total and dissolved), cyanide, mercury	5			
DHC and functional genes	5	1GW22, 1GW12, 1GW12A, 1GW26, 1GW26A				
Surface Water	Samples will be collected at the surface of the water	Water Hardness	5	1SW28, 1SW29, 1SW30, 1SW31, 1SW32	<p>Samples will be collected to evaluate surface water and soil/sediment characteristics at 3 locations along the unnamed tributary feeding to Indian Field Creek, one location will be collected within Indian Field Creek, and 1 location will be in the ephemeral stream leading to the unnamed tributary; for a total of 5 samples. Sample locations were selected to extend from the most likely point of discharge of contaminants to the ephemeral stream to the unnamed tributary and to the unnamed tributary itself. Additionally, one location was chosen at the confluence of the unnamed tributary and Indian Field Creek.</p> <p>Historically, there were locations at which no surface water was present during the Phase II groundwater RI, and the lack of obvious base flow casts some doubt on whether the moisture in the water bodies was due to previous overland storm water flow or groundwater discharge. In order to ensure no significant impacts from groundwater discharge are occurring to surface water and sediment and nothing further needs to be completed to address this pathway in the FS, the Partnering team recommended one additional round of data collection for these media.</p>	Surface water samples will be co-located with sediment samples. Surface water samples will be collected prior to the co-located sediment sample (Figure 12).
		TCL VOCs	5			
		1,4-Dioxane	5			
		TAL total and dissolved metals, cyanide, mercury	5			
		TDS	5			
Sediment	0-4 inches	TCL VOCs	5	1SD28, 1SD29, 1SD30, 1SD31, 1SD32		
		TAL metals	5			
		1,4-Dioxane	5			
		pH	5			
		Acid volatile sulfide (AVS)/simultaneously extractable metals (SEM)	5			
		TOC	5			
		grain size	5			
alkalinity	5					

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

TABLE 5
 Sampling Design and Rationale

Matrix	Depth to Sample	Analysis	Number of Samples	Station ID	Rationale	*Sampling Strategy
Sediment Pore Water	Samples will be collected from a machine-slotted well-point installed 0 to 12 inches below sediment surface	TCL VOCs	5	1WNO1, 1WNO2, 1WNO3, 1WNO4, 1WNO5	Samples will be collected to confirm the RI findings associated with the surface-water bodies to ensure that no significant impacts from groundwater discharge are occurring and to evaluate if 1,4-dioxane (if present) is discharging from groundwater to surface water. Sample locations were selected to extend from the most likely point of discharge of contaminants to the ephemeral stream to the unnamed tributary and to the unnamed tributary itself. Additionally, one location was chosen at the confluence of the unnamed tributary and Indian Field Creek. One location will be collected within Indian Field Creek, 3 locations will be collected within the unnamed tributary feeding to Indian Field Creek, and 1 location will be within the ephemeral stream leading to the unnamed tributary; for a total of 5 samples.	Sediment pore water samples will be co-located with the sediment and surface water samples as shown on Figure 12.
		1,4-Dioxane				
		TAL total and dissolved metals, cyanide, mercury				
		TDS				
		Water Hardness				
Seep	Seeps will be collected at the location of flow	TCL VOCs	3	1SP01, 1SP02, 1SP03	Evaluate any direct contribution of groundwater to surface water. Determine if seeps are impacted by contaminated groundwater in order to assist in determining if this groundwater to surface water pathway warrants consideration in the FS.	Seeps will be collected where present upon visual observation.
		1,4-Dioxane				
		TAL total and dissolved metals, cyanide, mercury				
		TDS				
		Water Hardness				

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

Surface Water, Sediment, and Sediment Pore-Water Sampling

Five surface water, sediment, and sediment pore water samples will also be collected in the vicinity of the unnamed tributary and the ephemeral stream to confirm groundwater discharge to sediment and surface water is similar to what was observed during the Phase II RI under potentially different flow conditions (**Figure 12**). Surface water samples will be analyzed for TCL VOCs, 1,4-dioxane, TAL total and dissolved metals, TDS, and hardness. Sediment samples will be analyzed for TCL VOCs, TAL metals, pH, AVS/SEM, TOC, grain size, and alkalinity. Sediment samples will be visually characterized and logged as they are collected. Sediment pore water samples will be analyzed for TCL VOCs, 1,4-dioxane, TAL total and dissolved metals, TDS, and hardness.

The rationale for collecting specific samples and details of the parameters to be analyzed for collecting specific samples is included in **Table 5**.

Seep Survey

A seep survey will also be performed as part of this SAP, and is anticipated to be conducted in the spring of 2013. A site visit will be conducted for visual reconnaissance of seeps. It is requested that the BTAG accompany the field team during this event. Upon visual observation of seeps, samples will be collected. For the purposes of this SAP, it is assumed that three seep samples will be collected; however, seeps samples will be field located and determined and the exact number may be modified. It is anticipated that seep samples will be collected along the southern and eastern perimeter of the site where groundwater is most likely to discharge along the ravine to the unnamed tributary and Indian Field Creek. Seeps will also be sampled if encountered at the site to further refine the understanding of potential groundwater contributions to surface water bodies.

The rationale for collecting specific samples and details of the parameters to be analyzed for collecting specific samples is included in **Table 5**.

Data from all sampled media will be summarized and evaluated in a Pre-FS Investigation Technical Memorandum and will be used to support the completion of the proposed FS for Site 1.

Who will collect and generate the data?

CH2M HILL field staff will collect the samples. In general, an offsite laboratory will analyze samples and produce sample data. In some cases, data will be field-generated, such as water quality parameters (e.g., DO, turbidity, etc.) and testing (e.g., water-level measurement) data. Laboratory services will be performed by ENCO laboratories (and their subcontractors), ALS-Rochester, Kemron, and Microbial Insights. ENCO is an offsite DoD Environmental Laboratory Accreditation Program (ELAP)-approved analytical laboratory; refer to **Appendix B** for all relevant DoD ELAP letters.

How will the data be reported?

CH2M HILL will receive the data and will upload it into a centralized database used for Navy projects by the project team. Data will be presented in tabular format and evaluated against prescribed screening criteria as previously outlined. The results of the investigations will be documented in a technical memorandum and used to support an FS.

How will the data be archived?

Data will be archived according to procedures dictated via the Navy CLEAN program and contract and will be uploaded into the Navy Installation Restoration Information System (NIRIS). At the end of the project, archived data will be returned to the Navy.

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SAP Worksheet #12-1—Measurement Performance Criteria Table for Field QC Samples

Matrix: Groundwater, Surface Water, Pore Water, Seeps

Analytical Group: VOCs, 1,4-dioxane

Concentration Level: Medium

QC Sample	Analytical Group	Frequency	Data Quality Indicators	Measurement Performance Criteria
Field Duplicate ¹	VOCs and 1,4-dioxane	1 per 10 field samples of similar matrix	Precision	Relative Percent Difference (RPD) $\leq 30\%$
Equipment Blank		1 per day of sampling for decontaminated equipment, 1 per lot for disposable equipment	Bias/Contamination	No target analytes detected > 1/2 LOQ
Trip Blank		1 per cooler to the laboratory containing VOC samples	Bias/Contamination	No target analytes detected > 1/2 LOQ
Cooler Temperature Indicator		1 per cooler to the laboratory	Representativeness	Temperature not 6°C frozen

Notes:

¹ Field QA/QC will be collected separately for each media.

SAP Worksheet #12-2—Measurement Performance Criteria Table for Field QC Samples

Matrix: Groundwater, Surface Water, Pore Water, Seeps
 Analytical Group: Total and/or Dissolved Metals, Cyanide
 Concentration Level: Medium/Low

QC Sample	Analytical Group ¹	Frequency	Data Quality Indicators	Measurement Performance Criteria
Field Duplicate ²	Total and Dissolved Metals, Cyanide	1 per 10 field samples of similar matrix	Precision	Relative Percent Difference (RPD) $\leq 20\%$
Equipment Blank		1 per day of sampling for decontaminated equipment, 1 per lot for disposable equipment	Bias/Contamination	No target analytes detected > 1/2 LOQ
Cooler Temperature Indicator		1 per cooler to the laboratory	Representativeness	Temperature frozen \leq

Notes:

¹ Field QA/QC as described in this table will be collected separately for total and dissolved metals.

² Field QA/QC will be collected separately for each media.

SAP Worksheet #12-3—Measurement Performance Criteria Table for Field QC Samples

Matrix: Groundwater, Surface Water, Sediment Pore Water, Seeps

Analytical Group: Wet Chemistry (MEE, CNNS, Sulfide, TOC, Alkalinity, and/or hardness and TDS), Microbial

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators	Measurement Performance Criteria
Cooler Temperature Indicator	Wet Chemistry, Microbial	1 per cooler to the laboratory	Representativeness	Temperature frozen ≤

Notes:

MEE = methane, ethane, ethene

CNNS = chloride, nitrate, nitrite, sulfate

SAP Worksheet #12-4—Measurement Performance Criteria Table for Field QC Samples

Matrix: Sediment

Analytical Group: VOCs, 1,4-dioxane

Concentration Level: Medium

QC Sample	Analytical Group	Frequency	Data Quality Indicators	Measurement Performance Criteria
Field Duplicate	VOCs, 1,4-dioxane	1 per 10 field samples of similar matrix	Precision	Relative Percent Difference (RPD) $\leq 30\%$
Equipment Blank		1 per day of sampling for decontaminated equipment, 1 per lot for disposable equipment	Bias/Contamination	No target analytes detected > 1/2 LOQ
Trip Blank		1 per cooler to the laboratory containing VOC samples	Bias/Contamination	No target analytes detected > 1/2 LOQ
Cooler Temperature Indicator		1 per cooler to the laboratory	Representativeness	Temperature frozen \leq

SAP Worksheet #12-5—Measurement Performance Criteria Table for Field QC Samples

Matrix: Sediment

Analytical Group: Metals, Cyanide

Concentration Level: Medium/Low

QC Sample	Analytical Group ¹	Frequency	Data Quality Indicators	Measurement Performance Criteria
Field Duplicate	Metals, Cyanide	1 per 10 field samples of similar matrix	Precision	Relative Percent Difference (RPD) $\leq 20\%$
Equipment Blank		1 per day of sampling for decontaminated equipment, 1 per lot for disposable equipment	Bias/Contamination	No target analytes detected > 1/2 LOQ
Cooler Temperature Indicator		1 per cooler to the laboratory	Representativeness	Temperature ≤ 6 °C, not frozen

Notes:

¹ Field QA/QC as described in this table will be collected and analyzed for each of the analytical groups listed; dissolved metals applies to surface water samples only.

SAP Worksheet #12-6—Measurement Performance Criteria Table for Field QC Samples

Matrix: Sediment

Analytical Group: Wet Chemistry (pH, Alkalinity, TOC), AVS/SEM

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators	Measurement Performance Criteria
Cooler Temperature Indicator	Wet Chemistry AVS/SEM	1 per cooler to the laboratory	Representativeness	Temperature frozen ≤

SAP Worksheet #12-7—Measurement Performance Criteria Table for Field QC Samples

Matrix: Sediment

Analytical Group: Grain-size

Concentration Level: N/A

QC Sample	Analytical Group	Frequency	Data Quality Indicators	Measurement Performance Criteria
None	Grain-size	N/A	N/A	N/A

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SAP Worksheet #13—Secondary Data Criteria and Limitations Table

Secondary Data	Data Source	Data Generator(s)	How Data Will Be Used	Limitations on Data Use
Yorktown Background Dataset	Draft Background Study Report, Naval Weapons Station Yorktown and Cheatham Annex. March 2011.	CH2M HILL	UTLs will be used to screen chemicals identified as posing potential risk to determine if those chemicals are site related	If background DLs are greater than concentrations of contaminants posing potential risk, usefulness may be limited

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SAP Worksheet #14—Summary of Project Tasks

Project Logistics

- In general, work will be performed in Level D personal protective equipment (PPE), which includes hard hat, safety glasses, safety toed boots, and hearing protection. Optional PPE includes the use of Tyvek coveralls as necessary. Triggers for upgrades to higher levels of PPE are discussed in the Health and Safety Plan (HASP), which will be provided as a separate document from this UFP-SAP.
- All field activities will take place during normal daylight working hours.
- Following completion of the investigation activities, the site will be restored to its original condition to the satisfaction of the property owner.

Project Tasks

Applicable SOPs for project tasks outlined in this section are listed on **Worksheet #21** and provided in **Appendix A**.

Utility Clearance

- Utilities will be cleared before beginning intrusive activities. CH2M HILL will coordinate utility clearance with Miss Utility of Virginia and the Base's approving authority. Additionally, a separate utility locating subcontractor will be procured to ensure the accuracy of the utility markings. Any proposed monitoring well locations in close proximity to utility locations will be relocated to avoid impact to utilities while continuing to meet the intent of the sampling rationale.

Investigation Activities

- **Monitoring Well Installation** – Five monitoring wells will be installed in the Yorktown-Eastover aquifer during investigation activities. Well depths and screened intervals will be discussed with the partnering team prior to installation.
- **Monitoring Well Construction** - Each new monitoring well will be constructed with 2-inch inside-diameter Schedule 40 polyvinyl chloride (PVC) screen and riser. The monitoring well screen will be 0.010-inch machine slotted. A silica filter pack will be placed around the annular space of the well screen from the bottom of the boring extending to 2 feet above the top of the screen. A 2-foot-thick bentonite layer will be placed above the sand pack. After the bentonite has been hydrated, a cement-bentonite grout will be placed in the remaining annular space. The monitoring wells will be completed with an above-grade protective casing with a watertight steel cover. A locking watertight cap will be placed on the PVC pipe and the well will be clearly marked with its identification number. Wells will be surrounded with bollards and locked.
- **Monitoring Well Development**--Each new monitoring well will be developed using a submersible pump. At least three well volumes of water will be removed, in addition to any amount of water which may have been added during the installation process. Development will continue until water quality parameters have stabilized within 10 percent for three consecutive readings and turbidity has been reduced to the extent practicable (preferably less than 10 nephelometric turbidity units [NTUs]). Development information, including turbidity, pH, specific conductivity, temperature, and gallons removed, will be recorded in the field logbook.

SAP Worksheet #14—Summary of Project Tasks (continued)

- **Groundwater Sampling**--All newly-installed and existing site monitoring wells (including 3GW29) will be sampled, excluding well 1GW12B, using a peristaltic or submersible pump and disposable tubing following low-flow sampling protocol. Groundwater quality parameters (pH, specific conductance, turbidity, DO, temperature, salinity, and ORP) will be recorded and stabilized before a sample is collected. Groundwater monitoring well 1GW12B will not be sampled because previous investigations have confirmed that the well is dry. Monitoring well 3GW29 will be sampled first, and other wells will be sampled from suspected locations of no/low levels of contamination to high levels of contamination.
- **Surface Water Sampling** – All sample locations will be approached from downstream (considering tidal fluctuations) to avoid disturbance of bottom sediments as much as possible. Prior to sample collection, water quality data will be measured from the top, middle, and bottom of the water column (where applicable) using a Horiba U-22 water quality meter (pH, conductivity, turbidity, DO, temperature, salinity, and ORP). To facilitate sample collection, a clean, unpreserved sample container will be gently submerged within the surface water with the mouth pointed upstream and the bottle tilted slightly downstream. Bubbles and floating materials will be prevented from entering the bottle. When the bottle is full, it will be gently removed from the water and the surface water sample transferred to the laboratory-supplied bottleware. Surface water samples will be collected prior to sediment and sediment pore water samples.
- **Sediment Sampling** –All sediment samples will be collected from 0- to 4-inches below the sediment surface. With the exception of VOC and AVS/SEM samples, sediment will be homogenized in stainless bowls prior to placement in laboratory-prepared sample containers. Samples collected for VOCs and AVS/SEM analysis will be placed directly into sample containers. Downstream sediment samples will be collected prior to upstream samples.
- **Sediment Pore Water Sampling** – Sediment pore water samples will be sampled using the “well point” method described in the SOP (**Appendix A**). The sampling approach will consist of a dual-cased well point system that incorporates an outer screen that isolates the sediment pore water from the surface water, and an inner screen with a pre-pack sand filter to reduce turbidity of the sample. Sediment pore water samples will be collected following surface water and sediment sampling.
- **Seep Sampling** – If seeps are found at Site 1 during the seep survey, seep samples will be collected directly from the seep into a clean, laboratory-prepared sample container.

Equipment Decontamination

- All non-disposable sampling equipment will be decontaminated before use and immediately after each use in accordance with applicable SOPs (**Appendix A**). The water level indicator will be rinsed with deionized water between each measurement. Heavy equipment such as drill rigs (e.g., augers, rods, split spoons) will be steam-cleaned before use at each new monitoring well location. Monitoring well risers and screens will also be steam-cleaned using the same procedure, unless they are certified by the manufacturer as clean and the plastic seals intact. A decontamination pad will be set up to prevent runoff of the decontamination water and to allow easy collection of decontamination fluids.

SAP Worksheet #14—Summary of Project Tasks (continued)

Investigation-derived Waste Handling

- Investigation-derived waste (IDW) generated during investigation activities at Site 1 will include disposable personal protective equipment (PPE) and sampling supplies, soil cuttings, well purge water, and solutions used to decontaminate drilling and hand augering equipment. Aqueous IDW and soil cuttings will be containerized in approved 55-gallon drums and will be managed using the procedure described below. Used PPE and sampling supplies will be placed in opaque contractor's bags and disposed of in an on-Base dumpster.

IDW Management Procedure

The process for coordinating the location of an IDW storage area includes:

- Informing the Navy RPM, Jim Gravette, of the number of IDW drums to be generated during the investigation.
- Coordinating with the Navy RPM, the Base Environmental Director, and Base IDW Coordinator to identify a location for IDW (including providing the number of drums and a figure with proposed IDW storage area).
- Site visit with the Base Environmental Director and/or the Base IDW Coordinator to field verify the location.
- The following considerations will be given to the IDW Storage Area:
 - Size (number of drums) requirement, levelness, and firmness of ground if not stored on asphalt or concrete
 - Accessibility to vehicles (height, width, turning radius), including semi-trailer
 - Protectiveness - sheltering, away from heavy traffic areas, limited accessibility to base employees if possible

The process for preparing an IDW storage area includes:

- Construction of a secondary containment area that requires:
 - Able to contain 10% of total volume of material to be stored
 - Minimum 6 mil poly sheeting flooring wrapped over minimum 4" side wall
- Pallets will be required to keep all drums directly off the poly sheeting
- Poly or other weather proof tarp capable preventing infiltration into the secondary containment
- Metal or fabric strapping capable of securing drums to each other and securing a tarp over the containment area
- A sign will be placed in plain view stating the purpose of the area and contact information
- IDW Spill Control Kit to be kept on site at all times that will include:
 - A fire extinguisher
 - Spill pads
 - Nitrile gloves
 - Trash bags and paper towels
 - Forms - additional drum labels and inspection forms, pens, markers

SAP Worksheet #14—Summary of Project Tasks (continued)

The process for filling and storing IDW drums will include:

- All drums used for IDW must be new or recondition 55-gallon DOT approved drums with open top
- Drums may only be filled to approximately $\frac{3}{4}$ full to meet weight requirements for transport
- Any excess material will be cleaned from the side of the drum
- The cover of the drum will be secured to prevent any leakage from the drum should it be placed on its side
- The filled drum will be placed on a pallet within the secondary storage container
- Labels will be affixed to the drum in accordance to the SOP included in **Appendix A**. The label will be affixed to the drum so that it is facing outward where it may be read by an inspector.
- Once the IDW operations have been completed for the day, a tarp will be placed over the drums and secured. The tarp will be placed in a way that prevents any precipitation from collecting in the secondary containment

The process for inspecting the IDW storage area will include:

- On a weekly basis, all aspects of the IDW storage area will be inspected
- The condition of the tarp, sidewalls, poly sheeting will be inspected for any holes or breaks. Any deficiencies will be corrected at the time of the inspection
- The drums will be inspected to ensure that no leaks or breaching of the drum has occurred or is imminent. All labels will be inspected to ensure that they are still properly affixed to the drum and that the information on them are current.
- The pallets will be inspected to ensure that there is no rotting or breakage on the wood.
- The inspection sheet provided by the base will be completed and kept with the IDW Spill Control Kit
- Any deficiencies that cannot be corrected at the time of the inspection will be communicated to the Navy RPM, the Base Environmental Director and/or the Base IDW Coordinator

The process for characterizing, profiling, and removal of the IDW from the base includes:

- Sampling of the IDW drums will be conducted by CH2MHILL and the parameters for disposal will be determined based on the contracted receiving facilities requirements
- Sampling results received by CH2M HILL will be forwarded on the IDW receiving facility and a waste profile will be generated to make the determination regarding the material being considered hazardous or non-hazardous.
- Sampling results and the waste profile will be forwarded to the Navy RPM for review
- Once the Navy approves of the profile, CH2M HILL will schedule a pick up date and time. This will be coordinated with the Navy RPM to ensure that a Navy representative is present to sign the appropriate disposal forms

SAP Worksheet #14—Summary of Project Tasks (continued)

Quality Control

- Implement SOPs for field (**Appendix A**) and laboratory activities being performed.
- Summaries of daily field activities will be documented in a field log book; this log book will also detail sampling activities and information regarding boring logs, well construction, and well development.
- QC samples to be collected are outlined on **Worksheet #20**.

Surveying

- All newly-installed monitoring wells will be horizontally (± 0.1 foot) and vertically (± 0.01 foot) located by a Virginia-licensed surveyor.
- The locations of all surface water, sediment, sediment pore water, and seep locations will be recorded via GPS.

Analytical Tasks

- The laboratory will maintain, test, inspect, and calibrate analytical instruments. (**Worksheets #24 and #25**).
- The laboratory will process and prepare samples for analysis.

Data Management

- See **Appendix C**, Navy CLEAN Data Management Plan for all data management procedures.
- Procedures for data tracking, storage, archiving, retrieval and security for both electronic and hardcopy data:
See the Navy CLEAN Data Management Plan for detailed information (**Appendix C**)
The PC (Clairette Campbell) is responsible for data tracking and storage
Monica Marrow of Critigen will coordinate archiving and retrieval of data

Project Assessment/Audit

- **Worksheets #31 and #32**

Data Review

- Data Validation (**Worksheets #35 and #36**)

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Worksheet #15-1—Reference Limits and Evaluation Table

Matrix: Groundwater (existing wells)

Analytical Group: Select VOCs including 1,4-dioxane

All units are µg/L

Analyte ⁴	CAS #	RSLs Tapwater Adjusted ¹	MCL ¹	Project QL Goal ²	Phase II RI Maximum Detection	Laboratory Limits			LCS and MS/MSD Recovery Limits and RPD ³ (%)		
						LOQ	LOD	DL	LCL	UCL	RPD
cis-1,2-Dichloroethene	156-59-2	2.8	70	1.4	3,000	2.0	1.0	0.53	70	125	30
Tetrachloroethene	127-18-4	3.5	5	1.75	0.21	2.0	1.0	0.76	45	150	
Trichloroethene	79-01-6	0.26	5	0.13	18,000	2.0	1.0	0.89	70	125	
Vinyl chloride	75-01-4	0.015	2	0.0075	3.6	2.0	1.0	0.71	50	145	
1,4-Dioxane ⁴	123-91-1	0.67	NC	0.335	NA	3.0	3.0	1.2	70	130	

Notes:

¹ Refer to Worksheet #11 for specific identification of PALs by matrix. The RSLs shown in this table are from May 2012.

² Project QL goals are equal to half of the minimum applicable PAL.

³ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits: values are bolded to indicate instances where in-house limits are used.

⁴ The VOC 1,4-dioxane will be reported by SW-846 8260B-SIM, all other VOCs will be reported by full scan.

NA - not analyzed

NC indicates that there is no criterion for an analyte.

Shading indicates instances where the PAL is lower than the LOD. Non-detects will not be treated as exceedances, though they will be reported at a value greater than the PAL.

Worksheet #15-2—Reference Limits and Evaluation Table

Matrix: Groundwater (new wells)
 Analytical Group: VOCs including 1,4-dioxane
 All units are µg/L

Analyte	CAS #	RSLs Tapwater Adjusted ¹	MCL ¹	Project QL Goal ²	Phase II RI Maximum Detection	Laboratory Limits			LCS and MS/MSD Recovery Limits and RPD ³ (%)		
						LOQ	LOD	DL	LCL	UCL	RPD
1,1,1-Trichloroethane	71-55-6	750	200	100	ND	2.0	1.0	0.80	65	130	30
1,1,2,2-Tetrachloroethane	79-34-5	0.066	NC	0.033	ND	2.0	1.0	0.54	65	130	
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	76-13-1	5300	NC	2650	ND	2.0	1.0	0.73	47	173	
1,1,2-Trichloroethane	79-00-5	0.041	5	0.0205	1.7	2.0	1.0	0.76	75	125	
1,1-Dichloroethane	75-34-3	2.4	NC	1.2	0.6	2.0	1.0	0.62	70	135	
1,1-Dichloroethene	75-35-4	26	7	3.5	8.6	2.0	1.0	0.94	70	130	
1,2,3-Trichlorobenzene	87-61-6	0.52	NC	0.26	ND	2.0	1.0	0.86	55	140	
1,2,4-Trichlorobenzene	120-82-1	0.39	70	0.195	ND	2.0	1.0	0.70	65	135	
1,2-Dibromo-3-chloropropane	96-12-8	0.00032	0.2	0.00016	ND	10	5.0	0.96	50	130	
1,2-Dibromoethane	106-93-4	0.0065	0.05	0.00325	ND	2.0	1.0	0.78	80	120	
1,2-Dichlorobenzene	95-50-1	28	600	14	ND	2.0	1.0	0.73	70	120	
1,2-Dichloroethane	107-06-2	0.15	5	0.075	ND	2.0	1.0	0.63	70	130	
1,2-Dichloropropane	78-87-5	0.38	5	0.19	ND	2.0	1.0	0.80	75	125	
1,3-Dichlorobenzene	541-73-1	NC	NC	Lab LOD	ND	2.0	1.0	0.77	75	125	
1,4-Dichlorobenzene	106-46-7	0.42	75	0.21	ND	2.0	1.0	0.76	75	125	
2-Butanone	78-93-3	490	NC	245	ND	25	12	4.5	30	150	
2-Hexanone	591-78-6	3.4	NC	1.7	ND	5.0	2.5	1.4	55	130	
4-Methyl-2-pentanone	108-10-1	100	NC	50	ND	5.0	2.5	0.79	60	135	
Acetone	67-64-1	1200	NC	600	ND	25	12	1.8	40	140	

Worksheet #15-2—Reference Limits and Evaluation Table (continued)

Matrix: Groundwater (new wells)
 Analytical Group: VOCs including 1,4-dioxane
 All units are µg/L

Analyte	CAS #	RSLs Tapwater Adjusted ¹	MCL ¹	Project QL Goal ²	Phase II RI Maximum Detection	Laboratory Limits			LCS and MS/MSD Recovery Limits and RPD ³ (%)		
						LOQ	LOD	DL	LCL	UCL	RPD
Benzene	71-43-2	0.39	5	0.195	0.24 J	2.0	1.0	0.71	80	120	
Bromochloromethane	74-97-5	8.3	NC	4.15	ND	2.0	1.0	0.94	65	130	
Bromodichloromethane	75-27-4	0.12	80	0.06	ND	2.0	1.0	0.52	75	120	
Bromoform	75-25-2	7.9	80	3.95	ND	2.0	1.0	0.75	70	130	
Bromomethane	74-83-9	0.7	NC	0.35	ND	2.0	1.0	0.95	30	145	
Carbon disulfide	75-15-0	72	NC	36	1.4	10	5.0	2.6	35	160	
Carbon tetrachloride	56-23-5	0.39	5	0.195	ND	2.0	1.0	0.94	65	140	
Chlorobenzene	108-90-7	7.2	100	3.6	ND	2.0	1.0	0.72	80	120	
Chloroethane	75-00-3	2100	NC	1050	ND	2.0	1.0	0.98	60	135	
Chloroform	67-66-3	0.19	80	0.095	0.74	2.0	1.0	0.80	65	135	
Chloromethane	74-87-3	19	NC	9.5	0.14 J	2.0	1.0	0.82	40	125	
cis-1,2-Dichloroethene	156-59-2	2.8	70	1.4	3,000	2.0	1.0	0.53	70	125	
cis-1,3-Dichloropropene	10061-01-5	0.41	NC	0.205	ND	2.0	1.0	0.59	70	130	
Cyclohexane	110-82-7	1300	NC	650	ND	2.0	1.0	0.93	45	147	
Dibromochloromethane	124-48-1	0.15	80	0.075	ND	2.0	1.0	0.44	60	135	
Dichlorodifluoromethane (Freon-12)	75-71-8	19	NC	9.5	0.14 J	2.0	1.0	0.74	30	155	
Ethylbenzene	100-41-4	1.3	700	0.65	0.16 J	2.0	1.0	0.69	75	125	
Isopropylbenzene	98-82-8	39	NC	19.5	ND	2.0	1.0	0.67	75	125	
m- and p-Xylene	m&pXYLENE	19	NC	9.5	ND	4.0	2.0	1.3	75	130	
Methyl acetate	79-20-9	1600	NC	800	ND	2.0	1.0	0.95	24	129	

Worksheet #15-2—Reference Limits and Evaluation Table (continued)

Matrix: Groundwater (new wells)
 Analytical Group: VOCs including 1,4-dioxane
 All units are µg/L

Analyte	CAS #	RSLs Tapwater Adjusted ¹	MCL ¹	Project QL Goal ²	Phase II RI Maximum Detection	Laboratory Limits			LCS and MS/MSD Recovery Limits and RPD ³ (%)		
						LOQ	LOD	DL	LCL	UCL	RPD
Methylcyclohexane	108-87-2	NC	NC	Lab LOD	ND	2.0	1.0	0.64	55	121	
Methylene chloride	75-09-2	8.4	5	2.5	ND	10	5.0	0.71	55	140	
Methyl-tert-butyl ether (MTBE)	1634-04-4	12	NC	6	ND	2.0	1.0	0.60	65	125	
o-Xylene	95-47-6	19	NC	9.5	ND	2.0	1.0	0.53	80	120	
Styrene	100-42-5	110	100	50	ND	2.0	1.0	0.61	65	135	
Tetrachloroethene	127-18-4	3.5	5	1.75	0.21	2.0	1.0	0.76	45	150	
Toluene	108-88-3	86	1000	43	ND	2.0	1.0	0.72	75	120	
trans-1,2-Dichloroethene	156-60-5	8.6	100	4.3	5.6	2.0	1.0	0.73	60	140	
trans-1,3-Dichloropropene	10061-02-6	0.41	NC	0.205	ND	2.0	1.0	0.73	55	140	
Trichloroethene	79-01-6	0.26	5	0.13	18,000	2.0	1.0	0.89	70	125	
Trichlorofluoromethane (Freon-11)	75-69-4	110	NC	55	ND	2.0	1.0	0.94	60	145	
Vinyl chloride	75-01-4	0.015	2	0.0075	3.6	2.0	1.0	0.71	50	145	
1,4-Dioxane ⁴	123-91-1	0.67	NC	0.335	NA	3.0	3.0	1.2	70	130	

Notes:

¹ Refer to Worksheet #11 for specific identification of PALs by matrix. The RSLs shown in this table are from May 2012.

² Project QL goals are equal to half of the minimum applicable PAL.

³ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits: values are bolded to indicate instances where in-house limits are used.

⁴ The VOC 1,4-dioxane will be reported by SW-846 8260B-SIM, all other VOCs will be reported by full scan.

NA - not analyzed

NC indicates that there is no criterion for an analyte.

ND - not detected

Shading indicates instances where the PAL is lower than the LOD. Non-detects will not be treated as exceedances, though they will be reported at a value greater than the PAL.

Worksheet #15-3—Reference Limits and Evaluation Table

Matrix: Surface Water, Pore Water, Seep
 Analytical Group: VOCs including 1,4-dioxane ⁴
 All units are µg/L

Analyte	CAS #	RSLs Tapwater Adjusted, x 10 for SW ¹	Surface Water ESV ¹	Project QL Goal ²	Phase II RI Maximum Detection	Laboratory Limits			LCS and MS/MSD Recovery Limits and RPD ³ (%)		
						LOQ	LOD	DL	LCL	UCL	RPD
1,1,1-Trichloroethane	71-55-6	7500	312	156	ND	2.0	1.0	0.80	65	130	30
1,1,2,2-Tetrachloroethane	79-34-5	0.66	90.2	0.33	ND	2.0	1.0	0.54	65	130	
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	76-13-1	53000	NC	26500	ND	2.0	1.0	0.73	47	173	
1,1,2-Trichloroethane	79-00-5	0.41	550	0.205	ND	2.0	1.0	0.76	75	125	
1,1-Dichloroethane	75-34-3	24	47	12	ND	2.0	1.0	0.62	70	135	
1,1-Dichloroethene	75-35-4	260	2240	130	ND	2.0	1.0	0.94	70	130	
1,2,3-Trichlorobenzene	87-61-6	5.2	NC	2.6	ND	2.0	1.0	0.86	55	140	
1,2,4-Trichlorobenzene	120-82-1	3.9	5.4	1.95	ND	2.0	1.0	0.70	65	135	
1,2-Dibromo-3-chloropropane	96-12-8	0.0032	NC	0.0016	ND	10	5.0	0.96	50	130	
1,2-Dibromoethane	106-93-4	0.065	NC	0.0325	ND	2.0	1.0	0.78	80	120	
1,2-Dichlorobenzene	95-50-1	280	42	21	ND	2.0	1.0	0.73	70	120	
1,2-Dichloroethane	107-06-2	1.5	1130	0.75	ND	2.0	1.0	0.63	70	130	
1,2-Dichloropropane	78-87-5	3.8	2400	1.9	ND	2.0	1.0	0.80	75	125	
1,3-Dichlorobenzene	541-73-1	NC	28.5	14.25	ND	2.0	1.0	0.77	75	125	
1,4-Dichlorobenzene	106-46-7	4.2	19.9	2.1	ND	2.0	1.0	0.76	75	125	
2-Butanone	78-93-3	4900	14000	2450	ND	25	12	4.5	30	150	
2-Hexanone	591-78-6	34	99	17	ND	5.0	2.5	1.4	55	130	
4-Methyl-2-pentanone	108-10-1	1000	123000	500	ND	5.0	2.5	0.79	60	135	
Acetone	67-64-1	12000	564000	6000	ND	25	12	1.8	40	140	

Worksheet #15-3—Reference Limits and Evaluation Table (continued)

Matrix: Surface Water, Pore Water, Seep
 Analytical Group: VOCs including 1,4-dioxane ⁴
 All units are µg/L

Analyte	CAS #	RSLs Tapwater Adjusted, x 10 for SW ¹	Surface Water ESV ¹	Project QL Goal ²	Phase II RI Maximum Detection	Laboratory Limits			LCS and MS/MSD Recovery Limits and RPD ³ (%)		
						LOQ	LOD	DL	LCL	UCL	RPD
Benzene	71-43-2	3.9	110	1.95	ND	2.0	1.0	0.71	80	120	
Bromochloromethane	74-97-5	83	NC	41.5	ND	2.0	1.0	0.94	65	130	
Bromodichloromethane	75-27-4	1.2	NC	0.6	ND	2.0	1.0	0.52	75	120	
Bromoform	75-25-2	79	640	39.5	ND	2.0	1.0	0.75	70	130	
Bromomethane	74-83-9	7	120	3.5	ND	2.0	1.0	0.95	30	145	
Carbon disulfide	75-15-0	720	92	46	0.12 L	10	5.0	2.6	35	160	
Carbon tetrachloride	56-23-5	3.9	1500	1.95	ND	2.0	1.0	0.94	65	140	
Chlorobenzene	108-90-7	72	25	12.5	ND	2.0	1.0	0.72	80	120	
Chloroethane	75-00-3	21000	NC	10500	ND	2.0	1.0	0.98	60	135	
Chloroform	67-66-3	1.9	815	0.95	ND	2.0	1.0	0.80	65	135	
Chloromethane	74-87-3	190	2700	95	0.12 J	2.0	1.0	0.82	40	125	
cis-1,2-Dichloroethene	156-59-2	28	680	14	ND	2.0	1.0	0.53	70	125	
cis-1,3-Dichloropropene	10061-01-5	4.1	7.9	2.05	ND	2.0	1.0	0.59	70	130	
Cyclohexane	110-82-7	13000	NC	6500	0.3 J	2.0	1.0	0.93	45	147	
Dibromochloromethane	124-48-1	1.5	NC	0.75	ND	2.0	1.0	0.44	60	135	
Dichlorodifluoromethane (Freon-12)	75-71-8	190	NC	95	ND	2.0	1.0	0.74	30	155	
Ethylbenzene	100-41-4	13	25	6.5	ND	2.0	1.0	0.69	75	125	
Isopropylbenzene	98-82-8	390	2.6	1.3	ND	2.0	1.0	0.67	75	125	
m- and p-Xylene	m&pXYLENE	190	19	9.5	ND	4.0	2.0	1.3	75	130	

Worksheet #15-3—Reference Limits and Evaluation Table (continued)

Matrix: Surface Water, Pore Water, Seep
 Analytical Group: VOCs including 1,4-dioxane ⁴
 All units are µg/L

Analyte	CAS #	RSLs Tapwater Adjusted, x 10 for SW ¹	Surface Water ESV ¹	Project QL Goal ²	Phase II RI Maximum Detection	Laboratory Limits			LCS and MS/MSD Recovery Limits and RPD ³ (%)		
						LOQ	LOD	DL	LCL	UCL	RPD
Methyl acetate	79-20-9	16000	NC	8000	ND	2.0	1.0	0.95	24	129	
Methylcyclohexane	108-87-2	NC	NC	Lab LOD	ND	2.0	1.0	0.64	55	121	
Methylene chloride	75-09-2	84	2560	42	ND	10	5.0	0.71	55	140	
Methyl-tert-butyl ether (MTBE)	1634-04-4	120	5000	60	ND	2.0	1.0	0.60	65	125	
o-Xylene	95-47-6	190	19	9.5	ND	2.0	1.0	0.53	80	120	
Styrene	100-42-5	1100	910	455	ND	2.0	1.0	0.61	65	135	
Tetrachloroethene	127-18-4	35	45	17.5	ND	2.0	1.0	0.76	45	150	
Toluene	108-88-3	860	215	107.5	ND	2.0	1.0	0.72	75	120	
trans-1,2-Dichloroethene	156-60-5	86	680	43	ND	2.0	1.0	0.73	60	140	
trans-1,3-Dichloropropene	10061-02-6	4.1	7.9	2.05	ND	2.0	1.0	0.73	55	140	
Trichloroethene	79-01-6	2.6	1940	1.3	ND	2.0	1.0	0.89	70	125	
Trichlorofluoromethane (Freon-11)	75-69-4	1100	NC	550	ND	2.0	1.0	0.94	60	145	
Vinyl chloride	75-01-4	0.15	930	0.075	ND	2.0	1.0	0.71	50	145	
1,4-Dioxane	123-91-1	6.7	NC	3.3	NS	3.0	3.0	1.2	70	130	30

Notes:

ND - not detected

NS - not sampled

¹ Refer to Worksheet #11 for specific identification of PALs by matrix (seep samples do not have PALs as they will be evaluated qualitatively). The RSLs shown in this table are from May 2012.

² Project QL goals are equal to half of the minimum applicable PAL.

³ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits: values are bolded to indicate instances where in-house limits are used.

⁴ The VOC 1,4-dioxane will be reported by SW-846 8260B-SIM, all other VOCs will be reported by full scan.

NC indicates that there is no criterion for an analyte.

Shading indicates instances where the PAL is lower than the LOD. Non-detects will not be treated as exceedances, though they will be reported at a value greater than the PAL.

Worksheet #15-4—Reference Limits and Evaluation Table

Matrix: Groundwater
 Analytical Group: Metals
 All units are µg/L

Analyte	CAS #	RSLs Tapwater Adjusted ¹	MCL ¹	Yorktown-Eastover Aquifer Background ²	Phase II RI Maximum Detection	Project QL Goal ³	Laboratory Limits			LCS and MS/MSD Recovery Limits and RPD ⁴ (%)		
							LOQ	LOD	DL	LCL	UCL	RPD
Aluminum	7429-90-5	1600	NC	2230	4,960	800	50.0	25.0	6.80	80	120	20
Antimony	7440-36-0	0.6	6	18.8	10.1	0.3	2.00	0.440	0.110			
Arsenic	7440-38-2	0.045	10	2.28	26.6	0.0225	20.0	10.0	0.610			
Barium	7440-39-3	290	2000	118	167 J	59	10.0	8.00	2.00			
Beryllium	7440-41-7	1.6	4	2.45	0.73 J	0.8	0.740	0.370	0.0940			
Cadmium	7440-43-9	0.69	5	0.605	11.4	0.3025	8.00	4.00	0.110			
Calcium	7440-70-2	NC	NC	169000	ND	84500	2400	1200	36.0			
Chromium	7440-47-3	0.031	100	15.1	35.2	0.0155	6.00	3.00	0.450			
Cobalt	7440-48-4	0.47	NC	20.6	11	0.235	1.00	0.840	0.210			
Copper	7440-50-8	62	1300	12.2	9.1	6.1	1.00	0.880	0.220			
Iron	7439-89-6	1100	NC	894	13,500	447	30.0	15.0	3.80			
Lead	7439-92-1	15	15	21.3	6 L	7.5	1.20	0.600	0.160			
Magnesium	7439-95-4	NC	NC	11500	ND	5750	240	120	30.0			
Manganese	7439-96-5	32	NC	57.9	705	16	2.56	1.28	0.320			
Mercury	7439-97-6	0.43	2	0.081	ND	0.0405	0.200	0.0690	0.0230			
Nickel	7440-02-0	30	NC	11.4	5.6 J	5.7	2.40	1.20	0.320			
Potassium	7440-09-7	NC	NC	12700	ND	6350	3500	1750	48.0			
Selenium	7782-49-2	7.8	50	NC	2.8 J	3.9	5.20	2.60	0.650			
Silver	7440-22-4	7.1	NC	NC	ND	3.55	0.240	0.120	0.0290			
Sodium	7440-23-5	NC	NC	64500	ND	32250	240	120	32.0			

Worksheet #15-4—Reference Limits and Evaluation Table (continued)

Matrix: Groundwater
 Analytical Group: Metals
 All units are µg/L

Analyte	CAS #	RSLs Tapwater Adjusted ¹	MCL ¹	Yorktown-Eastover Aquifer Background ²	Phase II RI Maximum Detection	Project QL Goal ³	Laboratory Limits			LCS and MS/MSD Recovery Limits and RPD ⁴ (%)		
							LOQ	LOD	DL	LCL	UCL	RPD
Thallium	7440-28-0	0.016	2	NC	ND	0.008	0.460	0.230	0.0580			
Vanadium	7440-62-2	7.8	NC	26.2	33.5	3.9	1.00	0.800	0.200			
Zinc	7440-66-6	470	NC	4.52	2,210	2.26	12.0	6.00	1.60			
Cyanide	57-12-5	0.93	200	NC	ND	0.465	22	11	3.8	85	115	20

Notes:

- ¹ Refer to Worksheet #11 for specific identification of PALs by matrix. The RSLs shown in this table are from May 2012.
 - ² The background values are 95 percent UTL values, except in cases where 95 percent UTLs were not evaluated, the max detection in a background sample is shown; max background values are bolded and italicized.
 - ³ Project QL goals are equal to half of the minimum applicable PAL.
 - ⁴ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits: values are bolded to indicate instances where in-house limits are used.
- NC indicates that there is no criterion for an analyte.
 ND indicates that the analyte was not detected in the Phase II RI.

Shading indicates instances where the PAL is lower than the LOD. Non-detects will not be treated as exceedances, though they will be reported at a value greater than the PAL.

Worksheet #15-5—Reference Limits and Evaluation Table

Matrix: Groundwater

Analytical Group: Dissolved Metals

All units are µg/L

Analyte	CAS #	RSLs Tapwater Adjusted ¹	MCL ¹	Yorktown-Eastover Aquifer Background ²	Phase II RI Maximum Detection	Project QL Goal ³	Laboratory Limits			LCS and MS/MSD Recovery Limits and RPD ⁴ (%)		
							LOQ	LOD	DL	LCL	UCL	RPD
Aluminum	7429-90-5	1600	NC	100	1,810	50	50.0	25.0	6.80	80	120	20
Antimony	7440-36-0	0.6	6	9.7	ND	0.3	2.00	0.440	0.110			
Arsenic	7440-38-2	0.045	10	1.37	28.6	0.0225	20.0	10.0	0.610			
Barium	7440-39-3	290	2000	127	162 J	63.5	10.0	8.00	2.00			
Beryllium	7440-41-7	1.6	4	NC	ND	0.8	0.740	0.370	0.0940			
Cadmium	7440-43-9	0.69	5	0.177	13	0.0885	8.00	4.00	0.110			
Calcium	7440-70-2	NC	NC	113000	ND	56500	2400	1200	36.0			
Chromium	7440-47-3	0.031	100	6.04	1.4 J	0.0155	6.00	3.00	0.450			
Cobalt	7440-48-4	0.47	NC	0.7	13.7	0.235	1.00	0.840	0.210			
Copper	7440-50-8	62	1300	3	21.6	1.5	1.00	0.880	0.220			
Iron	7439-89-6	1100	NC	275	8,000	137.5	30.0	15.0	3.80			
Lead	7439-92-1	15	15	1.7	5.3	0.85	1.20	0.600	0.160			
Magnesium	7439-95-4	NC	NC	11200	ND	5600	240	120	30.0			
Manganese	7439-96-5	32	NC	49.5	233	16	2.56	1.28	0.320			
Mercury	7439-97-6	0.43	2	0.1	0.15 L	0.05	0.200	0.0690	0.0230			
Nickel	7440-02-0	30	NC	12.2	9 J	6.1	2.40	1.20	0.320			
Potassium	7440-09-7	NC	NC	12600	ND	6300	3500	1750	48.0			
Selenium	7782-49-2	7.8	50	9.1	19.3 K	3.9	5.20	2.60	0.650			
Silver	7440-22-4	7.1	NC	NC	ND	3.55	0.240	0.120	0.0290			

Worksheet #15-5—Reference Limits and Evaluation Table

Matrix: Groundwater
 Analytical Group: Dissolved Metals
 All units are µg/L

Analyte	CAS #	RSLs Tapwater Adjusted ¹	MCL ¹	Yorktown-Eastover Aquifer Background ²	Phase II RI Maximum Detection	Project QL Goal ³	Laboratory Limits			LCS and MS/MSD Recovery Limits and RPD ⁴ (%)		
							LOQ	LOD	DL	LCL	UCL	RPD
Sodium	7440-23-5	NC	NC	62800	ND	31400	240	120	32.0			
Thallium	7440-28-0	0.016	2	NC	ND	0.008	0.460	0.230	0.0580			
Vanadium	7440-62-2	7.8	NC	4.3	4.4 J	2.15	1.00	0.800	0.200			
Zinc	7440-66-6	470	NC	NC	2,470	235	12.0	6.00	1.60			

Notes:

- ¹ Refer to Worksheet #11 for specific identification of PALs by matrix. The RSLs shown in this table are from May 2012.
 - ² The background values are 95 percent UTL values, except in cases where 95 percent UTLs were not evaluated, the max detection in a background sample is shown; max background values are bolded and italicized.
 - ³ Project QL goals are equal to half of the minimum applicable PAL.
 - ⁴ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits: values are bolded to indicate instances where in-house limits are used.
- J - Analyte present. Value may or may not be accurate or precise
 K - Analyte present. Value may be biased high or actual value may be lower
 L - Analyte present. Value may be biased low, actual value may be higher
 NC indicates that there is no criterion for an analyte.
 ND - not detected

Shading indicates instances where the PAL is lower than the LOD. Non-detects will not be treated as exceedances, though they will be reported at a value greater than the PAL.

Worksheet #15-6—Reference Limits and Evaluation Table

Matrix: Surface Water, Sediment Pore Water, Seeps

Analytical Group: Metals, Cyanide

All units are µg/L

Analyte	CAS #	RSLs Tapwater Adjusted, x 10 for SW ¹	Surface Water ESV ¹	Project QL Goal ²	Laboratory Limits			LCS and MS/MSD Recovery Limits and RPD ³ (%)		
					LOQ	LOD	DL	LCL	UCL	RPD
Aluminum	7429-90-5	1600	87	43.5	50	25	6.8	80	120	20
Antimony	7440-36-0	0.6	500	0.3	2	0.44	0.11			
Arsenic	7440-38-2	0.045	36	0.0225	20	10	0.61			
Barium	7440-39-3	290	200	100	10	8	2			
Beryllium	7440-41-7	1.6	100	0.8	0.74	0.37	0.094			
Cadmium	7440-43-9	0.69	8.85	0.345	8	4	0.11			
Calcium	7440-70-2	NC	NC	Lab LOD	2400	1200	36			
Chromium	7440-47-3	0.031	50.4	0.0155	6	3	0.45			
Cobalt	7440-48-4	0.47	23	0.235	1	0.84	0.21			
Copper	7440-50-8	62	3.73	1.865	1	0.88	0.22			
Iron	7439-89-6	1100	1000	500	30	15	3.8			
Lead	7439-92-1	15	8.52	4.26	1.2	0.6	0.16			
Magnesium	7439-95-4	NC	NC	Lab LOD	240	120	30			
Manganese	7439-96-5	32	100	16	2.56	1.28	0.32			
Mercury	7439-97-6	0.43	1.11	0.215	0.2	0.069	0.023			
Nickel	7440-02-0	30	8.28	4.14	2.4	1.2	0.32			
Potassium	7440-09-7	NC	NC	Lab LOD	3500	1750	48			
Selenium	7782-49-2	7.8	71.1	3.9	5.2	2.6	0.65			
Silver	7440-22-4	7.1	0.23	0.115	0.24	0.12	0.029			

Worksheet #15-6—Reference Limits and Evaluation Table (continued)

Matrix: Surface Water, Sediment Pore Water, Seeps

Analytical Group: Metals, Cyanide

All units are µg/L

Analyte	CAS #	RSLs Tapwater Adjusted, x 10 for SW ¹	Surface Water ESV ¹	Project QL Goal ²	Laboratory Limits			LCS and MS/MSD Recovery Limits and RPD ³ (%)		
					LOQ	LOD	DL	LCL	UCL	RPD
Sodium	7440-23-5	NC	NC	Lab LOD	240	120	32			
Thallium	7440-28-0	0.016	21.3	0.008	0.46	0.23	0.058			
Vanadium	7440-62-2	7.8	50	3.9	1	0.8	0.2			
Zinc	7440-66-6	470	85.6	42.8	12	6	1.6			
Cyanide	57-12-5	0.14	1	0.07	22	11	3.8	85	115	20

Notes:

¹ Refer to **Worksheet #11** for specific identification of PALs by matrix. The RSLs shown in this table are from May 2012.

² Project QL goals are equal to half of the minimum applicable PAL.

³ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits: values are bolded to indicate instances where in-house limits are used.

NC indicates that there is no criterion for an analyte.

Shading indicates instances where the PAL is lower than the LOD. Non-detects will not be treated as exceedances, though they will be reported at a value greater than the PAL.

Worksheet #15-7—Reference Limits and Evaluation Table

Matrix: Surface Water, Sediment Pore Water, Seeps

Analytical Group: Dissolved Metals

All units are µg/L

Analyte	CAS #	RSLs Tapwater Adjusted, x 10 for SW ¹	Surface Water ESV ¹	Project QL Goal ²	Laboratory Limits			LCS and MS/MSD Recovery Limits and RPD ³ (%)		
					LOQ	LOD	DL	LCL	UCL	RPD
Aluminum	7429-90-5	1600	87	43.5	50	25	6.8	80	120	20
Antimony	7440-36-0	0.6	500	0.3	2	0.44	0.11			
Arsenic	7440-38-2	0.045	36	0.0225	20	10	0.61			
Barium	7440-39-3	290	200	100	10	8	2			
Beryllium	7440-41-7	1.6	100	0.8	0.74	0.37	0.094			
Cadmium	7440-43-9	0.69	8.8	0.345	8	4	0.11			
Calcium	7440-70-2	NC	NC	Lab LOD	2400	1200	36			
Chromium	7440-47-3	0.031	50	0.0155	6	3	0.45			
Cobalt	7440-48-4	0.47	23	0.235	1	0.84	0.21			
Copper	7440-50-8	62	3.1	1.55	1	0.88	0.22			
Iron	7439-89-6	1100	1000	500	30	15	3.8			
Lead	7439-92-1	15	8.1	4.05	1.2	0.6	0.16			
Magnesium	7439-95-4	NC	NC	Lab LOD	240	120	30			
Manganese	7439-96-5	32	100	16	2.56	1.28	0.32			
Mercury	7439-97-6	0.43	0.94	0.215	0.2	0.069	0.023			
Nickel	7440-02-0	30	8.2	4.1	2.4	1.2	0.32			
Potassium	7440-09-7	NC	NC	Lab LOD	3500	1750	48			
Selenium	7782-49-2	7.8	71	3.9	5.2	2.6	0.65			
Silver	7440-22-4	7.1	0.23	0.115	0.24	0.12	0.029			

Worksheet #15-7—Reference Limits and Evaluation Table

Matrix: Surface Water, Sediment Pore Water, Seeps

Analytical Group: Dissolved Metals

All units are µg/L

Analyte	CAS #	RSLs Tapwater Adjusted, x 10 for SW ¹	Surface Water ESV ¹	Project QL Goal ²	Laboratory Limits			LCS and MS/MSD Recovery Limits and RPD ³ (%)		
					LOQ	LOD	DL	LCL	UCL	RPD
Sodium	7440-23-5	NC	NC	Lab LOD	240	120	32			
Thallium	7440-28-0	0.016	21.3	0.008	0.46	0.23	0.058			
Vanadium	7440-62-2	7.8	50	3.9	1	0.8	0.2			
Zinc	7440-66-6	470	81	40.5	12	6	1.6			
Cyanide	57-12-5	0.14	1	0.07	22	11	3.8	85	115	20

Notes:

¹ Refer to Worksheet #11 for specific identification of PALs by matrix. The RSLs shown in this table are from May 2012.

² Project QL goals are equal to half of the minimum applicable PAL.

³ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits: values are bolded to indicate instances where in-house limits are used.

NC indicates that there is no criterion for an analyte.

Shading indicates instances where the PAL is lower than the LOD. Non-detects will not be treated as exceedances, though they will be reported at a value greater than the PAL.

Worksheet #15-8—Reference Limits and Evaluation Table

Matrix: Groundwater

Analytical Group: Wet Chemistry

Units are as noted below

Analyte	CAS # ³	Project Indicator Limit ¹	Project QL Goal	Units	Laboratory Limits			LCS and MS/MSD Recovery Limits and RPD ² (%)		
					LOQ	LOD	DL	LCL	UCL	RPD
Ethane	74-84-0	NC	Lab LOD	UG_L	2.00	1.96	0.20	75	123	14
Ethene	74-85-1	NC	Lab LOD	UG_L	3.00	2.71	0.54	72	131	12
Methane	74-82-8	>500	Lab LOD	UG_L	1.00	0.95	0.43	74	120	18
Alkalinity	471-34-1	> 50	Lab LOD	MG_L	2	2	2	90	110	10
Chloride	16887-00-6	evaluate by trend	Lab LOD	MG_L	5.0	1.2	0.29	90	110	10
Nitrate	14797-55-8	evaluate by trend	Lab LOD	MG_L	1.0	0.21	0.052	90	110	10
Nitrite	14797-65-0	evaluate by trend	Lab LOD	MG_L	0.10	0.044	0.035	90	110	10
Sulfate	14808-79-8	<20	Lab LOD	MG_L	5.0	0.26	0.066	61	138	22
Sulfide	12597-04-5	>1	Lab LOD	MG_L	1.0	1.0	0.45	86	105	10
TOC	TOC	>20	Lab LOD	MG_L	10	0.66	0.22	85	115	21

Notes:

¹ Refer to Worksheet #11 (Table 3) for specific identification of the data-use for wet chemistry analytes.

² DoD QSM v.4.2 is the basis for LCS and MS/MSD limits: values are bolded to indicate instances where in-house limits are used.

³ In some instances a contractor-specific identifier is shown.

NC indicates that there is no criterion for an analyte.

Worksheet #15-9—Reference Limits and Evaluation Table

Matrix: Surface Water, Sediment Pore Water, Seeps

Analytical Group: Wet Chemistry¹

All units are mg/L

Analyte	CAS #	Project Indicator Limit ¹	Project QL Goal	Laboratory Limits			LCS and MS/MSD Recovery Limits and RPD ³ (%)		
				LOQ	LOD	DL	LCL	UCL	RPD
Hardness	HARDNESS	0-75, 75-150, 150-300, and 300 & up	Lab LOD	2	2	2	90	110	10
Total dissolved solids (TDS)	TDS	10,000	Lab LOD	10	10	10	90	110	10

Notes:

¹ Surface water ecological screening values for some target analytes are dependent on the hardness of the media. Hardness data will be used to support the ERA (Refer to Worksheet #11, Table 3).

² DoD QSM v.4.2 is the basis for LCS and MS/MSD limits: values are bolded to indicate instances where in-house limits are used.

³ In some instances a contractor-specific identifier is shown.

Worksheet #15-10—Reference Limits and Evaluation Table

Matrix: Groundwater

Analytical Group: Microbial

All units are cells per mL

Analyte	CAS # ²	Project Indicator Limit ¹	Laboratory Limits		
			LOQ	LOD	DL
DHC	DHC	>10 ³	0.5	0.1	0.1
VC R-Dase	VC-R	NC	0.5	0.1	0.1
TCE R-Dase	TCE-R	NC	0.5	0.1	0.1
BAV1-R-Dase	BAV1-F	NC	0.5	0.1	0.1

Notes:

¹ Microbial census data will be used to evaluate the suitability of the microbial community for reductive dechlorination (Refer to Worksheet #11, Table 3).

² In some instances a contractor-specific identifier is shown.

NC indicates that there is no criterion for an analyte.

Worksheet #15-11 - Reference Limits and Evaluation Table

Matrix: Sediment

Analytical Group: VOCs including 1,4-Dioxane

All units are mg/kg

Analyte	CAS Number	RSLs Residential Soil Adjusted, x 10 for SD ¹	Sediment ESV ¹	Project QL Goal ^{2,3}	Laboratory Limits			LCS and MS/MSD Recovery Limits and RPD ⁴ (%)		
					LOQ	LOD	DL	LCL	UCL	RPD
1,1,1-Trichloroethane	71-55-6	640	3.159	1.5795	0.0020	0.0010	0.0004	70	135	30
1,1,2,2-Tetrachloroethane	79-34-5	5.6	0.745	0.3725	0.0020	0.0010	0.0003	55	130	
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	76-13-1	910	NC	455	0.0020	0.0010	0.0006	70	130	
1,1,2-Trichloroethane	79-00-5	1.6	2.103	0.8	0.0020	0.0010	0.0006	60	125	
1,1-Dichloroethane	75-34-3	33	0.0996	0.0498	0.0020	0.0010	0.0006	75	125	
1,1-Dichloroethene	75-35-4	240	10.266	5.133	0.0020	0.0010	0.0006	65	135	
1,2,3-Trichlorobenzene	87-61-6	49	NC	24.5	0.0020	0.0010	0.0009	60	135	
1,2,4-Trichlorobenzene	120-82-1	62	1.745	0.8725	0.0020	0.0010	0.0008	65	130	
1,2-Dibromo-3-chloropropane	96-12-8	0.054	NC	0.027	0.0020	0.0010	0.0006	40	135	
1,2-Dibromoethane	106-93-4	0.34	NC	0.17	0.0020	0.0010	0.0003	70	125	
1,2-Dichlorobenzene	95-50-1	380	3.649	1.8245	0.0020	0.0010	0.0004	75	120	
1,2-Dichloroethane	107-06-2	4.3	0.923	0.4615	0.0020	0.0010	0.0003	70	135	
1,2-Dichloropropane	78-87-5	9.4	NC	4.7	0.0020	0.0010	0.0006	70	120	
1,3-Dichlorobenzene	541-73-1	NC	3.107	1.5535	0.0020	0.0010	0.0005	70	125	
1,4-Dichlorobenzene	106-46-7	24	0.11	0.055	0.0020	0.0010	0.0004	70	125	
2-Butanone	78-93-3	28000	NC	14000	0.0050	0.0025	0.0018	30	160	
2-Hexanone	591-78-6	210	NC	105	0.0050	0.0025	0.0009	45	145	
4-Methyl-2-pentanone	108-10-1	3400	NC	1700	0.0050	0.0025	0.0014	45	145	
Acetone	67-64-1	61000	NC	30500	0.025	0.012	0.0017	20	160	

Worksheet #15-11 - Reference Limits and Evaluation Table (continued)

Matrix: Sediment

Analytical Group: VOCs including 1,4-Dioxane

All units are mg/kg

Analyte	CAS Number	RSLs Residential Soil Adjusted, x 10 for SD ¹	Sediment ESV ¹	Project QL Goal ^{2,3}	Laboratory Limits			LCS and MS/MSD Recovery Limits and RPD ⁴ (%)		
					LOQ	LOD	DL	LCL	UCL	RPD
Benzene	71-43-2	11	0.506	0.253	0.0020	0.0010	0.0004	75	125	
Bromochloromethane	74-97-5	160	NC	80	0.0020	0.0010	0.0004	70	125	
Bromodichloromethane	75-27-4	2.7	NC	1.35	0.0020	0.0010	0.0004	70	130	
Bromoform	75-25-2	620	4.827	2.4135	0.0020	0.0010	0.0003	55	135	
Bromomethane	74-83-9	7.3	NC	3.65	0.0020	0.0010	0.0009	30	160	
Carbon disulfide	75-15-0	740	0.00314	0.00157	0.010	0.0050	0.0021	45	160	
Carbon tetrachloride	56-23-5	6.1	26.73	3.05	0.0020	0.0010	0.0006	65	135	
Chlorobenzene	108-90-7	290	0.598	0.299	0.0020	0.0010	0.0005	75	125	
Chloroethane	75-00-3	2100	NC	1050	0.0020	0.0010	0.0005	40	155	
Chloroform	67-66-3	2.9	0.0812	0.0406	0.0020	0.0010	0.0004	70	125	
Chloromethane	74-87-3	120	NC	60	0.0020	0.0010	0.0006	50	130	
cis-1,2-Dichloroethene	156-59-2	160	1.476	0.738	0.0020	0.0010	0.0005	65	125	
cis-1,3-Dichloropropene	10061-01-5	17	0.027	0.0135	0.0020	0.0010	0.0003	70	125	
Cyclohexane	110-82-7	120	NC	60	0.0020	0.0010	0.0005	70	130	
Dibromochloromethane	124-48-1	6.8	NC	3.4	0.0020	0.0010	0.0003	65	130	
Dichlorodifluoromethane (Freon-12)	75-71-8	94	NC	47	0.0020	0.0010	0.0006	35	135	
Ethylbenzene	100-41-4	54	1.125	0.5625	0.0020	0.0010	0.0006	75	125	
Isopropylbenzene	98-82-8	270	0.317	0.1585	0.0020	0.0010	0.0005	75	130	
m- and p-Xylene	m&pXYLENE	390	0.59	0.295	0.0040	0.0020	0.0010	80	125	

Worksheet #15-11 - Reference Limits and Evaluation Table (continued)

Matrix: Sediment

Analytical Group: VOCs including 1,4-Dioxane

All units are mg/kg

Analyte	CAS Number	RSLs Residential Soil Adjusted, x 10 for SD ¹	Sediment ESV ¹	Project QL Goal ^{2,3}	Laboratory Limits			LCS and MS/MSD Recovery Limits and RPD ⁴ (%)		
					LOQ	LOD	DL	LCL	UCL	RPD
Methyl acetate	79-20-9	29000	NC	14500	0.010	0.0050	0.0016	70	130	
Methylcyclohexane	108-87-2	NC	NC	Lab LOD	0.0020	0.0010	0.0005	70	130	
Methylene chloride	75-09-2	360	1.365	0.6825	0.010	0.0050	0.0007	55	140	
Methyl-tert-butyl ether (MTBE)	1634-04-4	430	NC	215	0.0020	0.0010	0.0003	58	123	
o-Xylene	95-47-6	430	0.59	0.295	0.0020	0.0010	0.0005	75	125	
Styrene	100-42-5	870	26.085	13.0425	0.0020	0.0010	0.0004	75	125	
Tetrachloroethene	127-18-4	86	0.057	0.0285	0.0020	0.0010	0.0005	65	140	
Toluene	108-88-3	820	4.007	2.0035	0.0020	0.0010	0.0005	70	125	
trans-1,2-Dichloroethene	156-60-5	150	1.476	0.738	0.0020	0.0010	0.0007	65	135	
trans-1,3-Dichloropropene	10061-02-6	17	0.027	0.0135	0.0020	0.0010	0.0003	65	125	
Trichloroethene	79-01-6	4.4	0.041	0.0205	0.0020	0.0010	0.0005	75	125	
Trichlorofluoromethane (Freon-11)	75-69-4	790	NC	395	0.0020	0.0010	0.0005	25	185	
Vinyl chloride	75-01-4	0.6	NC	0.3	0.0020	0.0010	0.0004	60	125	
1,4-Dioxane ⁵	123-91-1	49	NC	24	0.10	0.050	0.0055	44	134	

Notes:

¹ Refer to Worksheet #11 for specific identification of PALs by matrix. The Residential Soil RSLs shown in this table are from May 2012.

² PALs and Project QL Goals assume dry weight basis.

³ Project QL goals are equal to half of the minimum applicable PAL.

⁴ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits: values are bolded to indicate instances where in-house limits are used.

⁵ 1,4-dioxane will be analyzed by the same method as all other VOCs in sediment.

NC indicates that there is no criterion for an analyte.

Shading indicates instances where the PAL is lower than the LOD. Non-detects will not be treated as exceedances, though they will be reported at a value greater than the PAL.

Worksheet #15-12—Reference Limits and Evaluation Table

Matrix: Sediment
 Analytical Group: Metals
 All units are mg/kg

Analyte	CAS Number	RSLs Residential Soil Adjusted, x 10 for SD ¹	Sediment ESV ¹	Project QL Goal ^{2,3}	Phase II RI Maximum Detection	Laboratory Limits ³			LCS and MS/MSD Recovery Limits and RPD ⁴ (%)		
						LOQ	LOD	DL	LCL	UCL	RPD
Aluminum	7429-90-5	77000	18000	9000	25,600	10.0	5.00	1.90	80	120	20
Antimony	7440-36-0	31	2	1	ND	2.00	1.00	0.190			
Arsenic	7440-38-2	3.9	8.2	1.95	11.6 L	2.00	1.00	0.260			
Barium	7440-39-3	15000	48	24	47.6 J	0.500	0.250	0.0110			
Beryllium	7440-41-7	160	NC	80	1.5 J	0.0500	0.0250	0.00610			
Cadmium	7440-43-9	70	1.2	0.6	ND	0.100	0.0500	0.0140			
Calcium	7440-70-2	NC	NC	Lab LOD	ND	25.0	6.25	1.90			
Chromium	7440-47-3	2.9	81	1.45	51.6 L	0.500	0.250	0.0290			
Cobalt	7440-48-4	23	10	5	8.9	0.500	0.250	0.0230			
Copper	7440-50-8	3100	34	17	28.9	0.500	0.250	0.0760			
Iron	7439-89-6	55000	220000	27500	40,000	10.0	5.00	1.50			
Lead	7439-92-1	4000	46.7	23.35	29.6 J	1.00	0.500	0.100			
Magnesium	7439-95-4	NC	NC	Lab LOD	ND	25.0	6.25	1.80			
Manganese	7439-96-5	1800	260	130	316 L	1.00	0.500	0.0260			
Mercury	7439-97-6	23	0.15	0.075	0.069 J	0.0480	0.0240	0.0110			
Nickel	7440-02-0	1500	20.9	10.45	23	0.500	0.250	0.0200			
Potassium	7440-09-7	NC	NC	Lab LOD	ND	50.0	25.0	4.10			
Selenium	7782-49-2	390	1	0.5	ND	2.00	1.00	0.310			
Silver	7440-22-4	390	1	0.5	ND	0.500	0.250	0.0590			

Worksheet #15-12—Reference Limits and Evaluation Table (continued)

Matrix: Sediment
 Analytical Group: Metals
 All units are mg/kg

Analyte	CAS Number	RSLs Residential Soil Adjusted, x 10 for SD ¹	Sediment ESV ¹	Project QL Goal ^{2,3}	Phase II RI Maximum Detection	Laboratory Limits ³			LCS and MS/MSD Recovery Limits and RPD ⁴ (%)		
						LOQ	LOD	DL	LCL	UCL	RPD
Sodium	7440-23-5	NC	NC	Lab LOD	ND	25.0	6.25	2.70			
Thallium	7440-28-0	0.78	NC	0.39	ND	1.00	0.500	0.140			
Vanadium	7440-62-2	390	57	28.5	62.3 L	1.00	0.250	0.0460			
Zinc	7440-66-6	23000	150	75	125 L	1.00	0.500	0.190			
Cyanide	57-12-5	47	NC	23.5	ND	0.062	0.18	0.48	85	115	20

Notes:

¹ Refer to Worksheet #11 for specific identification of PALs by matrix. The Residential Soil RSLs shown in this table are from May 2012.

² PALs and Project QL Goals assume dry weight basis.

³ Project QL goals are equal to half of the minimum applicable PAL.

⁴ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits: values are bolded to indicate instances where in-house limits are used.

J - Analyte present. Value may or may not be accurate or precise

L - Analyte present. Value may be biased low, actual value may be higher

NC indicates that there is no criterion for an analyte.

ND - not detected

Worksheet #15-13—Reference Limits and Evaluation Table

Matrix: Sediment

Analytical Group: Wet Chemistry

Units are as noted below

Analyte	CAS Number ²	Project Indicator Limit ¹	Units	Laboratory Limits			LCS and MS/MSD Recovery Limits and RPD ³ (%)		
				LOQ	LOD	DL	LCL	UCL	RPD
TOC	TOC	2000	MG_KG	500	500	500	50	150	25
pH	PH	5 < pH > 8	pH	1	1	1	90	110	10
Alkalinity	471-34-1	>50 mg/L	MG_KG	20	20	20	90	110	10

Notes:

¹ TOC data in sediment will be used to adjust equilibrium partitioning-based ecological screening values and to evaluate habitat conditions.

² In some instances a contractor-specific identifier is shown.

³ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits: values are bolded to indicate instances where in-house limits are used.

NC indicates that there is no criterion for an analyte.

Worksheet #15-14—Reference Limits and Evaluation Table

Matrix: Sediment
 Analytical Group: AVS/SEM¹
 All units are umol/g

Analyte	CAS Number ²	Project QL Goal ³	Laboratory-Specific			LCS and MS/MSD Recovery Limits and RPD ³ (%)		
			LOQ	LOD ⁴	DL	LCL	UCL	RPD
AVS	ACIDSO2	Lab LOD	0.09	NA	0.0758	10	183	30
Cadmium	7440-43-9	Lab LOD	0.00044	NA	0.00006	LCS: 80 MS: 75	LCS: 120 MS: 125	20
Copper	7440-50-8	Lab LOD	0.0031	NA	0.0012			
Lead	7439-92-1	Lab LOD	0.0024	NA	0.0002			
Mercury	7439-97-6	Lab LOD	0.00001	NA	9.2E-07			
Nickel	7440-02-0	Lab LOD	0.00682	NA	0.00071			
Silver	7440-22-4	Lab LOD	0.00093	NA	0.00009			
Zinc	7440-66-6	Lab LOD	0.031	NA	0.011			

Notes:

- ¹ The ratio of SEM/AVS will be used to evaluate the potential bioavailability of certain metals in sediment.
- ² In some instances a contractor-specific identifier is shown.
- ³ There are no action limits or PQL goals for AVS/SEM.
- ⁴ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits: values are bolded to indicate instances where in-house limits are used.

Worksheet #15-15—Reference Limits and Evaluation Table

Matrix: Sediment

Analytical Group: Grain-size¹

Units are as noted below

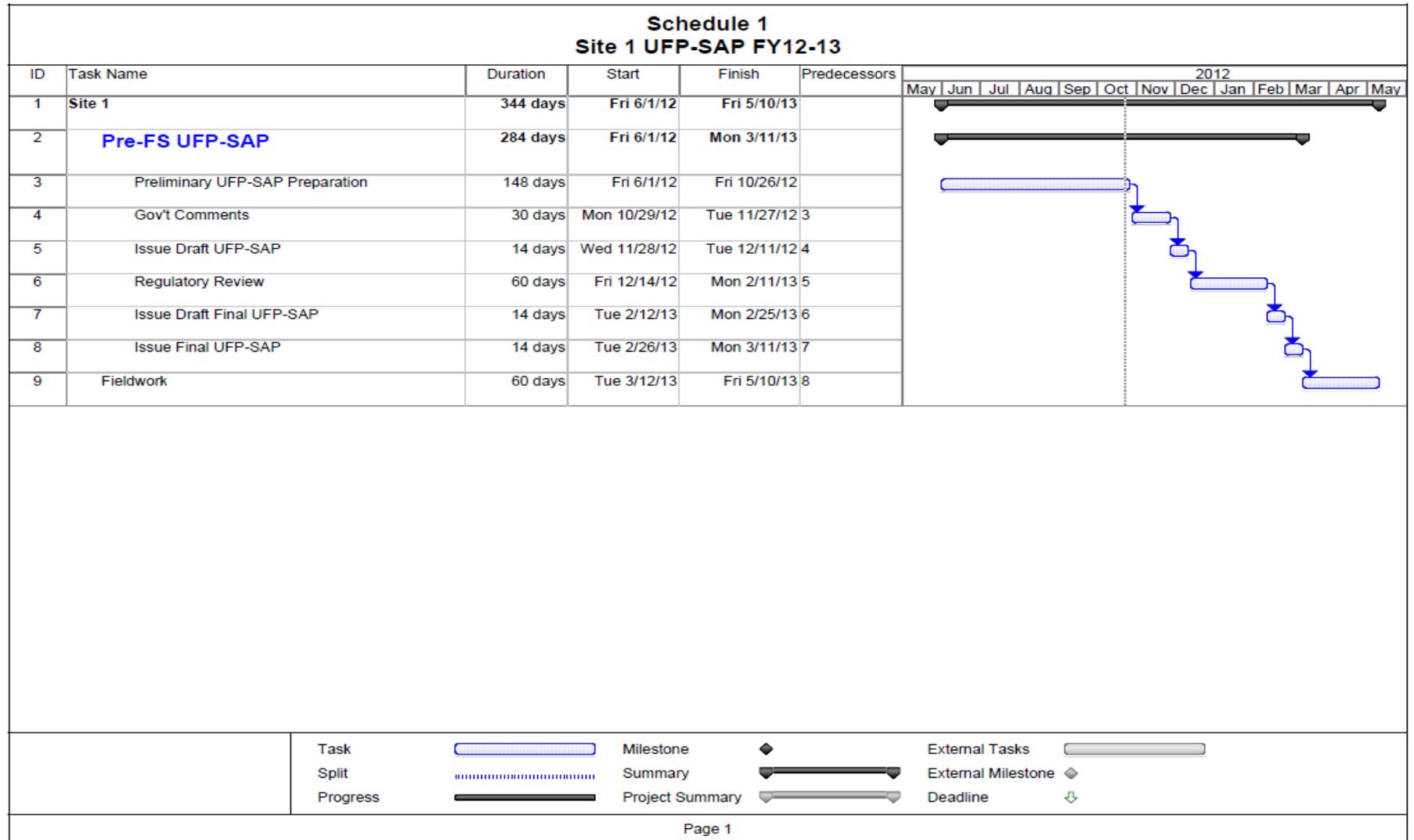
Analyte	CAS Number ²	Units
GS03 Sieve 3" (75 mm)	SIEVE75.0	PCT_P
GS05 Sieve 2" (50 mm)	SIEVE50.0	PCT_P
GS06 Sieve 1.5" (37.5 mm)	SIEVE37.5	PCT_P
GS07 Sieve 1" (25.0 mm)	SIEVE25.0	PCT_P
GS08 Sieve 0.75" (19.0 mm)	SIEVE19.0	PCT_P
GS10 Sieve 0.5" (12.5 mm)	SIEVE12.5	PCT_P
GS10 Sieve 0.375" (9.5 mm)	SIEVE9.5	PCT_P
Sieve No. 004 (4.75 mm)	SIEVE4.75	PCT_P
Sieve No. 010 (2.00 mm)	SIEVE2.0	PCT_P
Sieve No. 020 (850 µm)	SIEVE850	PCT_P
Sieve No. 040 (425 µm)	SIEVE425	PCT_P
Sieve No. 060 (250 µm)	SIEVE250	PCT_P
Sieve No. 140 (160 µm)	SIEVE160	PCT_P
Sieve No. 200 (75 µm)	SIEVE75	PCT_P
Gravel (%)	GRAVEL	PCT
Sand (%)	14808-60-7	PCT
Coarse Sand (%)	COARSESAND	PCT
Medium Sand (%)	MEDIUMSAND	PCT
Fine Sand (%)	FINESAND	PCT
Fines (%)	FINES	PCT

Notes:

¹ Grain-size data will be used to characterize sediment conditions in terms of habitat for certain invertebrates, and to compare site to reference habitat conditions.

² Contractor-specific identifiers are shown.

SAP Worksheet #16—Project Schedule/Timeline Table



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SAP Worksheet #17—Sampling Design and Rationale

See **Worksheet #11**, specifically **Table 5**, for details on sampling design and rationale.

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

Sampling Station	Sample ID	Matrix	Depth	Analytical Group	Number of Samples	Sampling SOP Reference ¹
YS03-GW029	YS03-GW029-MMY	GW	2 feet from bottom of well screen	Select VOCs, 1,4-dioxane, MEE, CNNS, Sulfide, TOC, Alkalinity	1	012_WaterQual 013_MWSamp-EPA Reg 014_LowFlow-EPA Reg I&III&III 020_VOCAq
YS01-GW004	YS01-GW004-MMY				3 (includes MS/MSD)	
YS01-GW004A	YS01-GW004A-MMY				1	
YS01-GW005	YS01-GW005-MMY				1	
YS01-GW005A	YS01-GW005A-MMY				1	
	YS01-GW005AP-MMY			1		
YS01-GW012	YS01-GW012-MMY			Microbial, Select VOCs, 1,4-dioxane, MEE, CNNS, Sulfide, TOC, Alkalinity	1	
YS01-GW012A	YS01-GW012A-MMY			1		
YS01-GW013	YS01-GW013-MMY			Select VOCs, 1,4-dioxane, MEE, CNNS, Sulfide, TOC, Alkalinity	1	
YS01-GW013A	YS01-GW013A-MMY				1	
YS01-GW014	YS01-GW014-MMY				1	
YS01-GW017	YS01-GW017-MMY				1	
YS01-GW018	YS01-GW018-MMY				1	
	YS01-GW018P-MMY			1		
YS01-GW019	YS01-GW019-MMY			Select VOCs, 1,4-dioxane, MEE, CNNS, Sulfide, TOC, Alkalinity	1	
YS01-GW020	YS01-GW020-MMY				1	
YS01-GW021	YS01-GW021-MMY				1	
YS01-GW022	YS01-GW022-MMY			Microbial, Select VOCs, 1,4-dioxane, MEE, CNNS, Sulfide, TOC, Alkalinity	1	
YS01-GW023	YS01-GW023-MMY			Select VOCs, 1,4-dioxane, MEE, CNNS, Sulfide, TOC, Alkalinity	1	

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

Sampling Station	Sample ID	Matrix	Depth	Analytical Group	Number of Samples	Sampling SOP Reference ¹
YS01-GW024	YS01-GW024-MMY			Select VOCs, 1,4-dioxane, MEE, CNNS, Sulfide, TOC, Alkalinity	1	
YS01-GW024A	YS01-GW024A-MMY			VOCs, 1,4-dioxane, Total and Dissolved Metals, Cyanide, MEE, CNNS, Sulfide, TOC, Alkalinity		
YS01-GW025	YS01-GW025-MMY			Select VOCs, 1,4-dioxane, MEE, CNNS, Sulfide, TOC, Alkalinity	1	
YS01-GW026	YS01-GW026-MMY			Microbial, VOCs, 1,4-dioxane, Total and Dissolved Metals, Cyanide, MEE, CNNS, Sulfide, TOC, Alkalinity	1	
YS01-GW026A	YS01-GW026A-MMY				1	
	YS01-GW026AP-MMY			VOCs, 1,4-dioxane, Total and Dissolved Metals, Cyanide		
YS01-GW027	YS01-GW027-MMY			VOCs, 1,4-dioxane, Total and Dissolved Metals, Cyanide, MEE, CNNS, Sulfide, TOC, Alkalinity	3 (includes MS/MSD)	
YS01-GW027A	YS01-GW027A-MMY				1	
YS01-SP01	YS01-SP01-MMY	Seeps	N/A	VOCs, including 1,4-dioxane, total and dissolved metals, cyanide, hardness (parent samples only), TDS (parent samples only)	1	020_VOCAq 025_Seep
YS01-SP02	YS01-SP02-MMY YS01-SP02P-MMY				3 (includes MS/MSD)	
YS01-SP03	YS01-SP03-MMY				1	
YS01-SWSD034	YS01-WN034-MMY	Pore Water	PDBs in 0-6" bgs	VOCs, including 1,4-dioxane, total and dissolved metals, cyanide, hardness (parent samples only), TDS (parent samples only)	3 (includes MS/MSD)	020_VOCAq 021_Well-Point-SOP
YS01-SWSD035	YS01-WN035-MMY				1	
	YS01-WN035P-MMY				1	
YS01-SWSD036	YS01-WN036-MMY				1	
YS01-SWSD037	YS01-WN037-MMY				1	
YS01-SWSD038	YS01-WN038-MMY	1				

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

Sampling Station	Sample ID	Matrix	Depth	Analytical Group	Number of Samples	Sampling SOP Reference ¹
YS01-GW024	YS01-GW024-MMY			Select VOCs, 1,4-dioxane, MEE, CNNS, Sulfide, TOC, Alkalinity	1	
YS01-SWSD034	YS01-SW034-MMY	Surface Water	N/A	VOCs, 1,4-dioxane, Total and Dissolved Metals, Cyanide, Hardness, TDS	1	020_VOCAq 022_SWSamp
YS01-SWSD035	YS01-SW035-MMY			VOCs, 1,4-dioxane, Total and Dissolved Metals, Cyanide	1	
	YS01-SW035P-MMY					
YS01-SWSD036	YS01-SW036-MMY			VOCs, 1,4-dioxane, Total and Dissolved Metals, Cyanide, Hardness, TDS	3 (includes MS/MSD)	
YS01-SWSD037	YS01-SW037-MMY				1	
YS01-SWSD038	YS01-SW038-MMY					
YS01-SWSD034	YS01-SD034-MMY	Sediment	0-4" bgs (colocated with surface water samples)	VOCs, 1,4-dioxane, Metals, Cyanide, pH, Alkalinity, TOC, AVS/SEM, grain-size	1	007_SedSamp
YS01-SWSD035	YS01-SD035-MMY				1	
YS01-SWSD036	YS01-SD036-MMY			VOCs, 1,4-dioxane, Metals, Cyanide	3 (includes MS/MSD)	
YS01-SWSD037	YS01-SD037-MMY				1	
	YS01-SD037P-MMY					
YS01-SWSD038	YS01-SD038-MMY			VOCs, 1,4-dioxane, Metals, Cyanide, pH, Alkalinity, TOC, AVS/SEM, grain-size	1	

Notes:

¹ Additional nomenclature instructions are as follows.

- duplicates will have "P" added after the station indicator, for example: YS01-SB21P-MMY
- for all sample IDs, "MMYY" will be replaced with the two-digit month and year in which the sample was collected
- equipment blanks will be identified with the two digit month, day and year, and what matrix it is relevant to, for example: YS01-EBMMDDYY
- trip blanks will be identified with the two digit month, day and year, and whether it is the first or other trip blank of the day, for example: YS01-TB01-MMDDYY

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SAP Worksheet #19—Analytical SOP Requirements Table

Matrix	Analytical Group	Analytical Method/SOP Reference	Containers (Number, Size, and Type)	Minimum Sample Amount Required for Analysis	Preservation Requirements (Chemical, Temperature, Light Protected)	Maximum Holding Time ² (Preparation/Analysis)
Groundwater, Seep, Pore Water, or Surface Water	VOCs	SW-846 8260B/5030B/VGCMS-05	3 of 40mL vials, glass	3 × 40mL	HCl to pH<2, No headspace, Cool to <6°C	14 days
	VOCs (1,4-dioxane)	SW-846 8260B-SIM/VGCMS-05				14 days
	Filtered Metals	EPA 6020A/7470B/3005A/MET-15 and EXMT-07/MET-03	2 of 250mL HDPE	100mL	field-filtered, HNO ₃ to pH<2, Cool to <6°C	180 days or 28 days (Hg)
	Total Metals	EPA 6020A/7470B/3005A/MET-15 and EXMT-12/MET-03	2 of 250mL HDPE	100mL	HNO ₃ to pH<2	180 days or 28 days (Hg)
	Cyanide	SW-846 9014/WETS-27	1 of 250mL HDPE	50mL	NaOH to pH>12, Cool to <6°C	14 days
	Ions	EPA 300.0/WETS-57	1 of 250 ml HDPE	50mL	Cool to <6°C	28 days
	Alkalinity	310.1/WETS-61		20mL		14 days
	Sulfide	SM 4500-S2-E (18th Ed.)/WETS-61	1 of 250 ml HDPE	20mL	ZnAc+NaOH to pH>9, Cool to <6°C	7 days
	TOC	SW-846 9060A/WETS-66	2X40mL VOA Vials	40mL	H ₂ SO ₄ to pH<2, Cool to 6°	28 days
	Dissolved gasses	RSK-175/VGC-11	2X40mL VOA Vials	40ml	Cool to <6°C	7 days
	Hardness	SM 2430C/WETS-10	2of 250mL HDPE	20mL	HNO ₃ to pH<2, Cool to <6°C	180 days
	Total Dissolved Solids	EPA 160.1/WETS-20		100mL	Cool to <6°C	7 days
	Microbial	qPCR with DNA extract/Laboratory SOP	1 L of sample passed through 1 bio-flo filter, or 1L HDPE	1000mL	Cool to <6°C	24-48 hours

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

Matrix	Analytical Group	Analytical Method/SOP Reference	Containers (Number, Size, and Type)	Minimum Sample Amount Required for Analysis	Preservation Requirements (Chemical, Temperature, Light Protected)	Maximum Holding Time ² (Preparation/Analysis)
Sediment	VOCs, including 1,4-dioxane	SW-846 8260B/VGCMS-05	3X 40mL VOA Vials + stirbar (tared)	5g	Store in 5mL water (2 vials), store in methanol (1 vial),	48 hours to freeze (for water-preserved only)/14 day to analysis
	Metals	SW-846 6010C/MET-05	2 of 4 oz glass jar	10g	none	180 days
		SW-846 7471A/MET-16		10g	Cool to <6°C	28 days
	Cyanide	SW-846 9014/WETS-27		5g		14 days
	Wet Chemistry (TOC, pH, alkalinity)	Walkley Black/WETS-90		10 g		14 days
		SW-846 9045D/WETS-56		20g		Analyze immediately
		310.1/WETS-88/WETS-04		10g		14 days
	Grain-size	ASTM D422		1 of 4 oz glass jar	varies	none
AVS/SEM	EPA 821_R-91-100/GEN-AVS/SEM	1 of 4 oz jar		10g	Cool to <6°C	14 days

Notes:

¹ Refer to Worksheet #18 for details regarding analytical groups to be tested for each media.

² Holdtime is from the time of sample collection, not the time of sample receipt.

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 Equip. Blanks	No. of Trip Blanks	Total No. of Samples to Lab ¹
Groundwater	Select VOCs, including 1,4-dioxane by SIM	19	2	1/1	6	6	35
	VOCs, including 1,4-dioxane by SIM	5	1	1/1	2	2	12
	Total Metals	5	1	1/1	2	-	10
	Dissolved Metals	5	1	1/1	2	-	10
	Cyanide	5	1	1/1	2	-	10
	Wet Chemistry (MEE, CNNS, Sulfide, Alkalinity, TOC)	24	-	-	-	-	24
	Microbial	5	-	-	-	-	5
Surface Water	VOCs, including 1,4-dioxane by SIM	5	1	1/1	1	1	10
	Total Metals	5	1	1/1	1	-	9
	Dissolved Metals	5	1	1/1	1	-	9
	Cyanide	5	1	1/1	1	-	9
	Wet Chemistry (Hardness, TDS)	5	-	-	-	-	5
Seep ²	VOCs, including 1,4-dioxane by SIM	3	1	1/1	1	1	8
	Total Metals	3	1	1/1	1	-	7
	Dissolved Metals	3	1	1/1	1	-	7
	Cyanide	3	1	1/1	1	-	7
Pore Water	VOCs, including 1,4-dioxane by SIM	5	1	1/1	1	1	10
	Total Metals	5	1	1/1	1	-	9
	Dissolved Metals	5	1	1/1	1	-	9
	Cyanide	5	1	1/1	1	-	9

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 Equip. Blanks	No. of Trip Blanks	Total No. of Samples to Lab ¹
Sediment	VOCs, including 1,4-dioxane by full scan	5	1	1/1	1	1	10
	Metals	5	1	1/1	1	-	9
	Cyanide	5	1	1/1	1	-	9
	Wet Chemistry (pH, Alkalinity, TOC)	5	-	-	-	-	5
	Grain-size	5	-	-	-	-	5
	AVS/SEM	5	-	-	-	-	5

Notes:

- ¹ The number of field QC samples to be collected is dependent on the number of parent samples and the number of days of the sampling event.
- Field duplicates are collected at a frequency of 1 per 10 field samples per matrix.
 - MS/MSD pairs are collected at a frequency of 1 per 20 samples per matrix sent to the laboratory (including duplicates).
 - Equipment Blanks for deconned equipment are collected once per day of sampling, per type of equipment. Equipment Blanks for disposable equipment are collected once per lot.
 - Trip Blanks are collected for each cooler to the laboratory containing VOC samples.
 - Field Blanks will not be collected as part of this investigation.
- ² Samples from groundwater seeps will only be collected if groundwater seeps are observed at the time of sampling.

MEE = Methane, Ethane, Ethene

CNNS = Chloride, Nitrate, Nitrite, Sulfate

TDS = Total Dissolved Solids

SAP Worksheet #21—Project Sampling SOP References Table

TABLE 3-1
 Field SOPs Reference Table

SOP Reference Number	Title/Author	Revision Date or Version Number	Location of SOP (if not included in the SAP)	Any planned deviation for Project Work	Comments
001_BlankPrep	Equipment Blank and Field Blank Preparation	08/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Sample Preparation and Handling	N/A	N/A
002_COC	Chain-of-Custody	08/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Sample Preparation and Handling	N/A	N/A
004_GPS	Global Positioning System (GPS)	08/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Other	N/A	N/A
005_Homog	Homogenization of Soil and Sediment Samples	08/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Sample Preparation and Handling	N/A	N/A
006_Log Books	Log Books	08/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Log Books	N/A	N/A
007_SedSamp	Sediment Sampling	08/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Surface-Water and Sediment Sampling	N/A	N/A
008_Ship	Packaging and Shipping Procedures for Low-Concentration Samples	08/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Sample Preparation and Handling	N/A	N/A
009_DeconRig	Decontamination of Drilling Rigs and Equipment	08/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Decontamination	N/A	N/A
010_Decon	Decontamination of Personnel and Equipment	08/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Decontamination	N/A	N/A
011_Dispose	Disposal of Waste Fluids and Solids	08/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Decontamination	N/A	N/A

SAP Worksheet #21—Project Sampling SOP References Table (continued)

TABLE 3-1
 Field SOPs Reference Table

SOP Reference Number	Title/Author	Revision Date or Version Number	Location of SOP (if not included in the SAP)	Any planned deviation for Project Work	Comments
012_WaterQual	Field Measurement of pH, Specific Conductance, Turbidity, DO, ORP, and Temperature Using a Water Quality Parameter Meter	08/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Field Parameters	N/A	N/A
013_MWSamp-EPA Reg I&III	Groundwater Sampling from Monitoring Wells	08/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Groundwater Sampling	N/A	N/A
014_LowFlow-EPA Reg I&III	Low-Flow Groundwater Sampling from Monitoring Wells	08/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Groundwater Sampling	N/A	N/A
015_MWInstal	General Guidance for Monitoring Well Installation	08/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Hydrogeology	N/A	N/A
016_MWshall	Installation of Shallow Monitoring Wells	08/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Hydrogeology	N/A	N/A
017_WaterLevels	Water Level Measurements	08/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Hydrogeology	N/A	N/A
018_SBLog	Logging of Soil Borings	08/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Soil Sampling	N/A	N/A
019_Utility Location_General	Locating and Clearing Underground Utilities	08/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Utility Location	N/A	N/A
020_VOCAq	VOC Sampling	08/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Sample Preparation and Handling	N/A	N/A
021_Well-Point-SOP	Groundwater-Surface Water Investigation: Well Point Method Pore Water Sampling Procedure	08/2012	Appendix A	N/A	N/A
022_SWSamp	Surface Water Sampling	08/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Surface-Water and Sediment Sampling	N/A	N/A
023_SlugTest	Aquifer Slug Test	08/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Hydrogeology	N/A	N/A

SAP Worksheet #21—Project Sampling SOP References Table (continued)

TABLE 3-1
 Field SOPs Reference Table

SOP Reference Number	Title/Author	Revision Date or Version Number	Location of SOP (if not included in the SAP)	Any planned deviation for Project Work	Comments
024_MiniRAE	Mini RAE Photoionization Detector (PID)	08/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Health and Safety	N/A	N/A
025_MultiRAE	Multi RAE PID	08/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Health and Safety	N/A	N/A
026_Seep	Seep Groundwater Sample Collection	08/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Groundwater Sampling	N/A	N/A
027_MWDeep	Installation of Surface-Cased Monitoring Wells	08/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Hydrogeology	N/A	N/A
028_Landfill_Delin_Trench	Trenching for Landfill Delineation	08/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Soil Sampling	N/A	N/A

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

Field Equipment	Activity ¹	Frequency	Acceptance Criteria	CA	Resp. Person	SOP Reference ²	Comments
Multi-RAE 2000 PID	Maintenance- Check mechanical and electronic parts, verify system continuity, check battery, and clean filter (change if clogged or dirty). Calibration check	Daily before use, at the end of the day, and when unstable readings occur.	Fresh air calibration reads 0.0 parts per million (ppm) ± 3.0 ppm, span gas calibration (isobutylene) reads 100.0 ppm ± 3.0 ppm	Replace filter, clean airway and check for obstructions. Use external filter if there is high humidity or if it is raining. Do not use instrument if not able to calibrate properly.	Field Team Lead	MiniRAE 2000	
Water Quality Meter pH probe	Calibration	Daily, before use	pH reads 4.0 $\pm 3\%$	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly	Field Team Lead	WaterQual	
Water Quality Meter Specific conductance probe	Calibration	Daily, before use	Conductivity reads 4.49 $\pm 3\%$	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	Field Team Lead	WaterQual	
Turbidity Meter	Calibration	Daily, before use	Turbidity reads 0 $\pm 3\%$	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	Field Team Lead	WaterQual	
Water Quality Meter DO and Temperature Probes	Testing	Daily, before use	Consistent with the current atmospheric pressure and ambient temperature	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	Field Team Lead	WaterQual	
Water Quality Meter	Maintenance- Check mechanical and electronic parts, verify system continuity, check battery, and clean probes. Calibration check	Daily before use, at the end of the day, and when unstable readings occur.	Stable readings after 3 minutes. pH reads 4.0 $\pm 3\%$ conductivity reads 4.49 $\pm 3\%$ turbidity reads 0 $\pm 3\%$	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	Field Team Lead	WaterQual	

Notes:

¹ Activities may include: calibration, verification, testing, and/or maintenance.

² References from Worksheet #21.

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SAP Worksheet #23-1—ENCO Labs Analytical SOP References Table

Lab SOP Number	Title, Revision Date, and Number	Date reviewed if not revised	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Variance to QSM	Modified for Project Work?
LOGINS-03	RECEIVING SAMPLES (Rev. 11, Effective 07/31/2012)	4/20/2011	NA	NA	NA	none	No
ADMIN-14	WASTE DISPOSAL AND CHARACTERIZATION (Rev. 6, 09/16/2011)	NA	NA	NA	NA	none	No
MET-03	Mercury in Waters by Digestion/CVAA (Rev. 5, 02/20/2012)	NA	Definitive	Aqueous, Metals	CVAA	Do not Perform MSA ¹	No
MET-05	Metals Analysis by ICP-AES (Rev. 10, 04/06/2012)	NA	Definitive	Aqueous/Solids, Metals	ICP		No
Met-15	Metals Analysis by ICP-MS (Rev. 5, 2/14/2011)	2/1/2012	Definitive	Aqueous/Solids, Metals	ICP-MS		No
MET-16	Mercury in Soils By Digestion/CVAA (Rev. 5, 03/12/2012)	NA	Definitive	Soils, Metals	CVAA		No
EXMT-07	Acid Digestion of Aqueous Samples & Extracts for Analysis by ICP or ICP-MS (Rev.7, 08/23/2011)	NA	NA	Aqueous Extraction, Metals	NA	none	No
EXMT-09	Acid Digestion of Soil and Waste Samples for Analysis by ICP and (Rev. 6, 08/31/2011) ICP-MS	NA	NA	Solid Extraction, Metals	NA	none	No
VGCMS-05	Analysis of Volatile Organic Compounds by GC/MS (Rev. 17, 08/26/2011)	NA	Definitive	Aqueous/Solids, Volatile Organics	GCMS	none	No
VGC-11	Analysis of Dissolved Gases by Headspace GC/TCD/FID (Rev. 5, 06/24/2011)	under review	Definitive	Aqueous Dissolved Gases	GC	none	No
WETS-04	Alkalinity (Titrametric, pH 4.5); EPA Method 310.1 (Rev. 9, 07/30/2012)	NA	Definitive	Aqueous/Solids, Alkalinity	Buret	none	No
WETS-10	Hardness, Total; EPA 130.2; SM2340C (Rev. 8, 06/30/2011)	03/22/2012	Definitive	Aqueous, Wet Chemistry	Buret	none	No
WETS-20	Total Dissolved Solids (Rev. 6, 01/12/2010)	05/18/2012	Definitive	Aqueous, Wet Chemistry			

SAP Worksheet #23-1—ENCO Labs Analytical SOP References Table (continued)

Lab SOP Number	Title, Revision Date, and Number	Date reviewed if not revised	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Variance to QSM	Modified for Project Work?
WETS-27	Colorimetric Determination of Total Cyanides (Rev. 11, 1/12/2010)	1/6/2012	Definitive	Aqueous/Solids, Wet Chemistry	Spectrophotometer	none	No
WETS-56	pH (Electrometric, Solid/Waste Samples) (Rev. 3, 03/23/2010)	1/10/2012	Definitive	Solids, pH	Electrode	none	No
WETS-57	Ion Chromotography (Rev. 5, 01/28/2010)	under review	Definitive	Aqueous, Ions	IC	none	No
WETS-61	Sulfide (Titrametric), (Rev. 6, 07/20/2012)	NA	Definitive	Aqueous, Wet Chemistry	Buret	none	No
WETS-66	Total and Dissolved Organic Carbon by Combustion-Infrared Method Using the Tekmar Apollo 9000 TOC Combustion Analyzer (Rev. 4, 01/23/2010)	4/30/2012	Definitive	Aqueous, Wet Chemistry	NA	none	No
WETS-88	De-ionized Water Leaching Procedure for Wet Chemistry Tests in Soils/Solids (Rev. 2, 05/10/2010)	5/2/2012	NA	NA	NA	none	No
WETS-90	Total Organic Carbon in Soil Using Walkley Black Titration (Rev. 1, 01/12/2010)	5/1/2012	Definitive	Solids, TOC	Buret	none	No

Notes:

DoD ELAP certification is required for this work, this laboratory's DoD ELAP certification expires March 31, 2014

¹ The laboratory will not perform MSA for metals samples that have post-digestion spike recoveries outside of acceptance criteria. Should samples not meet the post-digestion spike criteria, matrix interference would have been confirmed and data flagged appropriately. This clarification of variance to QSM has no anticipated negative effect on the quality of data.

SAP Worksheet #23-2—Other Laboratory Analytical SOP References Table

Lab SOP Number	Title, Revision Date, and Number	Date reviewed if not revised	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Work	Variance to QSM	Modified for Project Work?
GEN-AVS/SEM ¹	Sulfide, Acid Volatile & Simultaneously Extractable Metals	7/18/11 revised	Screening	solids, AVS/SEM	Spectrophotometer	ALS-Rochester	None	No
Met 200.7/6010B	Determination of Metals & Trace elements by ICP	7/18/11 revised	Screening	solids, AVS/SEM	ICP-AES,CVAA	ALS-Rochester	None	No
AG-SOP-014B	Particle-Size Analysis of Soils without Hydrometer, rev 0	N/A	Screening	solids, Grain-Size	sieves	Kemron	N/A	No
MI SOP qPCR	Quantitative Polymerase Chain Reaction (qPCR), 1/10/06, Rev 1.0	6/22/2012	Screening	Aqueous Microbials	qPCR	Microbial Insights	None	N
MI SOP DNA-EXT	Extraction of DNA from Environmental Samples (Matrix- Water, Soil, Biofilm, Bio-Sep Beads), 1/5/06, Rev 1.0	6/22/2012	NA	Aqueous Microbials prep	NA	Microbial Insights	None	N

Notes:

¹ No certification is required for this method. CAS-Rochester is a DoD ELAP accredited lab, and has certification for the analysis of sulfide and metals, which is valid through May 21, 2012. The laboratory's certifications do not apply to the AVS/SEM sample preparation.

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SAP Worksheet #24—Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference ¹
GC-MS (VOA)	Tuning	Prior to ICAL and at the beginning of each 12-hour period.	Refer to method for specific ion criteria.	Retune instrument and verify. Rerun affected samples.	Analyst	VGCMS-05
	Minimum five-point initial calibration (ICAL) for all analytes	ICAL prior to sample analysis.	1. Average response factor (RF) for system performance check compounds (SPCCs): VOCs ≥ 0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane; VOCs ≥ 0.1 for chloromethane, bromoform, and 1,1-dichloroethane. 2. RSD for RFs for calibration check compounds (CCCs): VOCs $\leq 30\%$ and one option below: Option 1: RSD for each analyte $\leq 15\%$; Option 2: linear least squares regression $r \geq 0.995$; Option 3: non-linear regression. coefficient of determination (COD) $r^2 \geq 0.990$ (6 points shall be used for second order, 7 points shall be used for third order).	Correct problem then repeat ICAL.		
	Second source calibration verification (ICV)	Once after each ICAL.	All project analytes within $\pm 20\%$ of true value.	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.		
	Retention time window position establishment for each analyte and surrogate.	Once per ICAL.	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not performed, the initial CCV is used.	NA.		
	Evaluation of relative retention times (RRT)	With each sample.	RRT of each target analyte within ± 0.06 RRT units.	Correct problem, then rerun ICAL.		
	Continuing calibration verification (CCV)	Daily before sample analysis and every 12 hours of analysis time.	1. Average RF for SPCCs: VOCs ≥ 0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane; ≥ 0.1 for chloromethane, bromoform, and 1,1-dichloroethane. 2. %Difference/Drift for all target compounds and surrogates: VOCs $\leq 20\%D$ (Note: D = difference when using RFs or drift when using least squares regression or non-linear calibration).	DoD project level approval must be obtained for each of the failed analytes or corrective action must be taken. Correct problem, then rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since last acceptable CCV.		
ICP-AES	Initial calibration (ICAL) - minimum one high standard and a calibration blank for all analytes	Daily ICAL prior to sample analysis.	More than one calibration standard is used, $R \geq 0.995$.	Correct problem, then repeat ICAL.	Analyst	MET-05
	Low-level calibration check standard	Daily, after one-point ICAL.	Within $\pm 20\%$ of true value.	Correct problem, then reanalyze.		
	Second source calibration verification	Once after each ICAL, prior to beginning a sample run.	Value of second source for all analytes within $\pm 10\%$ of true value.	Verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.		
	Continuing calibration verification (CCV)	After every 10 field samples and at the end of the analysis sequence.	All analytes within $\pm 10\%$ of true value.	Correct problem, rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification.		
	Calibration blank	Before beginning a sample run, after every 10 samples, and at end of the analysis sequence.	No analytes detected $> LOD$.	Correct problem. Re-prepare and reanalyze calibration blank. All samples following the last acceptable calibration blank must be reanalyzed.		
	Interference check solutions (ICS-A and ICS-AB)	At the beginning of an analytical run and every 12 hours.	ICS-A: Absolute value of concentration for all non-spiked analytes $< LOD$ (unless they are a verified trace impurity from one of the spiked analytes); ICS-AB: Within $\pm 20\%$ of true value.	Terminate analysis, locate and correct problem, reanalyze ICS, reanalyze all samples.		

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

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference ¹
ICP-MS	Tuning	Prior to ICAL.	Mass calibration ≤ 0.1 amu from the true value; resolution < 0.9 amu full width at 10% peak height; For stability, RSD $\leq 5\%$ for at least four replicate analyses.	Retune instrument then reanalyze tuning solutions.	Analyst	MET-15
	ICAL for all analytes (minimum 2 point calibration)	Daily ICAL prior to sample analysis.	More than one calibration standard is used, $R \geq 0.995$.	Correct problem, then repeat ICAL.		
	Second source calibration verification	Once after each ICAL, prior to beginning a sample run.	Value of second source for all analytes within $\pm 10\%$ of true value.	Verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.		
	CCV	After every 10 field samples and at the end of the analysis sequence.	All analytes within $\pm 10\%$ of true value.	Correct problem, rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification.		
	Calibration blank	Before beginning a sample run, after every 10 samples, and at end of the analysis sequence.	No analytes detected $> LOD$.	Correct problem. Re-prepare and reanalyze calibration blank. All samples following the last acceptable calibration blank must be reanalyzed.		
	Interference check solutions (ICS-A and ICS-AB)	At the beginning of an analytical run and every 12 hours.	ICS-A: Absolute value of concentration for all non-spiked analytes $< LOD$ (unless they are a verified trace impurity from one of the spiked analytes); ICS-AB: Within $\pm 20\%$ of true value.	Terminate analysis, locate and correct problem, reanalyze ICS, reanalyze all samples.		
CVAA (Mercury)	ICAL - minimum 5 standards and a calibration blank	Initial calibration daily prior to sample analysis.	Correlation coefficient > 0.995 ; accepted if the second-source calibration verification passes.	Correct problem, then repeat initial calibration.	Analyst	MET-03 and MET-16
	Second-source Calibration Verification	Once per initial calibration, prior to beginning a sample run.	Less than 10% difference from expected concentration for all target analytes.	Correct problem, then repeat. If still fails, repeat initial calibration.		
	CCV	Following SCV, after every 10 samples and the end of the sequence.	Within $\pm 20\%$ of true value.	Correct problem, then repeat. If still fails, repeat initial calibration. Re-analyze all samples since the last successful calibration verification.		
	Calibration blank	Daily after initial calibration and every ten samples.	No analytes detected $> LOD$.	Correct problem, re-prepare and reanalyze calibration blank. Re-analyze all samples following the last acceptable calibration blank.		
Cyanide Analyzer	Initial Calibration (ICAL) - six standards and a calibration blank	Daily ICAL prior to sample analysis.	$r \geq 0.995$	Correct problem, then repeat ICAL.	Analyst	WETS-027
	Second Source Calibration Verification (SCV)	Once after each ICAL, prior to beginning a sample run.	Within $\pm 15\%$ of true value.	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.		
GC-FID(MEE)	Initial calibration (ICAL) for all analytes	Daily ICAL prior to sample analysis.	Calculate response factor (RF) for each standard, compute average response factor and percent RSD. RSD $< 20\%$. Optionally, a linear regression curve may be fit if the correlation coefficient > 0.990 .	Correct problem then repeat ICAL.	Analyst	VGC-11
	Second source calibration verification	Once after each ICAL.	All project analytes within $\pm 25\%$ of true value.	Verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.		
	Continuing calibration verification (CCV)	Before any samples in sequences that don't include initial calibrations, after every 24 hours, and at the end of the sequence.	All project analytes within $\pm 20\%$ of true value.	Correct problem, rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification.		
IC (Ions)	Initial calibration (ICAL), minimum of three standards and a calibration blank	Every 6 months, ICAL prior to sample analysis.	Coefficient of determination at least 0.995	Correct problem then repeat ICAL.	Analyst	WETS-57
	Second source calibration verification	Once after each ICAL.	All analytes within $\pm 10\%$ of true value and retention times within appropriate windows	Verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.		

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

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference ¹
	Continuing calibration verification (CCV)	After every 10 field samples and at the end of the analysis sequence.	All project analytes within established retention time windows. Within $\pm 10\%$ of true value.	Correct problem, then rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification.		
	Retention Time Windows	One per multipoint calibration	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not performed, the initial CCV is used.	NA		
TOC Analyzer	Initial calibration (ICAL), minimum of five standards and a calibration blank	Annually, ICAL prior to sample analysis.	Coefficient of determination at least 0.995	Correct problem then repeat ICAL.	Analyst	WETS-066
	Second source calibration verification	Once after each ICAL.	All analytes within $\pm 15\%$ of true value and retention times within appropriate windows	Verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.		
	Continuing calibration verification (CCV)	After every 10 field samples and at the end of the analysis sequence.	All analytes within $\pm 15\%$ of true value.	Correct problem, rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification.		
pH Buffer Check	The pH meter is calibrated daily using 4.0 (± 0.1) and 10.0 (± 0.1) buffers.	Deviation within 99 - 101% of true value.	Recalibrate, reanalyze all samples analyzed since the last pH buffer that met criteria.	Correct problem then repeat ICAL.	Analyst	WETS-056
ICP-AES (SEM Metals)	Initial Calibration (ICAL)	Each analytical sequence - 3 Standards and a Blank	$cc \geq 0.998$	Recalibrate	Lab Section Supervisor	MET-200.7/6010C
	Initial Calibration Verification (ICV)	Once after each ICAL, prior to beginning a sample run	Analytes must agree within 10% of the expected value	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.		
	Continuing Calibration Verification (CCV)	Every 10 samples and at the end of the analytical sequence	Analytes must agree within 10% of the expected value	Correct problem, rerun CCV. If that fails, then repeat ICAL. Reanalyze all samples since the last acceptable CCV.		
	High-level check standard	Daily	Analytes must agree within 10% of the expected value	Correct problem, reanalyze		
	MRL standard	Beginning and end of daily run	70-130%	Correct problem, reanalyze		
	Calibration Blank	Before beginning a sample run, after every 10 samples, and at the end of the analysis sequence.	No analytes detected > LOQ	Correct problem. Re-prepare and reanalyze calibration blank. All samples following the last acceptable calibration blank must be reanalyzed except samples <LOQ.		
	Interference check solutions (ICS)	At beginning and end of the daily sequence	ICS-A: Absolute value of concentration for all non-spiked analytes < LOQ (<2XLOQ for elements with LOQ<10mg/L) ICS-AB: Within 20% of true value	Terminate analysis; locate and correct problem; reanalyze ICS, reanalyze affected samples.		
CVAA (SEM Mercury)	ICAL	Each analytical sequence (5 standards)	Correlation coefficient of calibration curve ≥ 0.995	Correct problem, repeat ICAL	Lab Section Supervisor	MET-7470A/245.1
	ICV	Once after each ICAL, prior to beginning a sample run	Analytes must agree within 10% of the expected value	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.		
	CCV	Every 10 samples and at the end of the analytical sequence	Analyte must agree within 20% of the expected value	Correct problem, rerun CCV. If that fails, then repeat ICAL. Reanalyze all samples since the last acceptable CCV.		
	Calibration Blank	Before beginning a sample run, after every 10 samples, and at the end of the analysis sequence.	No analytes detected > LOQ	Correct problem. Re-prepare and reanalyze calibration blank. All samples following the last acceptable calibration blank must be reanalyzed.		
Spectrophotometer(AVS)	ICAL	As needed	The correlation coefficient must be ≥ 0.995	Correct problem then repeat ICAL	Lab Section Supervisor	GEN-AVS
	ICV	After each initial calibration	$\pm 10\%$ of the expected value	Correct problem and rerun ICV. If that fails, correct problem and repeat ICAL.		

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

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference ¹
	CCV	Before beginning a sample run, after every 10 samples, and at the end of the analysis sequence.	± 10% of the expected value	Correct problem, rerun CCV. If that fails, then repeat ICAL. Reanalyze all samples since the last acceptable CCV.		
ABI 7300	Initial	Primary – annual	Standard curve R ² >0.95	Rerun assay/check reagents.	Analyst	MI SOP-qPCR
	Continuing Calibration Verification	Secondary – every plate (assay)	Cycle threshold value within 2 units of same point on standard curve	Rerun assay/check reagents.		

¹ Refer to **Worksheet #23** for a complete reference to relevant analytical SOPs.

² The specifications in this table meet the requirements of DoD QSM 4.2.

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

Instrument/Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
GC/MS (VOCs)	Clean sources, maintain vacuum pumps.	Tuning	Instrument performance and sensitivity.	Service vacuum pumps twice per year, other maintenance as needed.	Tune and CCV pass criteria.	Recalibrate instrument.	Analyst	VGCMS-05
	Change septum, clean injection port, change or clip column, install new liner, change trap.	Sensitivity check	Instrument performance and sensitivity.	Daily or as needed.	Tune and CCV pass criteria.	Re-inspect injector port, cut additional column, re-analyze CCV, and recalibrate instrument.		
ICP-AES	Change tubing	None	None	Every other run	None	None	Analyst	MET-05
	Clean air filter	Inspect air filters	Visual	Monthly	Air Filters are clean	Clean, replace air filters		
	Clean lenses	Inspect lenses for cleanliness		As needed	Lenses are clean	None		
	Clean injector	Inspect injector for cleanliness			verify injector is clean			
ICP-MS	Clean, inspect, change cones	Monitor ISTD counts for variation		Instrument performance and sensitivity	As needed	Monitor ISTD counts for variation	Re-calibrate	Analyst
	Clean, inspect, change spray chamber, injector, torch		Replace windings, re-calibrate and re-analyze					
	Replace pump windings							
CVAA(mercury)	Replace disposables, flush lines	Sensitivity check	Instrument performance and sensitivity	Daily or as needed	CCV pass criteria	Recalibrate	Analyst	MET -03 and MET-16
	Clean lens				Method Blank pass criteria			
	Replace pump tubing	Flow Rate Check		As needed	Monitor flow rate for variation	Replace windings, recalibrate and re-analyze		
Cyanide Analyzer	Clean sample cell before use	Turn on instrument and wait 15 minutes to warm-up	Visual	Before each run	Calibrate by zeroing; blank and CCV pass criteria	Recalibrate instrument	Analyst	WETS-27
GC-FID (MEE)	Injection port maintenance	NA	Evaluate baseline and peak shapes	As needed	Analyst judgment of excessive tailing or baseline fluctuation	Clip the guard column, replace the injection port liner, replace the gold seal, clean the injection port, replace the injection port septum.	Analyst	VGC-11
IC (Ions)	Fill eluent bottles and Fill reservoir water bottle.	NA	Visual	Weekly or as needed	NA	Fill bottle as needed	Analyst	WETS-057
	Check back pressure is below 2300 PSI.	NA	Visual	Weekly or as needed	NA	clean or replace guard column and frit		
	Check IC for leaks.	NA	visual check for liquid or pressure fluctuation	Weekly or as needed	NA	fix leak		
Lachat(Alkalinity)	Oil Pump Rollers	NA	back flow observed	Every 2 weeks	CCV pass criteria	oil as needed	Analyst	WETS-047
	Replace sample line and water reservoir line	NA	back flow observed.	Every 2 weeks	CCV pass criteria	Change as needed or look for line clogs		
	Replace reagent lines	NA	back flow observed	Monthly	CCV pass criteria	Change as needed or look for line clogs		
	Replace valve o-ring	NA	back flow observed	Monthly	CCV pass criteria	Change as needed or look for line clogs		

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

Instrument/Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
TOC Analyzer	Inspect/Clean TOC syringe.	NA	Visual	Monthly	NA	Clean as needed	Analyst	WETS-066
	Inspect Permeation Dryer.	NA	Visual	Monthly	NA	Replace if humidity observed		
	Test fittings on 8 port valve	NA	Visual check for leaks	Monthly	NA	Replace or tight fittings as needed		
	Replace Injection Line.	NA	Peak shape and uniformity between injection replicas	As needed	CCV pass criteria	Replace line		
	Replace Corrosive Scrubber (Tin and Copper).	NA	Color discoloration	As needed	CCV pass criteria	Replace Tin and Copper		
	Replace/wash and condition Catalys and Combustion Tube	NA	CCV passing	As needed	CCV pass criteria	Replace and condition.		
pH Meter	Clean and change pobe fluid	NA	Fluid is low or crystal have formed	as needed	NA	NA	Analyst	WETS-056
ICP-AES (SEM Metals)	Clean plasma torch; clean filters; clean spray and nebulizer chambers; replace pump tubing	SEM Metals	Torch, filters, nebulizer chamber, pump, pump tubing	Perform as needed.	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service.	Lab Area Supervisor	MET-200.7/6010B
CVAA (SEM Metals)	Clean or replace dehydrator tubing and sample mixing coil tubing; replace sample probe; replace pump tubing; clean optical cell.	SEM Mercury	Tubing, sample probe, optical cell	Perform as needed.				MET-7470A/245.1
Spectrophotometer (AVS)	Inspect lamp alignment. Adjust zero. Replace lamp as needed.	AVS	Check wavelengths against NIST traceable standards	Every 6 months				Within 3% of certified transmittance density values or 2nm for holmium oxide
ABI 7300 (DHC)	Background check monthly; Dye calibration annually	Initial Calibration Verification and Background check	Monitor instrument performance via Initial Calibration Verification and Blank	Daily, after every 10 samples	Standard curve r^2 value >0.95; CT value within 2 units of same point on standard curve	Clean wells, rerun background assay. See SOP	Analyst	MI SOP qPCR

SAP Worksheet #26—Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Field Team/CH2M HILL Sample Packaging (Personnel/Organization): FTL/CH2M HILL Coordination of Shipment (Personnel/Organization): FTL/CH2M HILL Type of Shipment/Carrier: Overnight Carrier/FedEx
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Logins/ENCO Labs, CAS-Rochester, Kemron, Microbial Insights Sample Custody and Storage (Personnel/Organization): Logins/ENCO Labs, CAS-Rochester, Kemron, Microbial Insights Sample Preparation (Personnel/Organization): Inorganic Prep and Organic Prep/ENCO Labs, CAS-Rochester, Kemron, Microbial Insights Sample Determinative Analysis (Personnel/Organization): Analysts/ENCO Labs, CAS-Rochester, Kemron, Microbial Insights
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 45 Sample Extract/Digestate Storage (No. of days from extraction/digestion): 45 Microbial Sample Storage (No. of days from sample collection): not applicable
SAMPLE DISPOSAL
Personnel/Organization: Sample Custody Personnel/ENCO Labs, CAS-Rochester, Kemron, Microbial Insights Number of Days from Analysis: 45

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SAP Worksheet #27—Sample Custody Requirements Table

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 and labeled. Labels will be taped to the containers to ensure they do not separate. Samples will be cushioned with packaging material and placed into coolers containing enough ice to keep the samples <6 degrees Celsius (°C) until they are received by the laboratory.

The chain of custody will be placed into the cooler in a Ziploc bag. Coolers will be taped up and shipped to the laboratories via Fed Ex overnight, 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 to CH2M HILL.

See Worksheet #21 for SOPs containing sample custody guidance.

All microbial samples will be shipped to Microbial Insights.

All other samples will be shipped to ENCO Labs in Orlando, FL. ENCO will send samples for AVS/SEM to CAS-Rochester and samples for grain-size to Kemron.

Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal):

Laboratory custody procedures can be found in the laboratory SOPs, which are referenced in Worksheet #23. Laboratory SOPs will be provided upon request.

Sample Identification Procedures:

Sample labels will include, at a minimum, client name, site, sample ID, date/time collected, analysis group or method, preservation, and sampler's initials. The field logbook will identify the sample ID with the location and 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 and Worksheet #18. The laboratory will send sample log-in forms to the PC to check that 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 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 Laboratory Information Management Systems (LIMS) database for each sample.

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SAP Worksheet #28-1—Laboratory QC Samples Table

Matrix: Groundwater, Surface Water, Pore Water, Seeps
 Analytical Group: VOCs (except 1,4-dioxane)
 Analytical Method/SOP Reference: SW-846 8260B/VGCMS-05

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method blank	One per preparatory batch	No target analytes > 1/2 LOQ and >1/10 the amount measure in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > LOQ.	Correct problem. If QC acceptance limits still not met, re-prep and re-analyze method blank and all samples processed with the contaminated blank.	Analyst	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
Laboratory Control Sample (LCS)		Refer to Worksheet #15.	LCS is reanalyzed. If still fails, samples along with QC, are re-prepped and re-analyzed.		Precision and Accuracy/Bias	
Matrix Spike (MS)		Same as LCS.	In the absence of client specific requirements, flag the data.		Precision and Accuracy/Bias	
Matrix Spike Duplicate (MSD)		Same as LCS and RPD $\leq 30\%$.			Precision and Accuracy/Bias	
Internal Standards (IS)	Spiked in Every Sample	Retention time within 30 seconds from retention time of the midpoint standard in the ICAL; areas within -50% to +100% of ICAL midpoint standard.	Inspect mass spectrometer and GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.		Precision and Accuracy	
Surrogates		Dibromofluoromethane 85-115%, Toluene-d8 85-120%, 1,2-Dichloroethane-d4 70-120%, 4-Bromofluorobenzene 75-120%	Re-prep and re-analyze sample unless objective evidence of suspected or confirmed sample matrix effects are available. If insufficient sample exists for reanalysis, client will be contacted for instructions. In the absence of client instruction, data will be qualified.		Precision and Accuracy/Bias	

Notes:

The specifications in this table meet the requirements of DoD QSM 4.2.

SAP Worksheet #28-2—Laboratory QC Samples Table

Matrix: Groundwater, Pore Water, Surface Water, Seeps
 Analytical Group: VOCs (1,4-dioxane)
 Analytical Method/SOP Reference: SW-846 8260B-SIM/VGCMS-10

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method blank	One per preparatory batch	No target analytes > 1/2 LOQ and >1/10 the amount measure in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > LOQ.	Correct problem. If QC acceptance limits still not met, re-prep and re-analyze method blank and all samples processed with the contaminated blank.	Analyst	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
Laboratory Control Sample (LCS)		Refer to Worksheet #15.	LCS is reanalyzed. If still fails, samples along with QC, are re-prepped and re-analyzed.		Precision and Accuracy/Bias	
Matrix Spike (MS)		Same as LCS.	In the absence of client specific requirements, flag the data.		Precision and Accuracy/Bias	
Matrix Spike Duplicate (MSD)		Same as LCS and RPD $\leq 30\%$.			Precision and Accuracy/Bias	
Internal Standards (IS)	Spiked in Every Sample	Retention time within 30 seconds from retention time of the midpoint standard in the ICAL; areas within -50% to +100% of ICAL midpoint standard.	Inspect mass spectrometer and GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.		Precision and Accuracy	
Surrogates		Toluene-d8 85-120%	Re-prep and re-analyze sample unless objective evidence of suspected or confirmed sample matrix effects are available. If insufficient sample exists for reanalysis, client will be contacted for instructions. In the absence of client instruction, data will be qualified.		Precision and Accuracy/Bias	

Notes:

The specifications in this table meet the requirements of DoD QSM 4.2.

SAP Worksheet #28-3—Laboratory QC Samples Table

Matrix: Groundwater, Surface Water, Seeps, Sediment Pore Water
 Analytical Group: Total and Dissolved Metals (except mercury)
 Analytical Method/SOP Reference: SW-846 6020A/MET-15

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per preparatory batch.	No analytes detected > 1/2 LOQ. Blank result must not otherwise affect sample results.	Correct problem; then repeat. If the method blank still fails; redigest and analyze all affected samples.	Analyst	Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
LCS		Refer to Worksheet #15.	LCS is re-analyzed. If still fails, samples, along with QC, are re-prepped and re-analyzed. Client will be contacted for guidance about whether to re-prepare samples. In the absence of client specific requirements, flag the data.		Precision and Accuracy/Bias	
MS		Same as LCS.	Perform a dilution test and/or post spike to evaluate matrix effects.		Precision and Accuracy/Bias	
MSD		Same as LCS and refer to Worksheet #15 for MS/MSD RPD.			Precision and Accuracy/Bias	
Dilution Test		Recovery within ±10% of true value.	Perform post spike.		Precision and Accuracy/Bias	
Post Spike		When dilution test fails or analyte concentration for all samples < 50x LOD.	Recovery within ±25% of true value.		If dilution test recovers outside of QC acceptance limits but post spike meets QC acceptance criteria, matrix effects are not confirmed, reprep and reanalyze sample.	
Internal Standard (IS)	Spiked in every sample.	IS intensity within 30-120% of intensity of IS in ICAL.	Re-analyze sample at 5x dilution with the addition of appropriate amounts of IS.	Precision and Accuracy		

Notes:

The specifications in this table meet the requirements of DoD QSM 4.2.

SAP Worksheet #28-4—Laboratory QC Samples Table

Matrix: Groundwater, Surface Water, Seeps, Sediment Pore Water

Analytical Group: Total and Dissolved Metals (mercury)

Analytical Method/SOP Reference: SW-846 7470B/MET-16 or MET-03

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per preparatory batch.	No analytes detected > 1/2 LOQ. Blank result must not otherwise affect sample results.	Correct problem; then repeat. If the method blank still fails; re-prepare and re-analyze all samples processed with contaminated blank.	Analyst	Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
LCS		Refer to Worksheet #15.	Correct problem, then reprepare and reanalyze the LCS and all samples in the associated preparatory batch.		Precision and Accuracy/Bias	
MS		Same as LCS.	Examine the project specific DQOs. In absence of project specific instruction, flag the data.		Precision and Accuracy/Bias	
MSD		Same as LCS and refer to Worksheet #15 for MS/MSD RPD.	Examine the project-specific DQOs, Contact the client as to additional measures to be taken.		Precision and Accuracy/Bias	

Notes:

The specifications in this table meet the requirements of DoD QSM 4.2.

SAP Worksheet #28-5—Laboratory QC Samples Table

Matrix: Groundwater, Surface Water, Seeps, Sediment Pore Water

Analytical Group: Cyanide

Analytical Method/SOP Reference: SW-846 9014/WETS-27

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per preparatory batch.	No analytes detected > ½ RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.	Correct problem; then repeat. If the method blank still fails; redigest and analyze all affected samples.	Analyst	Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
LCS		Refer to Worksheet #15.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.		Precision and Accuracy/Bias	
MS		Same as LCS.	In absence of client specific requirements, flag the data.		Precision and Accuracy/Bias	
MSD		Same as LCS and refer to Worksheet #15 for MS/MSD RPD.				

Notes:

The specifications in this table meet the requirements of DoD QSM 4.2.

SAP Worksheet #28-6—Laboratory QC Samples Table

Matrix: Groundwater

Analytical Group: Wet Chemistry (MEE)

Analytical Method/SOP Reference: RSK-175/VGC-11

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per preparatory batch	No target analytes > 1/2 LOQ; no common laboratory contaminants > LOQ	Correct problem. If QC acceptance limits still not met, re-prep and re-analyze method blank and all samples processed with the contaminated blank.	Analyst	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS		Refer to Worksheet #15.	LCS is reanalyzed. If still fails, samples along with QC, are re-prepped and re-analyzed. In the absence of client specific requirements, flag the data.		Precision and Accuracy/Bias	
MS/MSD		Same as LCS, see Worksheet #15 for RPD	In the absence of client specific requirements, flag the data		Precision and Accuracy/Bias	

SAP Worksheet #28-7—Laboratory QC Samples Table

Matrix: Groundwater

Analytical Group: Wet Chemistry (Chloride, Nitrate, Nitrite, Sulfate)

Analytical Method/SOP Reference: SW-846 9056/WETS-057

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per preparatory blank	No target analytes > 1/2 LOQ	Correct problem; then repeat. If the method blank still fails; repeat initial calibration.	Analyst	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS		Refer to Worksheet #15.	LCS is reanalyzed. If still fails, samples, along with QC, are re-prepped and reanalyzed. Client will be contact for guidance about whether to re-prep samples. In the absence of client specific requirements, flag the data.		Precision and Accuracy/Bias	
MS/MSD		Same as LCS, see Worksheet #15 for RPD	In the absence of client specific requirements, flag the data		Precision and Accuracy/Bias	

Notes:

The specifications in this table meet the requirements of DoD QSM 4.2.

SAP Worksheet #28-8—Laboratory QC Samples Table

Matrix: Groundwater

Analytical Group: Wet Chemistry (Sulfide)

Analytical Method/SOP Reference: 18 SM 4500-S-E/WETS-061

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per preparatory blank	No target analytes > 1/2 LOQ	Correct problem; then repeat. If the method blank still fails; repeat initial calibration.	Analyst	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS		Refer to Worksheet #15.	LCS is reanalyzed. If still fails, samples, along with QC, are re-prepped and reanalyzed. Client will be contact for guidance about whether to re-prepare samples. In the absence of client specific requirements, flag the data.		Precision and Accuracy/Bias	
MS/MSD		Same as LCS, see Worksheet #15 for RPD	In the absence of client specific requirements, flag the data		Precision and Accuracy/Bias	

SAP Worksheet #28-9—Laboratory QC Samples Table

Matrix: Groundwater

Analytical Group: Wet Chemistry (Alkalinity)

Analytical Method/SOP Reference: EPA 310.1/WETS-004

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per preparatory blank	No target analytes > 1/2 LOQ	Correct problem; then repeat. If the method blank still fails; repeat initial calibration.	Analyst	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS		Refer to Worksheet #15.	LCS is reanalyzed. If still fails, samples, along with QC, are re-prepped and reanalyzed. Client will be contact for guidance about whether to re-prepare samples. In the absence of client specific requirements, flag the data.		Precision and Accuracy/Bias	
MS/MSD		Same as LCS, see Worksheet #15 for RPD	In the absence of client specific requirements, flag the data		Precision and Accuracy/Bias	

SAP Worksheet #28-10—Laboratory QC Samples Table

Matrix: Groundwater

Analytical Group: Wet Chemistry (TOC)

Analytical Method/SOP Reference: SW-846 9060A/WETS-066

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per preparatory batch	No target analytes > 1/2 LOQ	Correct problem; then repeat. If the method blank still fails; repeat initial calibration.	Analyst	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS		Refer to Worksheet #15.	LCS is reanalyzed. If still fails, samples, along with QC, are re-prepped and reanalyzed. In the absence of client specific requirements, flag the data.		Precision and Accuracy/Bias	
MS/MSD		Same as LCS, see Worksheet #15 for RPD	In the absence of client specific requirements, flag the data		Precision and Accuracy/Bias	

SAP Worksheet #28-11—Laboratory QC Samples Table

Matrix: Groundwater

Analytical Group: Microbial

Analytical Method/SOP Reference: qPCR/MI SOP qPCR

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Assay Negative Control (Blank)	1 per analytical assay plate	Values for positive samples are set above any fluorescence for the negative control.	Rerun assay; may have to reoptimize assay.	Analyst	Accuracy/Bias, Contamination	Same as Method/SOP QC Acceptance Limits.
DNA extraction negative control		Cycle threshold \leq Assay Negative Control	Rerun assay or reextract samples if problem persists		Accuracy/Bias	
Positive Control		Calculated concentration within +/-20% of same concentration on standard curve	Rerun assay/check reagents		Accuracy/Bias	

SAP Worksheet #28-12—Laboratory QC Samples Table

Matrix: Sediment

Analytical Group: VOCs including 1,4-dioxane

Analytical Method/SOP Reference: SW-846 8260B/VGCMS-05

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method blank	One per preparatory batch	No target analytes > 1/2 LOQ and >1/10 the amount measure in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > LOQ.	Correct problem. If QC acceptance limits still not met, re-prepare and re-analyze method blank and all samples processed with the contaminated blank.	Analyst	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
Laboratory Control Sample (LCS)		Refer to Worksheet #15.	LCS is reanalyzed. If still fails, samples along with QC, are re-prepped and re-analyzed.		Precision and Accuracy/Bias	
Matrix Spike (MS)		Same as LCS.	In the absence of client specific requirements, flag the data.		Precision and Accuracy/Bias	
Matrix Spike Duplicate (MSD)		Same as LCS and refer to Worksheet #15.			Precision and Accuracy/Bias	
Internal Standards (IS)	Spiked in Every Sample	Retention time within 30 seconds from retention time of the midpoint standard in the ICAL; areas within -50% to +100% of ICAL midpoint standard.	Inspect mass spectrometer and GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.		Precision and Accuracy	
Surrogates		<i>Dibromofluoromethane 74-133%</i> , Toluene-d8 85-115%, <i>1,2-Dichloroethane-d4 59-133%</i> , 4-Bromofluorobenzene 85-120%	Re-prepare and re-analyze sample unless objective evidence of suspected or confirmed sample matrix effects are available. If insufficient sample exists for reanalysis, client will be contacted for instructions. In the absence of client instruction, data will be qualified.		Precision and Accuracy/Bias	

Notes:

¹ The specifications in this table meet the requirements of DoD QSM 4.2.

² Italicized limits indicate that in-house criteria is used when DoD QSM 4.2 does not specify.

SAP Worksheet #28-13—Laboratory QC Samples Table

Matrix: Sediment

Analytical Group: Metals (except mercury)

Analytical Method/SOP Reference: SW-846 6010C/MET-05

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per preparatory batch.	No analytes detected > 1/2 LOQ. Blank result must not otherwise affect sample results.	Correct problem; then repeat. If the method blank still fails; redigest and analyze all affected samples.	Analyst	Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
Laboratory Control Sample (LCS)		Refer to Worksheet #15.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch.		Precision and Accuracy/Bias	
Matrix Spike (MS)		Same as LCS.	If matrix spike falls outside of QC acceptance limits, additional quality control tests are required to evaluate matrix effects (dilution test, post-digestion spike).		Precision and Accuracy/Bias	
Matrix Spike Duplicate (MSD)		Same as LCS and refer to Worksheet #15 for MS/MSD RPD.			Precision and Accuracy/Bias	
Dilution Test		Recovery within ±10% of true value.	Perform Post Spike		Precision and Accuracy/Bias	
Post Spike		One is performed when dilution test fails or analyte concentration for all samples < 50x LOD.	Recovery within ± 25% of true value.		If dilution test recoveries are outside of QC acceptance limits but post spike meets QC acceptance criteria, and matrix effects are not confirmed, reprep and reanalyze sample.	

SAP Worksheet #28-14—Laboratory QC Samples Table

Matrix: Sediment

Analytical Group: Metals (mercury)

Analytical Method/SOP Reference: SW-846 7471A/MET-16 or MET-03

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per preparatory batch.	No analytes detected > 1/2 LOQ. Blank result must not otherwise affect sample results.	Correct problem; then repeat. If the method blank still fails; re-prep and re-analyze all samples processed with contaminated blank.	Analyst	Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
LCS		Refer to Worksheet #15.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch.		Precision and Accuracy/Bias	
MS		Same as LCS.	Examine the project specific DQOs. In absence of project specific instruction, flag the data.		Precision and Accuracy/Bias	
MSD		Same as LCS and refer to Worksheet #15 for MS/MSD RPD.	Examine the project-specific DQOs, Contact the client as to additional measures to be taken.		Precision and Accuracy/Bias	

Notes:

The specifications in this table meet the requirements of DoD QSM 4.2.

SAP Worksheet #28-15—Laboratory QC Samples Table

Matrix: Sediment

Analytical Group: Cyanide

Analytical Method/SOP Reference: SW-846 9014/WETS-27

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per preparatory batch.	No analytes detected > 1/2 RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.	Correct problem; then repeat. If the method blank still fails; redigest and analyze all affected samples.	Analyst	Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
LCS		Refer to Worksheet #15.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.		Precision and Accuracy/Bias	
MS		Same as LCS.	In absence of client specific requirements, flag the data.		Precision and Accuracy/Bias	
MSD		Same as LCS and RPD ≤ 20% .				

Notes:

The specifications in this table meet the requirements of DoD QSM 4.2.

SAP Worksheet #28-16—Laboratory QC Samples Table

Matrix: Sediment

Analytical Group: Wet Chemistry (TOC)

Analytical Method/SOP Reference: Walkely Black/WETS-090

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per preparatory batch.	No analytes detected > 1/2 LOQ. Blank result must not otherwise affect sample results.	There are no corrective actions for the method blank.	Analyst	Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
LCS		Refer to Worksheet #15.	The LCS is reanalyzed to confirm the contamination, which if confirmed, requires re-analysis of all associated samples.		Precision and Accuracy	
MS/MSD		50-150%, RPD 25%	In the absence of client specific requirements, flag the data		Precision and Accuracy	

SAP Worksheet #28-17—Laboratory QC Samples Table

Matrix: Sediment
 Analytical Group: Wet Chemistry (pH)
 Analytical Method/SOP Reference: SW-846 9045D/WETS-56

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
LCS	One per preparatory batch.	Refer to Worksheet #15.	The LCS is reanalyzed to confirm the contamination, which if confirmed, requires re-analysis of all associated samples.	Analyst	Precision and Accuracy	Same as Method/QC Acceptance Limits.
Duplicate		25%	If precision between duplicate samples is outside of the acceptance limits, the sample and its duplicate must be reanalyzed		Precision and Accuracy	

SAP Worksheet #28-18—Laboratory QC Samples

Matrix: Sediment (AVS extract digested as a liquid by MET-3010)

Analytical Group: SEM Metals (except mercury)

Analytical Method/SOP Reference: EPA 821_R-91-100 (SW-846 6010C)/MET-200.7

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One is performed for each batch of up to 20 samples. This blank carries through AVS extraction and SEM digestion and analysis.	If measured sample result <10 times LOQ, No analytes detected > LOQ in the blank. If measured sample result \geq 10 times LOQ, no analytes detected in the blank > 1/10 the amount measured in any sample.	Correct the problem; if acceptance limits still not met, reprep and reanalyze the method blank and all samples processed with the contaminated blank.	Analyst/Laboratory Area Supervisor	Contamination/Bias	Same as Method/SOP QC Acceptance Limits.
Digestion Blank	One is performed for each batch of 20 samples. This blank does not undergo AVS extraction. It only undergoes SEM digestion and analysis.				Contamination/Bias	
LCS	One is performed for each batch of 20 samples. The LCS is spiked after AVS extraction and before SEM digestion.	Refer to Worksheet #15.	Re-prepare and analyze all associated samples.		Accuracy/Bias	
MS/MSD	One is performed for each batch of 20 samples. The MS is spiked after AVS extraction and before SEM digestion.	Same as LCS and refer to Worksheet #15 for MS/MSD RPD.	Examine results of LCS. If both the LCS and MS/MSD are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.		Precision/Accuracy/Bias	
Serial Dilution	One is performed for each preparation batch with sample concentration(s) > 50x LOQ.	The five-fold dilution result must agree within \pm 10% of the original sample result.	Qualify the results.		Precision/Accuracy	
Post Digestion Spike	One is performed when serial dilution fails or analyte concentration(s) in all samples < 50x LOD.	The result must agree within \pm 25% of expected result.	Run all associate sample in the preparatory batch by method of standard additions or qualify results.		Precision/Accuracy	

SAP Worksheet #28-19—Laboratory QC Samples

Matrix: Sediment (AVS extract digested as a liquid)

Analytical Group: SEM Mercury

Analytical Method/SOP Reference: EPA 821_R-91-100 (SW-846 7470A)/MET-245.1

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One is performed for each batch of up to 20 samples. This blank carries through AVS extraction and SEM digestion and analysis.	If measured sample result <10 times LOQ, No analytes detected > LOQ in the blank. If measured sample result ≥10 times LOQ, no analytes detected in the blank > 1/10 the amount measured in any sample.	Correct the problem; if acceptance limits still not met, reprep and reanalyze the method blank and all samples processed with the contaminated blank.	Analyst/Laboratory Area Supervisor	Contamination/Bias	Same as Method/SOP QC Acceptance Limits.
Digestion Blank	One is performed for each batch of 20 samples. This blank does not undergo AVS extraction. It only undergoes SEM digestion and analysis.				Contamination/Bias	
LCS	One is performed for each batch of 20 samples. The LCS is spiked after AVS extraction and before SEM digestion.	Refer to Worksheet #15.	Re-prepare and analyze all associated samples.		Accuracy/Bias	
MS/MSD	One is performed for each batch of 20 samples. The MS is spiked after AVS extraction and before SEM digestion.	Same as LCS and refer to Worksheet #15 for MS/MSD RPD.	Examine results of LCS. If both the LCS and MS/MSD are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.		Precision/Accuracy/Bias	

SAP Worksheet #28-20—Laboratory QC Samples

Matrix: Sediment(AVS extract)

Analytical Group: AVS

Analytical Method/SOP Reference: EPA 821_R-91-100/GEN-AVSSEM

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One is performed for each batch of up to 20 samples.	If measured sample result <10 times LOQ, No analytes detected > LOQ in the blank. If measured sample result ≥10 times LOQ, no analytes detected in the blank > 1/10 the amount measured in any sample.	Correct the problem; if acceptance limits still not met, reprep and reanalyze the method blank and all samples processed with the contaminated blank.	Analyst/Laboratory Area Supervisor	Contamination/Bias	Same as Method/SOP QC Acceptance Limits.
LCS		Refer to Worksheet #15.	Re-prepare and analyze all associated samples.		Accuracy/Bias	
DUP		≤30 RPD	Note outlier in case narrative		Precision	
MS		Same as LCS and refer to Worksheet #15 for MS/MSD RPD.	Examine results of LCS. If both the LCS and MS are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.		Accuracy/Bias	

SAP Worksheet #29—Project Documents and Records Table

Sample Collection Documents and Records	Onsite Analysis Documents and Records	Offsite Analysis Documents and Records ¹	Data Assessment Documents and Records	Other
<ul style="list-style-type: none"> • Field Notebooks • Chain-of-Custody Records • Air Bills • Custody Seals • CA Forms • Electronic Data Deliverables • Identification of QC Samples • Meteorological Data from Field (Logging daily weather) • Sampling Instrument Calibration Logs • Sampling Locations and Sampling Plan • Sampling Notes and Drilling Logs 	<ul style="list-style-type: none"> • No onsite analysis will take place other than visual inspection of test pit excavations and collecting water quality parameters. These readings will be recorded in field logbooks as they are collected 	<ul style="list-style-type: none"> • Sample Receipt, Chain-of-Custody, and Tracking Records • Standard Traceability Logs • Equipment Calibration Logs • Sample Prep Logs • Run Logs • Equipment Maintenance, Testing, and Inspection Logs • CA Forms • Reported Field Sample Results • Reported Result for Standards, QC Checks, and QC Samples • Instrument printouts (raw data) for Field Samples, Standards, QC Checks, and QC Samples • Data Package Completeness Checklists • Sample disposal records • Extraction/Clean-up Records • Raw Data (stored on disk) 	<ul style="list-style-type: none"> • Fixed Laboratory Audit Checklists • Data Validation Reports • CA Forms • Laboratory QA Plan • Method Detection Limit (MDL) Study Information 	

¹ Offsite documents except for analytical laboratory data are archived with Iron Mountain Inc. which is headquartered at 745 Atlantic Avenue, Boston, MA 02111. Analytical laboratory data is archived with the Federal Records Center.

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SAP Worksheet #30—Analytical Services Table

Matrix	Analytical Group	Sample Locations/ID Number	Analytical Method	Data Package Turnaround Time	Laboratory/Organization	Backup Laboratory/Organization
Groundwater	Microbial	Refer to Worksheet #18 and #20	qPCR by Lab SOP	28 calendar days	Microbial Insights 2340 Stock Creek Blvd. Rockford, TN 37853 Anita Biernacki - (865) 573-8188	TBD
	VOCs		SW-846 8260B			
	VOCs (1,4-dioxane)		SW-846 8260B SIM			
	Total Metals		SW-846 6020A, 7470A			
	Dissolved Metals		SW-846 6020A, 7470A			
	Cyanide		SW-846 9014			
	Wet Chemistry (MEE, CNNS, Sulfide, Alkalinity, TOC)		Various (RSK-175, SW-846 9056, SM4500-S2-E [18th Ed], SM2330B, SW-846 9060A)			
Surface Water	VOCs		SW-846 8260B			
	VOCs (1,4-dioxane)		SW-846 8260B SIM			
	Total Metals		SW-846 6020A, 7470A			
	Dissolved Metals		SW-846 6020A, 7470A			
	Cyanide		SW-846 9014			
	Wet Chemistry (hardness, TDS)		SM2430C, EPA 160.1			
Seep	VOCs		SW-846 8260B			
	VOCs (1,4-dioxane)	SW-846 8260B SIM				
	Total Metals	SW-846 6020A, 7470A				
	Dissolved Metals	SW-846 6020A, 7470A				
Pore Water	VOCs	SW-846 8260B				
	VOCs (1,4-dioxane)	SW-846 8260B SIM				
	Total Metals	SW-846 6020A, 7470A				
	Dissolved Metals	SW-846 6020A, 7470A				
Sediment	VOCs including 1,4-dioxane	SW-846 8260B				
	Metals	SW-846 6010C, 7470A				
	Cyanide	SW-846 9014				
	Wet Chemistry (pH, Alkalinity, TOC)	Various (SW-846 9045D, SM2330B, Walkley-Black)				
	AVS/SEM	EPA 821_R-91-100				
	Grain-size	ASTM D422				
					ENCO Laboratories 10775 Central Port Drive Orlando, FL 32824 Marcia Colon - (407) 826-5314	
					ENCO with Columbia Analytical Services, Inc 1565 Jefferson Road, Building 300, Suite 360 Rochester, NY 14623 Deb Patton - 585-672-7473	
					ENCO with Kemron Environmental Services, Inc. Tommy Jordan - 404-516-3172	

Note: A backup laboratory has not been chosen at this prior. Should the need arise a backup will be chosen prior to the field event and Navy QAO will be given the opportunity to review.

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SAP Worksheet #31-1—Planned Project Assessments Table

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person Responsible for Performing Assessment	Person Responsible for Responding to Assessment Findings	Person Responsible for Identifying and Implementing CA	Person Responsible for Monitoring Effectiveness of CA
Field QA and H&S Audit	Once	Internal	CH2M HILL	Stephen Brand	TBD, FTL and Field Staff	Stephen Brand	Brett Doerr Mark Orman
Onsite Laboratory Technical Systems Audit (applies to definitive data only)	Laboratory must have a current accreditation from the DoD ELAP which will identify the period of performance and scope of analytical methods. The laboratory must be re-evaluated prior to expiration of period of performance	External	Third Party Accrediting Body	Third Party Accrediting Body (TBD)	Respective Laboratory QAO	Respective Laboratory QAO	Anita Dodson, Program Chemist, CH2M HILL

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SAP Worksheet #31-2—Laboratory 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:

Anita Dodson, CH2M HILL Program Chemist

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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 QA and H&S Audit	Checklist and Written Audit Report	Linda Saksvig/ CH2M HILL, PM	Within 1 week of audit	Memorandum	TBD FTL CH2M HILL Doug Bitterman AQM CH2M HILL	Within 1 week of receipt of CA Form
Onsite Laboratory Technical Systems Audit	Written audit report from DoD Laboratory Accrediting Body	Respective Laboratory QAO	Within 2 months of audit	Memorandum	DoD Laboratory Accrediting Body (TBD)	Within 2 months of receipt of initial notification

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SAP Worksheet #33—Quality Assurance Management Reports Table

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (title and organizational affiliation)	Report Recipient(s) (title and organizational affiliation)
Pre-FS Technical Memorandum	Post-Field Event	TBD	Linda Saksvig, PM, CH2M HILL	Stakeholders, see Worksheet #4

The Pre-Feasibility Report will address the following:

- Summary of project QA/QC requirements/procedures

- Conformance of project to UFP-SAP requirements/procedures

- Status of project schedule

- Deviations from the UFP-SAP and approved amendments that were made

- Results of data review activities (how much usable data was generated)

- CAs if needed and their effectiveness

- Data usability with regards to: precision, accuracy, representativeness, completeness, comparability, and sensitivity

- Limitations on data use

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SAP Worksheets #34-36—Data Verification and Validation (Steps I and IIa/IIb) Process Table

Data Review Input	Description	Responsible for Verification/Validation	Internal/ External ²
Field Notebooks	Field notebooks will be reviewed internally and placed into the project file for archival at project closeout.	FTL/CH2M HILL	Internal
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 chains-of-custody retained in the site file, and the original and remaining copies taped inside the cooler for shipment. Chains-of-custody will also be reviewed for adherence to the SAP by the PC.	FTL/CH2M HILL PC/CH2M HILL	Internal & External
Sample Condition upon Receipt	Any discrepancies, missing, or broken containers will be communicated to the PC in the form of laboratory logins.	PC/CH2M HILL	External
Documentation of Laboratory Method Deviations	Laboratory Method Deviations will be discussed and approved by the PC. Documentation will be incorporated into the case narrative which becomes part of the final hardcopy data package.	PC/CH2M HILL	External
Electronic Data Deliverables	Electronic Data Deliverables will be compared against hardcopy laboratory results (10% check).	PC/CH2M HILL	External
Case Narrative	Case narratives will be reviewed by the data validator during the data validation process. This is verification that they were generated and applicable to the data packages.	Data Validator/CH2M HILL	External
Laboratory Data	All laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal.	Respective Laboratory QAO	Internal
Laboratory Data	The data will be verified for completeness by the PC.	PC/CH2M HILL	External
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.	PM/CH2M HILL PC/CH2M HILL	Internal
CA Reports	CA reports will be reviewed by the PC or PM and placed into the project file for archival at project closeout.	PM/CH2M HILL PC/CH2M HILL	External
Laboratory Methods	Ensure the laboratory analyzed samples using the correct methods.	PC/CH2M HILL	External
TCL and TAL	Ensure the laboratory reported all analytes from each analysis group.	PC/CH2M HILL	External

SAP Worksheets #34-36—Data Verification and Validation (Steps I and IIa/IIb) Process Table (continued)

Data Review Input	Description	Responsible for Verification/Validation	Internal/ External ²
Reporting Limits (RLs)	Ensure the laboratory met the project-designated quantitation limits (QLs). If QLs were not met, the reason will be determined and documented.	PC/CH2M HILL	External
Field SOPs	Ensure that all field SOPs were followed.	FTL/CH2M HILL	Internal
Laboratory SOPs	Ensure that approved analytical laboratory SOPs were followed.	Respective Laboratory QAO	Internal
Raw Data	10 percent review of raw data to confirm laboratory calculations.	Data Validator/CH2M HILL	External
Onsite Screening	All non-analytical field data will be reviewed against SAP requirements for completeness and accuracy based on the field calibration records.	FTL/CH2M HILL	Internal
Documentation of Method QC Results	Establish that all required QC samples were run.	Data Validator/CH2M HILL	External
Documentation of Field QC Sample Results	Establish that all required QC samples were run.	PC/CH2M HILL	Internal
DoD ELAP Evaluation	Ensure that each laboratory is DoD ELAP Certified for the analyses they are to perform. Ensure evaluation timeframe does not expire.	PC/CH2M HILL	External
Analytical data for VOCs, Metals (total and dissolved), and 1,4-dioxane and Cyanide, in all matrixes analyzed, e.g. groundwater, surface water, seep, pore water, and/or sediment.	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, data may be qualified. The data qualifiers used are those presented in Region III Modifications to the National Functional Guidelines for Organic Data Review (USEPA, 1994) and in Region III Modifications to the Laboratory Data Validation Guidelines for Inorganic Data Review (USEPA, 1993). National Functional Guidelines will not be used for data validation; however, the specific qualifiers listed therein may be applied to data should non-conformances against the QA/QC criteria as presented in this SAP be identified.	Data Validator/CH2M HILL	External
Analytical data for wet chemistry, AVS/SEM, grain-size, or microbial in all matrixes analyzed, e.g. groundwater, surface water, or sediment.	Wet chemistry, AVS/SEM, grain-size, and microbial analytical data will not undergo third-party data validation, but are subject to all other data review protocols detailed above.	PC/CH2M HILL	NA

Notes:

¹ Verification (Step I) is a completeness check that is performed before the data review process continues in order to determine whether the required information (complete data package) is available for further review. Validation (Step IIa) is a review that the data generated is in compliance with analytical methods, procedures, and contracts. Validation (Step IIb) is a comparison of generated data against measurement performance criteria in the SAP (both sampling and analytical).

² Internal or external is in relation to the data generator.

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 quantitation limits (PQLs) in **Worksheet #15** were achieved. If PQLs were achieved and the verification and validation steps yielded acceptable data, then the data is considered usable. If PQLs were not achieved, then the reason will be investigated and documented, and the impact on data usability will be discussed in the usability assessment or elsewhere in the resulting document.
 - During verification and validation steps, data may be qualified as estimated with the following qualifiers: J, UJ, K, L, or UL. 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 and in most cases are not considered usable for project decisions.
 - J- Analyte present. Reported value is estimated and may or may not be accurate or precise
 - UJ- Analyte not detected. Reported non-detect value (LOD) may be inaccurate or imprecise
 - K- Analyte present. Reported value is estimated and may be biased high. Actual value is expected to be lower
 - L- Analyte present. Reported value is estimated and may be biased low. Actual value is expected to be higher
 - UL- Analyte not detected. QL is probably higher.
 - R- Rejected result. Result is not usable.
- Additional qualifiers that may be given by the validator include B, E, N, NJ, and U:
 - B- Not detected more than 5 times than that in an associated blank (10 times for common laboratory contaminants in VOCs)
 - N- Tentative Identification. Consider Present. Special methods may be needed to confirm its presence or absence in future sampling efforts
 - NJ- Qualitative identification questionable due to poor resolution. Presumptively present at approximate quantity
 - U- Not Detected
- For statistical comparison, non-detect values will be represented by a concentration equal to one-half the sample RL. For duplicate sample results, the greater of values 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 have been uploaded into the electronic database, another check will be performed to ensure all results were loaded accurately.
- Field and laboratory precision will be assessed as RPD between the two results.
 - Deviations from the SAP will be reviewed to assess whether CA is warranted and to assess impacts to achievement of project objectives.
 - Identify the personnel responsible for performing the usability assessment.

SAP Worksheet #37—Usability Assessment (continued)

- The PM, PC, and other team members will be responsible for compiling the data. The data will then be presented to the Partnering Team who, as a whole, will evaluate the data usability according to project objectives.

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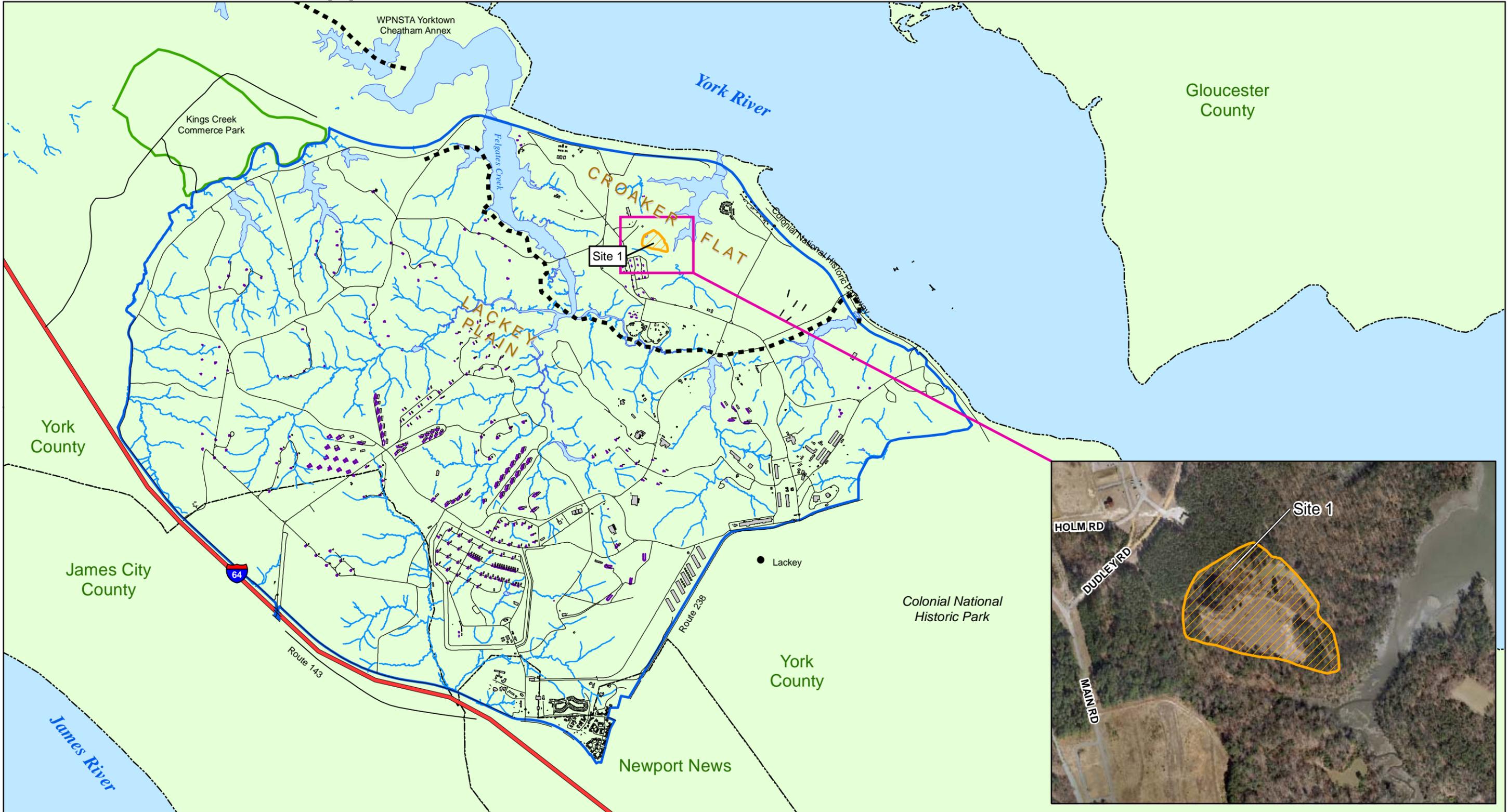
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Figures



- Legend**
- Generalized Study Area
 - Buildings and Structures
 - Yorktown Naval Weapons Station Base Boundary
 - Kings Creek Commerce Park
 - Camp Peary Scarp
 - Shoreline and Water Bodies
 - Interstate 64
 - Magazines
 - County Boundary

*All study area boundaries are solely for the purpose of showing general site locations. They are not intended to connote the extent of contamination, boundaries of investigation, or delineation of media associated with a particular site.

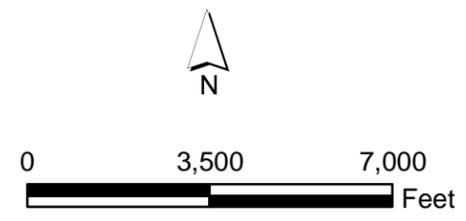


Figure 1
 Base and Site 1 Map
 Pre-FS UFP-SAP, Site 1
 Naval Weapons Station Yorktown
 Yorktown, Virginia



Legend

- Columbia Aquifer Monitoring Well
- Yorktown-Eastover Aquifer Monitoring Well
- Elevation Contour (10 ft interval)
- Tributary
- - - Intermittent Tributary
- Approximate Area of Excavation of Arsenic Contaminated Soil
- Landfill Area with New Cap (2001 Remedial Action, OHM)
- Approximate Boundary of Former Clearing and Activities
- Former Sand Reclamation Pit (Roy F. Weston, Inc., 1993)

Notes:

The extent of the landfill and soil cover is not clearly documented; however, it is anticipated that the landfill and cover do not extend outside the "Approximate Boundary of Former Clearing and Activities".

GW012 - Waste Identified during previous investigations



1 inch = 150 feet

Figure 2
Site 1 Layout
Pre-FS UFP-SAP, Site 1
WPNSTA Yorktown
Yorktown, Virginia

SYSTEM	SERIES	GEOLOGIC UNIT	HYDROGEOLOGIC UNIT IN THIS REPORT		HYDROGEOLOGIC UNIT				
QUATERNARY	HOLOCENE	ALLUVIAL AND MARSH DEPOSITS	YORK COUNTY SHALLOW AQUIFER SYSTEM	CORNWALLIS CAVE CONFINING UNIT	LACKEY PLAIN	CROAKER FLAT			
	PLEISTOCENE	TABB FORMATION			COLUMBIA AQUIFER (WHERE UNCONFINED)	COLUMBIA AQUIFER	COLUMBIA AQUIFER		
		SHIRLEY FORMATION			YORK COUNTY SHALLOW AQUIFER SYSTEM	CORNWALLIS CAVE CONFINING UNIT	COLUMBIA AQUIFER	YORKTOWN CONFINING UNIT	
		CHUCKATUCK FORMATION					CORNWALLIS CAVE CONFINING UNIT	YORKTOWN CONFINING UNIT	
		WINDSOR FORMATION					CORNWALLIS CAVE AQUIFER (WHERE CONFINED)	YORKTOWN CONFINING UNIT	
BACONS CASTLE FORMATION	CORNWALLIS CAVE AQUIFER	YORKTOWN CONFINING UNIT							
TERTIARY	PLIOCENE	SEDLEY FORMATION	YORK COUNTY SHALLOW AQUIFER SYSTEM	CORNWALLIS CAVE CONFINING UNIT	YORKTOWN CONFINING UNIT	YORKTOWN CONFINING UNIT			
		CHESAPEAKE GROUP			MOORE HOUSE MEMBER	YORK COUNTY SHALLOW AQUIFER SYSTEM	CORNWALLIS CAVE CONFINING UNIT	YORKTOWN CONFINING UNIT	YORKTOWN CONFINING UNIT
					MORGARTS BEACH MEMBER			YORKTOWN CONFINING UNIT	YORKTOWN CONFINING UNIT
					RUSHMERE MEMBER			YORKTOWN CONFINING UNIT	YORKTOWN CONFINING UNIT
					SUNKEN MEADOW MEMBER			YORKTOWN CONFINING UNIT	YORKTOWN CONFINING UNIT
	YORKTOWN FORMATION	YORKTOWN-EASTOVER AQUIFER	YORKTOWN-EASTOVER AQUIFER						
	MIOCENE	EASTOVER FORMATION	COBHAM BAY MEMBER	YORK COUNTY SHALLOW AQUIFER SYSTEM	CORNWALLIS CAVE CONFINING UNIT	YORKTOWN-EASTOVER AQUIFER	YORKTOWN-EASTOVER AQUIFER		
			CLAREMONT MANOR MEMBER			YORKTOWN-EASTOVER AQUIFER	YORKTOWN-EASTOVER AQUIFER		
		CHESAPEAKE GROUP	ST. MARYS FORMATION			YORK COUNTY SHALLOW AQUIFER SYSTEM	CORNWALLIS CAVE CONFINING UNIT	EASTOVER-CALVERT CONFINING UNIT	EASTOVER-CALVERT CONFINING UNIT
			CALVERT FORMATION					EASTOVER-CALVERT CONFINING UNIT	EASTOVER-CALVERT CONFINING UNIT

SOURCE: BROCKMAN, ET AL 1997 GEOHYDROLOGY OF THE SHALLOW AQUIFER SYSTEM, NAVAL WEAPONS STATION YORKTOWN, YORKTOWN, VIRGINIA

Figure 4
 Hydrogeologic Units in York County
 Pre-FS UFP-SAP, Site 1
 Naval Weapons Station Yorktown
 Yorktown, Virginia



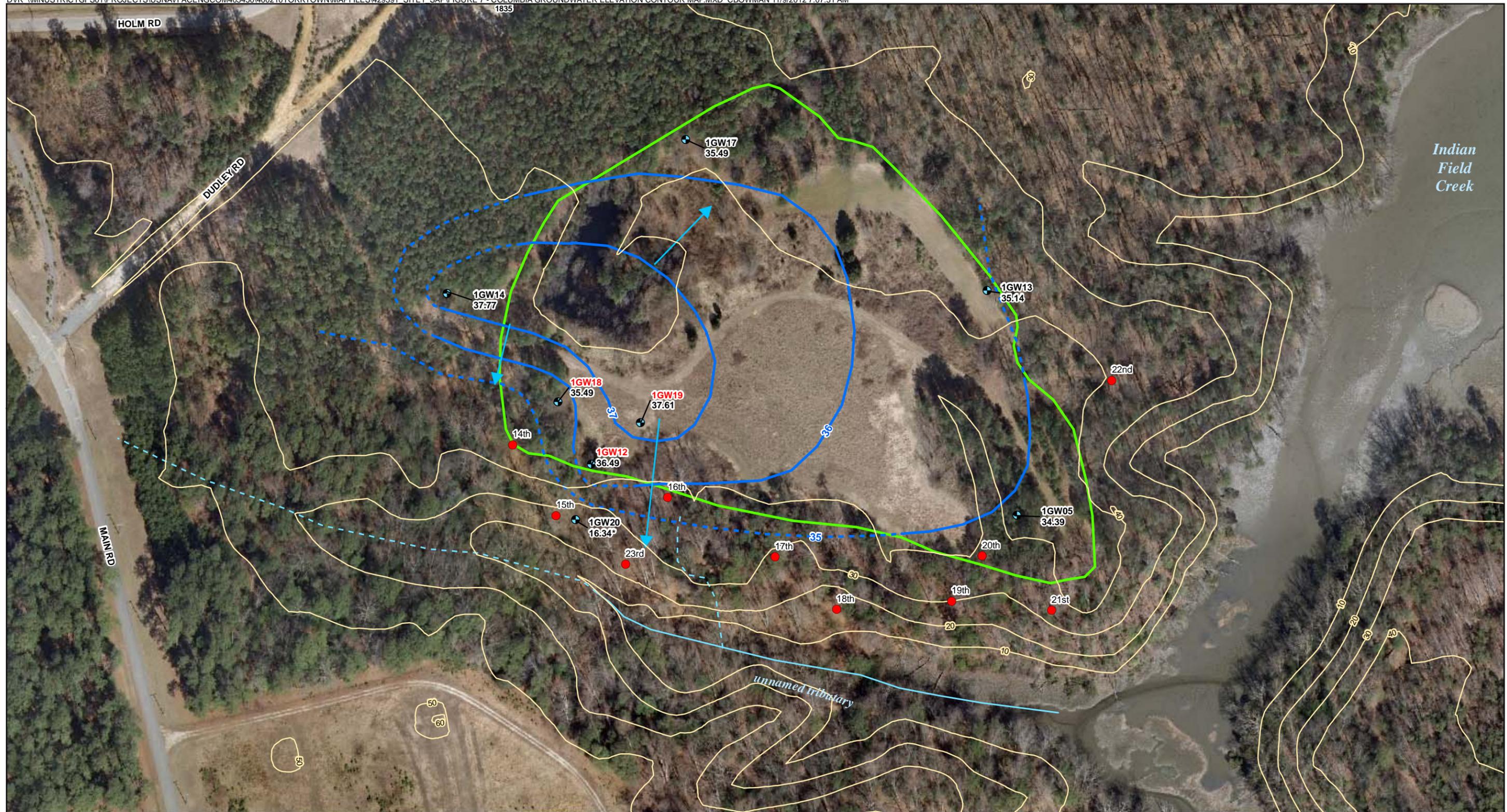
Legend

-  Camp Peary Scarp
-  Elevation Contours (20 ft interval)
-  WPNSTA Boundary
-  Generalized Study Area



0 750 1,500
Feet

Figure 5
Site Location and Major Geologic Features
Pre-FS UFP-SAP, Site 1
Naval Weapons Station, Yorktown
Yorktown, Virginia



- Legend**
- MIP Location
 - Columbia Aquifer Monitoring Well
 - Elevation Contour (10 ft interval)
 - Groundwater Flow Direction
 - Groundwater Elevation Contour
 - - - Inferred Groundwater Elevation Contour
 - Tributary
 - - - Intermittent Tributary

□ Approximate Boundary of Former Clearing and Activities

Notes:
 * - 1GW20 water elevation not used for groundwater elevation contours
GW012 - Waste Identified during previous investigations

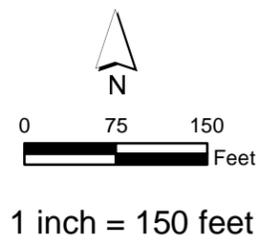
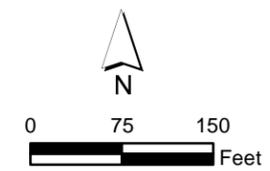


Figure 7
 Site 1 Groundwater Elevation Contour Map
 Columbia Aquifer
 Pre-FS UFP-SAP, Site 1
 Naval Weapons Station Yorktown
 Yorktown, Virginia



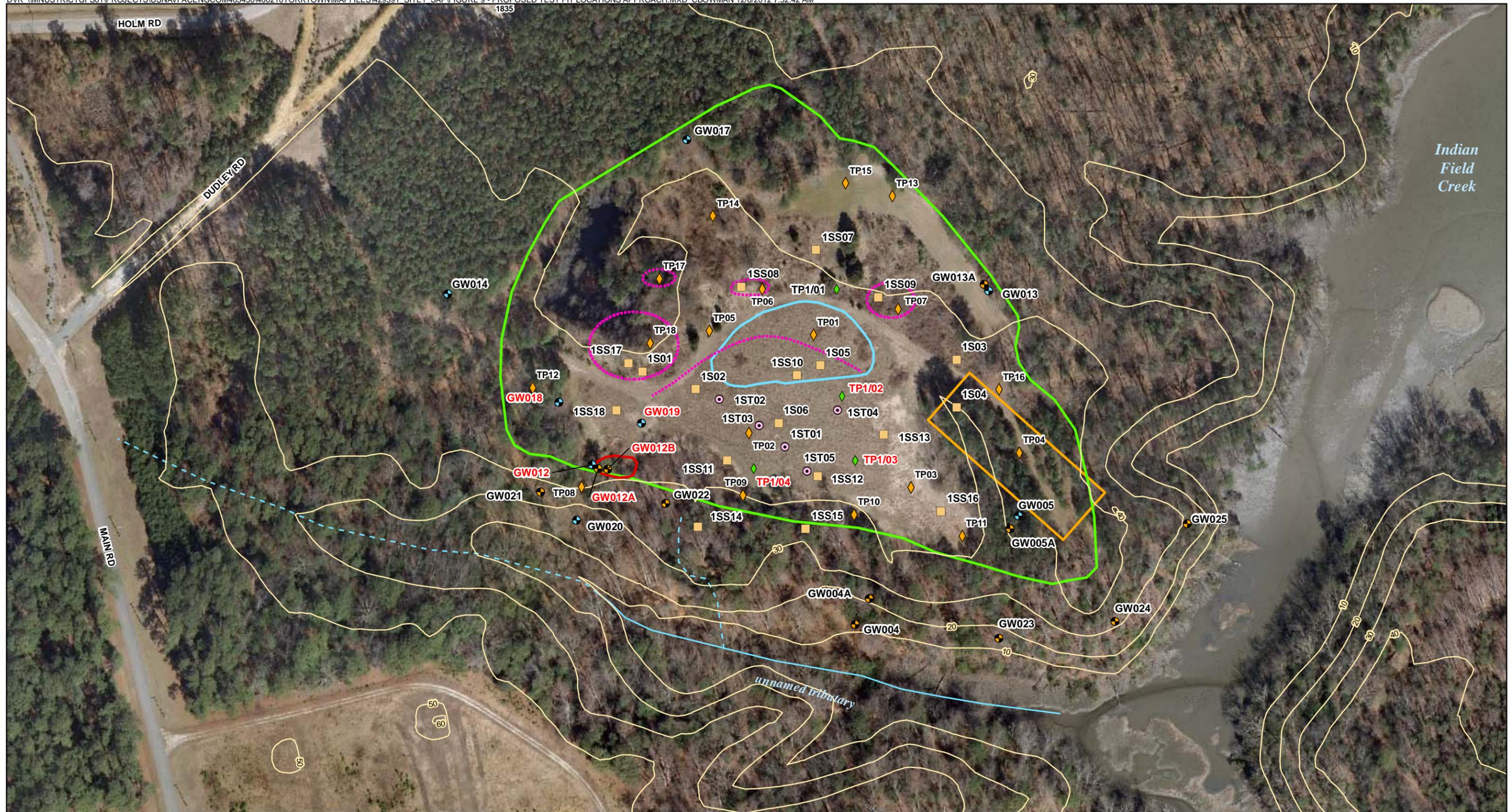
- Legend**
- Yorktown-Eastover Aquifer Monitoring Well
 - MIP Location
 - Elevation Contour (10 ft interval)
 - Groundwater Flow Direction
 - Groundwater Elevation Contour
 - Inferred Groundwater Elevation Contour
 - Tributary
 - Intermittent Tributary

GW012 - Waste Identified during previous investigations



1 inch = 150 feet

Figure 8
 Site 1 Groundwater Contour Map
 Yorktown-Eastover Aquifer
 Pre-FS UFP-SAP, Site 1
 Naval Weapons Station Yorktown
 Yorktown, Virginia



Legend

- ◆ Proposed Test Pit Location
- ◆ Previous Test Pit Location
- Previous Shelby Tube Sampling Location
- Previous Surface Soil Sampling Location
- Columbia Aquifer Monitoring Well
- Yorktown-Eastover Aquifer Monitoring Well
- Elevation Contour (10 ft interval)
- Tributary
- - - Intermittent Tributary
- Approximate locations of geophysical anomalies, (Roy F. Weston, 1993)
- Approximate Area of Excavation of Arsenic Contaminated Soil
- Landfill Area with New Cap (2001 Remedial Action, OHM)
- Approximate Boundary of Former Clearing and Activities
- Former Sand Reclamation Pit (Roy F. Weston, Inc., 1993)

Notes:

The extent of the landfill and soil cover is not clearly documented; however, it is anticipated that the landfill and cover do not extend outside the "Approximate Boundary of Former Clearing and Activities".

GW012 - Waste Identified during previous investigations



0 75 150
Feet

1 inch = 150 feet

Figure 9
Proposed Test Pit Locations and Approach
Pre-FS UFP-SAP, Site 1
WPNSTA Yorktown
Yorktown, Virginia



- Legend**
- Proposed Deep Monitoring Well
 - Proposed Shallow Monitoring Well
 - Membrane Interface Probe Location
 - Columbia Aquifer Monitoring Well
 - Yorktown-Eastover Aquifer Monitoring Well
 - Tributary
 - - Intermittent Tributary

- Approximate Area of Excavation of Arsenic Contaminated Soil
- Landfill Area with New Cap (2001 Remedial Action, OHM)
- Approximate Boundary of Former Clearing and Activities
- Former Sand Reclamation Pit (Roy F. Weston, Inc., 1993)

GW012 - Waste Identified during previous investigations

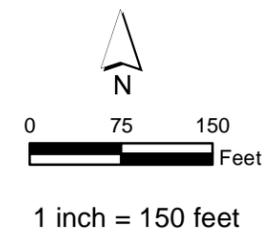


Figure 10
 Site 1 Proposed Groundwater Sample Locations
 Pre-FS UFP-SAP, Site 1
 Naval Weapons Station Yorktown
 Yorktown, Virginia

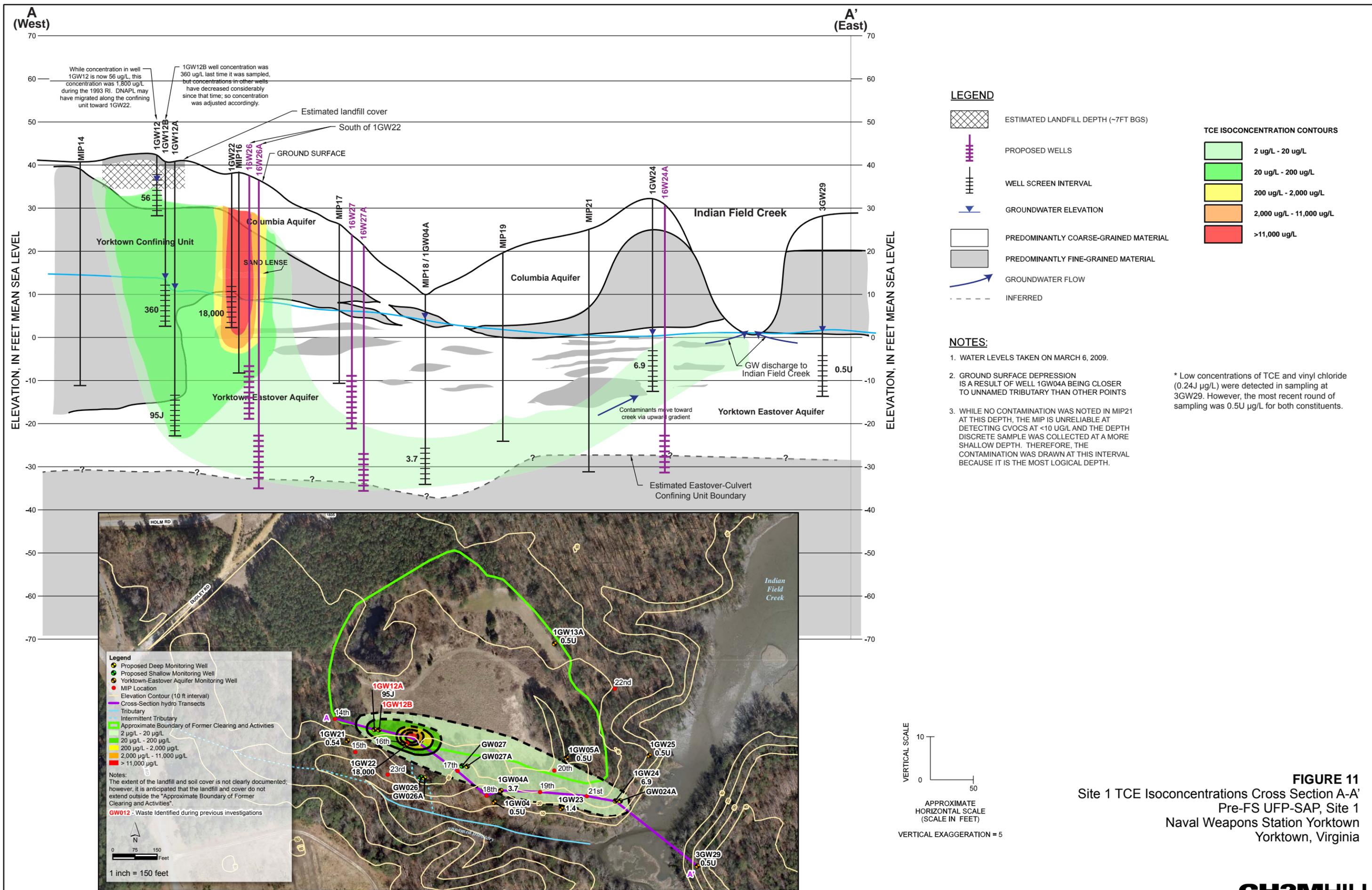
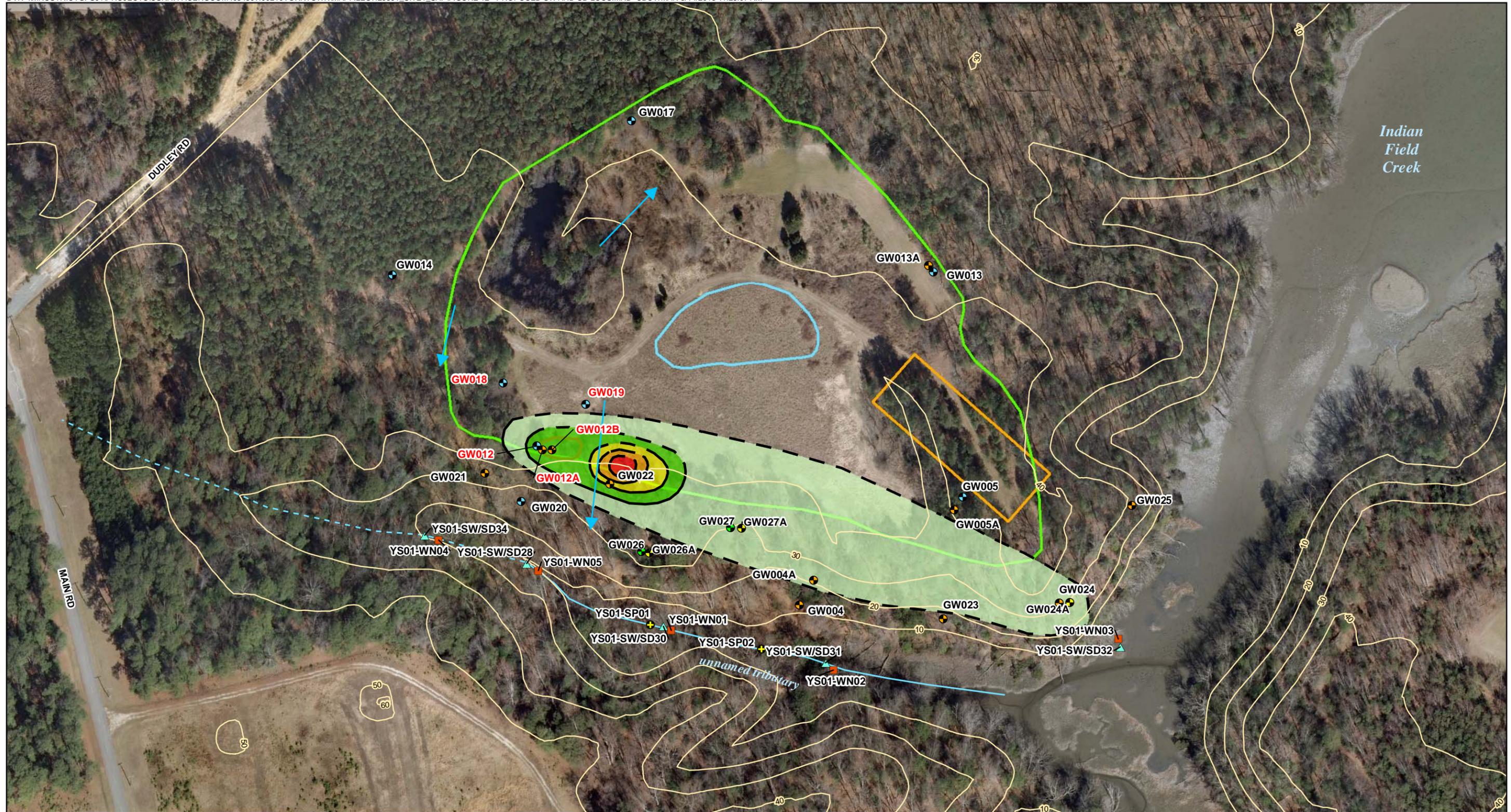


FIGURE 11
 Site 1 TCE Isoconcentrations Cross Section A-A'
 Pre-FS UFP-SAP, Site 1
 Naval Weapons Station Yorktown
 Yorktown, Virginia



Legend

- Proposed Deep Monitoring Well
- Proposed Shallow Monitoring Well
- Sediment Pore Water Sample Locations
- Surface Water and Sediment Sample Locations
- Seep Sample Location
- Columbia Aquifer Monitoring Well
- Yorktown-Eastover Aquifer Monitoring Well
- Groundwater Flow Direction
- Elevation Contour (10 ft interval)
- Tributary
- Intermittent Tributary
- Landfill Area with New Soil Cover
- Approximate Area of Excavation of Arsenic Contaminated Soil
- Approximate Boundary of Former Clearing and Activities
- Former Sand Reclamation Pit (Roy F. Weston, Inc., 1993)
- GW012** - Waste Identified during previous investigations
- 2 µg/L - 20 µg/L
- 20 µg/L - 200 µg/L
- 200 µg/L - 2,000 µg/L
- 2,000 µg/L - 11,000 µg/L
- > 11,000 µg/L

Proposed Surface Water, Sediment, and Sediment-Pore Water Sample Locations
 Pre-FS UFP-SAP, Site 1
 Naval Weapons Station Yorktown
 Yorktown, Virginia

0 75 150
 Feet

1 inch = 150 feet

Figure 12

Proposed Surface Water, Sediment, and Sediment-Pore Water Sample Locations
 Pre-FS UFP-SAP, Site 1
 Naval Weapons Station Yorktown
 Yorktown, Virginia

Appendix A
Field Standard Operating Procedures

Equipment Blank and Field Blank Preparation

I. Purpose

To prepare blanks to determine whether decontamination procedures are adequate and whether any cross-contamination is occurring during sampling due to contaminated air and dust.

II. Scope

The general protocols for preparing the blanks are outlined. The actual equipment to be rinsed will depend on the requirements of the specific sampling procedure.

III. Equipment and Materials

- Blank liquid (use ASTM Type II or lab grade water)
- Millipore™ deionized water
- Sample bottles as appropriate
- Gloves
- Preservatives as appropriate

IV. Procedures and Guidelines

- A. Decontaminate all sampling equipment that has come in contact with sample according to SOP *Decontamination of Personnel and Equipment*.
- B. To collect an equipment blank for volatile analysis from the surfaces of sampling equipment other than pumps, pour blank water over one piece of equipment and into two 40-ml vials until there is a positive meniscus, then seal the vials. Note the sample number and associated piece of equipment in the field notebook as well as the type and lot number of the water used.

For non-volatiles analyses, one aliquot is to be used for equipment. For example, if a pan and trowel are used, place trowel in pan and pour blank fluid in pan such that pan and trowel surfaces which contacted the sample are contacted by the blank fluid. Pour blank fluid from pan into appropriate sample bottles.

Do not let the blank fluid come in contact with any equipment that has not been decontaminated.

- C. When collecting an equipment blank from a pump, run an extra gallon of deionized water through the pump while collecting the pump outflow into appropriate containers. Make sure the flow rate is low when sampling VOCs. If a Grundfos Redi-Flo2 pump with disposable tubing is used, remove the disposable tubing after sampling but before decon. When decon is complete, put a 3- to 5-foot segment of new tubing onto the pump to collect the equipment blank.
- D. To collect a field blank, slowly pour ASTM Type II or lab grade water directly into sample containers.
- E. Document and ship samples in accordance with the procedures for other samples.
- F. Collect next field sample.

V. Attachments

None.

VI. Key Checks and Items

- Wear gloves.
- Do not use any non-decontaminated equipment to prepare blank.
- Use ASTM-Type II or lab grade water.

Chain-of-Custody

I Purpose

The purpose of this SOP is to provide information on chain-of-custody procedures to be used under the CLEAN Program.

II Scope

This procedure describes the steps necessary for transferring samples through the use of Chain-of-Custody Records. A Chain-of-Custody Record is required, without exception, for the tracking and recording of samples collected for on-site or off-site analysis (chemical or geotechnical) during program activities (except wellhead samples taken for measurement of field parameters). Use of the Chain-of-Custody Record Form creates an accurate written record that can be used to trace the possession and handling of the sample from the moment of its collection through analysis. This procedure identifies the necessary custody records and describes their completion. This procedure does not take precedence over region specific or site-specific requirements for chain-of-custody.

III Definitions

Chain-of-Custody Record Form - A Chain-of-Custody Record Form is a printed two-part form that accompanies a sample or group of samples as custody of the sample(s) is transferred from one custodian to another custodian. One copy of the form must be retained in the project file.

Custodian - The person responsible for the custody of samples at a particular time, until custody is transferred to another person (and so documented), who then becomes custodian. A sample is under one's custody if:

- It is in one's actual possession.
- It is in one's view, after being in one's physical possession.
- It was in one's physical possession and then he/she locked it up to prevent tampering.
- It is in a designated and identified secure area.

Sample - A sample is physical evidence collected from a facility or the environment, which is representative of conditions at the point and time that it was collected.

IV. Procedures

The term “chain-of-custody” refers to procedures which ensure that evidence presented in a court of law is valid. The chain-of-custody procedures track the evidence from the time and place it is first obtained to the courtroom, as well as providing security for the evidence as it is moved and/or passed from the custody of one individual to another.

Chain-of-custody procedures, recordkeeping, and documentation are an important part of the management control of samples. Regulatory agencies must be able to provide the chain-of-possession and custody of any samples that are offered for evidence, or that form the basis of analytical test results introduced as evidence. Written procedures must be available and followed whenever evidence samples are collected, transferred, stored, analyzed, or destroyed.

Sample Identification

The method of identification of a sample depends on the type of measurement or analysis performed. When *in situ* measurements are made, the data are recorded directly in bound logbooks or other field data records with identifying information.

Information which shall be recorded in the field logbook, when in-situ measurements or samples for laboratory analysis are collected, includes:

- Field Sampler(s),
- Contract Task Order (CTO) Number,
- Project Sample Number,
- Sample location or sampling station number,
- Date and time of sample collection and/or measurement,
- Field observations,
- Equipment used to collect samples and measurements, and
- Calibration data for equipment used

Measurements and observations shall be recorded using waterproof ink.

Sample Label

Samples, other than for *in situ* measurements, are removed and transported from the sample location to a laboratory or other location for analysis. Before removal, however, a sample is often divided into portions, depending upon the analyses to be performed. Each portion is preserved in accordance with the Sampling and Analysis Plan. Each sample container is identified by a sample label (see Attachment A). Sample labels are provided, along with sample containers, by the analytical laboratory. The information recorded on the sample label includes:

- Project - CTO Number.
- Station Location - The unique sample number identifying this sample.
- Date - A six-digit number indicating the day, month, and year of sample collection (e.g., 08/21/12).

- Time - A four-digit number indicating the 24-hour time of collection (for example: 0954 is 9:54 a.m., and 1629 is 4:29 p.m.).
- Medium - Water, soil, sediment, sludge, waste, etc.
- Sample Type - Grab or composite.
- Preservation - Type and quantity of preservation added.
- Analysis - VOA, BNAs, PCBs, pesticides, metals, cyanide, other.
- Sampled By - Printed name of the sampler.
- Remarks - Any pertinent additional information.

Using only the work assignment number of the sample label maintains the anonymity of sites. This may be necessary, even to the extent of preventing the laboratory performing the analysis from knowing the identity of the site (e.g., if the laboratory is part of an organization that has performed previous work on the site). The field team should always follow the sample ID system prepared by the project EIS and reviewed by the Project Manager.

Chain-of-Custody Procedures

After collection, separation, identification, and preservation, the sample is maintained under chain-of-custody procedures until it is in the custody of the analytical laboratory and has been stored or disposed.

Field Custody Procedures

- Samples are collected as described in the site Sampling and Analysis Plan. Care must be taken to record precisely the sample location and to ensure that the sample number on the label matches the Chain-of-Custody Record exactly.
- A Chain-of-Custody Record will be prepared for each individual cooler shipped and will include *only* the samples contained within that particular cooler. The Chain-of-Custody Record for that cooler will then be sealed in a zip-log bag and placed in the cooler prior to sealing. This ensures that the laboratory properly attributes trip blanks with the correct cooler and allows for easier tracking should a cooler become lost during transit.
- The person undertaking the actual sampling in the field is responsible for the care and custody of the samples collected until they are properly transferred or dispatched.
- When photographs are taken of the sampling as part of the documentation procedure, the name of the photographer, date, time, site location, and site description are entered sequentially in the site logbook as photos are taken. Once downloaded to the server or developed, the electronic files or photographic prints shall be serially numbered, corresponding to the logbook descriptions; photographic prints will be stored in the project files. To identify

sample locations in photographs, an easily read sign with the appropriate sample location number should be included.

- Sample labels shall be completed for each sample, using waterproof ink unless prohibited by weather conditions (e.g., a logbook notation would explain that a pencil was used to fill out the sample label if the pen would not function in freezing weather.)

Transfer of Custody and Shipment

Samples are accompanied by a Chain-of-Custody Record Form. **A Chain-of-Custody Record Form must be completed for each cooler and should include only the samples contained within that cooler.** A Chain-of-Custody Record Form example is shown in Attachment B. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the Record. This Record documents sample custody transfer from the sampler, often through another person, to the analyst in the laboratory. The Chain-of-Custody Record is filled out as given below:

- Enter header information (CTO number, samplers, and project name).
- Enter sample specific information (sample number, media, sample analysis required and analytical method grab or composite, number and type of sample containers, and date/time sample was collected).
- Sign, date, and enter the time under “Relinquished by” entry.
- Have the person receiving the sample sign the “Received by” entry. If shipping samples by a common carrier, print the carrier to be used in this space (i.e., Federal Express).
- If a carrier is used, enter the airbill number under “Remarks,” in the bottom right corner;
- Place the original (top, signed copy) of the Chain-of-Custody Record Form in a plastic zipper-type bag or other appropriate sample-shipping package. Retain the copy with field records.
- Sign and date the custody seal, a 1-inch by 3-inch white paper label with black lettering and an adhesive backing. Attachment C is an example of a custody seal. The custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field. Custody seals shall be provided by the analytical laboratory.
- Place the seal across the shipping container opening (front and back) so that it would be broken if the container were to be opened.
- Complete other carrier-required shipping papers.

The custody record is completed using waterproof ink. Any corrections are made by drawing a line through and initialing and dating the change, then entering the correct information. Erasures are not permitted.

Common carriers will usually not accept responsibility for handling Chain-of-Custody Record Forms; this necessitates packing the record in the shipping container (enclosed with other documentation in a plastic zipper-type bag). As long as custody forms are sealed inside the shipping container and the custody seals are intact, commercial carriers are not required to sign the custody form.

The laboratory representative who accepts the incoming sample shipment signs and dates the Chain-of-Custody Record, completing the sample transfer process. It is then the laboratory's responsibility to maintain internal logbooks and custody records throughout sample preparation and analysis.

V Quality Assurance Records

Once samples have been packaged and shipped, the Chain-of-Custody copy and airbill receipt become part of the quality assurance record.

VI Attachments

- A. Sample Label
- B. Chain of Custody Form
- C. Custody Seal

VII References

USEPA. *User's Guide to the Contract Laboratory Program*. Office of Emergency and Remedial Response, Washington, D.C. (EPA/540/P-91/002), January 1991.

Attachment A
Example Sample Label



Quality Analytical Laboratories, Inc.
2567 Fairlane Drive
Montgomery, Alabama 36116
PH. (334)271-2440

Client _____

Sample No. _____

Location _____

Analysis _____

Preservative **HCL** _____

Date _____ By _____

**CEIMIC
CORPORATION**

10 Dean Knauss Drive, Narragansett, R.I. 02882 • (401) 782-8900

SITE NAME _____ **DATE** _____

ANALYSIS _____ **TIME** _____

_____ **PRESERVATIVE** _____

SAMPLE TYPE

Grab Composite Other _____

COLLECTED BY: _____

Attachment B
Example Chain-of-Custody Record

Attachment C
Example Custody Seal



CUSTODY SEAL

Date _____

Signature _____

Global Positioning System

I. Purpose

The procedure describes the calibration, operation, and functions associated with a Trimble® Pro XRS GPS Unit with a TSC-1 Asset Surveyor for datalogging. GPS signal information is differentially corrected to sub-meter accuracy on a continual basis using a second satellite signal broadcast from OmniSTAR satellite subscription service. The procedure applies to all field data collection activities.

II. Scope

This procedure provides information regarding the field operation and general maintenance of a Trimble® Pro XRS GPS Unit with a TSC-1 Asset Surveyor for datalogging. The information contained herein presents the operation procedures for this equipment. Review of the equipment's instruction manual is a necessity for more detailed descriptions pertaining to the operation and maintenance of the equipment.

III. Definitions

GPS: Global Positioning System - A system of 24 satellites developed and operated by the US DOD. Continuous 3D coordinate information is broadcast free of charge on a worldwide basis enabling precise positional location. Three standard categories of positional accuracy are generally used:

1. Uncorrected Signal - accuracy +/-10 meters - a single satellite transmission is used
2. Differentially Corrected Signal - accuracy +/- <1 meter - additional positional transmissions are recorded simultaneously and used to triangulate coordinate position.
3. Carrier Phase Signal- accuracy +/- <1 centimeter - requires a second receiver and additional software. Both receivers need to be equipped to receive Carrier Phase signals.

IV. Procedures and Guidelines

The procedure for calibration, operation, and maintenance of the GPS unit is outlined below. Daily calibration and battery recharging is typical operating procedure; frequencies other than daily shall be noted in the logbook and reason for increased frequency recorded. If using a different instrument, the operation manual supplied by the manufacturer should be consulted for instructions.

The procedures described below include additional features pre-programmed into the GPS datalogger to aid the data collection process.

A. Calibration

1. Check to ensure that the datalogger and antenna cables are properly connected to the receiver and that the batteries are securely connected.
2. Turn the datalogger unit on by pressing the green **On** key in the bottom left corner. The datalogger will perform a self-calibration. Wait to ensure that the antenna is receiving a sufficient number of satellite signals (usually a minimum of 3).
3. Once the datalogger receives a satellite signal then it is ready for operation.

B. Operations for surveying coordinates of a location

1. The datalogger and GPS receiver are ready for use after the initial self-calibration.
2. Field data may be immediately recorded in the datalogger.
3. The first screen view is the 'Main Menu'. Use the round keypad to select 'Data Collection' and press the **Enter** key.
4. Use the round keypad to select either 'Create new file' or 'Open existing file' and press the **Enter** key. It is not necessary to create a new file at each new location; however, it may be useful to create a new file at the beginning of each day.
5. If a new file is created then the GPS unit will automatically assign it a file name. The file name may be changed if desired. Press the enter key after the file name is assigned. If opening an existing file then use the round keypad to scroll through existing file names.
6. The next screen is 'Antenna options'. Press the **Enter** key to move to the next screen.
7. Select the type of activity to be performed. At the beginning of each day 'Sample Site Detail' should be completed. This allows the operator to enter each field team member, weather, objectives, health and safety meetings, etc. Once the 'Sample Site Detail' is completed then data entry activities may begin including well purging, water level elevations, and sample collection
8. The datalogger prompts the operator when a data field is required and by using the round key pad, numeric, alphanumeric, enter, and escape keys, the operator can perform electronic data capture on the GPS datalogger.
9. Once all information pertaining to an individual site has been recorded, press enter to complete data entry. If GPS signal is obstructed (tree canopy, building height, etc) user may choose to remain in same location until satellite transmission clears the obstruction. This usually takes only a few moments. Data may still be captured and recorded electronically even if GPS signal is insufficient for positioning.
10. To shut down, press the **Escape** key to return to the 'Main Menu'. The unit can be turned off by pressing the green key in the left hand corner. The datalogger should only be turned off when the 'Main Menu' screen is displayed.
11. All data from the datalogger should be downloaded into Trimble Pathfinder Office software on a PC a minimum of once daily. It is recommended that data is downloaded twice daily. Data may be viewed and mapped using Pathfinder Office or exported to

other software. Export file formats support standard ASCII text, generic database .dbf and most GIS and CAD software.

C. Operations for locating a point using coordinates/reacquiring a previously surveyed location

1. The datalogger and GPS receiver are ready for use after the initial self-calibration.
2. Use the Trimble Pathfinder software to load the data file containing the coordinates for each desired location (“programmed location”).
3. The first screen view is the 'Main Menu'. Use the keypad to select 'Navigation' and press the **Enter** key.
4. Use the round keypad to select 'Open existing file' to open the file loaded in Step 2 above.
5. Select the location to be reacquired from the screen and press the enter key.
6. A circle with an arrow will appear. As you begin walking, the arrow will point in the direction of the programmed location. Walk in the direction indicated by the arrow.
7. Once you are within 10-feet of the location being reacquired, the GPS unit will display a circle (representing the programmed location) and an “X” (representing the GPS unit). Continue to walk in the direction of the circle until the “X” is centered in the circle. Once the “X” is centered, you are standing at the programmed location.
8. To shut down, press the **Escape** key to return to the 'Main Menu'. The unit can be turned off by pressing the green key in the left hand corner. The datalogger should only be turned off when the 'Main Menu' screen is displayed.

D. Preventive Maintenance

The antenna and datalogger are weatherproof. It is recommended that the receiver remain in the provided backpack carrier. Care should be taken not to crease, pinch or bend the antenna cable. Data should be downloaded from the datalogger a minimum of once daily, twice daily is preferred. At the end of each day the receiver batteries should be recharged. For technical assistance call the rental company through which you acquired the Trimble® unit. Guidance is also provided in the manual and at <http://www.trimble.com>.

Homogenization of Soil and Sediment Samples

I. Purpose

The homogenization of soil and sediment samples is performed to minimize any bias of sample representativeness introduced by the natural stratification of constituents within the sample.

II. Scope

Standard techniques for soil and sediment homogenization and equipment are provided in this SOP. These procedures do not apply to aliquots collected for VOCs or field GC screening; samples for these analyses should NOT be homogenized.

III. Equipment and Materials

Sample containers, stainless steel spoons or spatulas, and stainless steel pans.

IV. Procedures and Guidelines

Soil and sediment samples to be analyzed for semivolatiles, pesticides, PCBs, metals, cyanide, or field XRF screening should be homogenized in the field. After a sample is taken, a stainless steel spatula should be used to remove the sample from the split spoon or other sampling device. The sampler should not use fingers to do this, as gloves may introduce organic interferences into the sample.

Samples for VOCs should be taken immediately upon collection and should not be homogenized.

Prior to homogenizing the soil or sediment sample, any rocks, twigs, leaves, or other debris should be removed from the sample. The sample should be placed in a decontaminated stainless steel pan and thoroughly mixed using a stainless steel spoon. The soil or sediment material in the pan should be scraped from the sides, corners, and bottom, rolled into the middle of the pan, and initially mixed. The sample should then be quartered and moved to the four corners of the pan. Each quarter of the sample should be mixed individually, and then rolled to the center of the pan and mixed with the entire sample again.

All stainless steel spoons, spatulas, and pans must be decontaminated following procedures specified in SOP *Decontamination of Personnel and Equipment* prior to homogenizing the sample. A composite equipment rinse blank of homogenization equipment should be taken each day it is used.

V. Attachments

None.

VI. Key Checks and Items

- Take VOC samples immediately and do not homogenize the soil.
- Homogenize soil for analyses other than VOCs in a clean, stainless steel bowl.

Preparing Field Log Books

I. Purpose

This SOP provides general guidelines for entering field data into log books during site investigation and remediation activities.

II. Scope

This is a general description of data requirements and format for field log books. Log books are needed to properly document all field activities in support of data evaluation and possible legal activities.

III. Equipment and Materials

- Log book
- Indelible pen

IV. Procedures and Guidelines

Properly completed field log books are a requirement for much of the work we perform under the Navy CLEAN contract. Log books are legal documents and, as such, must be prepared following specific procedures and must contain required information to ensure their integrity and legitimacy. This SOP describes the basic requirements for field log book entries.

A. PROCEDURES FOR COMPLETING FIELD LOG BOOKS

1. Field notes commonly are kept in bound, hard-cover logbooks used by surveyors and produced, for example, by Peninsular Publishing Company and SESCO, Inc. Pages should be water-resistant and notes should be taken only with water-proof, non-erasable permanent ink, such as that provided in Sanford Sharpie® permanent markers.
2. On the inside cover of the log book the following information should be included:
 - Company name and address
 - Log-holders name if log book was assigned specifically to that person
 - Activity or location

- Project name
 - Project manager's name
 - Phone numbers of the company, supervisors, emergency response, etc.
3. All lines of all pages should be used to prevent later additions of text, which could later be questioned. Any line not used should be marked through with a line and initialed and dated. Any pages not used should be marked through with a line, the author's initials, the date, and the note "Intentionally Left Blank."
 4. If errors are made in the log book, cross a single line through the error and enter the correct information. All corrections shall be initialed and dated by the personnel performing the correction. If possible, all corrections should be made by the individual who made the error.
 5. Daily entries will be made chronologically.
 6. Information will be recorded directly in the field log book during the work activity. Information will not be written on a separate sheet and then later transcribed into the log book.
 7. Each page of the log book will have the date of the work and the note takers initials.
 8. The final page of each day's notes will include the note-takers signature as well as the date.
 9. Only information relevant to the subject project will be added to the log book.
 10. The field notes will be copied and the copies sent to the Project Manager or designee in a timely manner (at least by the end of each week of work being performed).

B. INFORMATION TO BE INCLUDED IN FIELD LOG BOOKS

1. Entries into the log book should be as detailed and descriptive as possible so that a particular situation can be recalled without reliance on the collector's memory. Entries must be legible and complete.
2. General project information will be recorded at the beginning of each field project. This will include the project title, the project number, and project staff.
3. Scope: Describe the general scope of work to be performed each day.
4. Weather: Record the weather conditions and any significant changes in the weather during the day.
5. Tail Gate Safety Meetings: Record time and location of meeting, who was present, topics discussed, issues/problems/concerns identified,

and corrective actions or adjustments made to address concerns/problems, and other pertinent information.

6. Standard Health and Safety Procedures: Record level of personal protection being used (e.g., level D PPE), record air monitoring data on a regular basis and note where data were recording (e.g., reading in borehole, reading in breathing zone, etc). Also record other required health and safety procedures as specified in the project specific health and safety plan.
7. Instrument Calibration; Record calibration information for each piece of health and safety and field equipment.
8. Personnel: Record names of all personnel present during field activities and list their roles and their affiliation. Record when personnel and visitors enter and leave a project site and their level of personal protection.
9. Communications: Record communications with project manager, subcontractors, regulators, facility personnel, and others that impact performance of the project.
10. Time: Keep a running time log explaining field activities as they occur chronologically throughout the day.
11. Deviations from the Work Plan: Record any deviations from the work plan and document why these were required and any communications authorizing these deviations.
12. Health and Safety Incidents: Record any health and safety incidents and immediately report any incidents to the Project Manager.
13. Subcontractor Information: Record name of company, record names and roles of subcontractor personnel, list type of equipment being used and general scope of work. List times of starting and stopping work and quantities of consumable equipment used if it is to be billed to the project.
14. Problems and Corrective Actions: Clearly describe any problems encountered during the field work and the corrective actions taken to address these problems.
15. Technical and Project Information: Describe the details of the work being performed. The technical information recorded will vary significantly between projects. The project work plan will describe the specific activities to be performed and may also list requirements for note taking. Discuss note-taking expectations with the Project Manager prior to beginning the field work.
16. Any conditions that might adversely affect the work or any data obtained (e.g., nearby construction that might have introduced excessive amounts of dust into the air).

17. Sampling Information; Specific information that will be relevant to most sampling jobs includes the following:
- Description of the general sampling area – site name, buildings and streets in the area, etc.
 - Station/Location identifier
 - Description of the sample location – estimate location in comparison to two fixed points – draw a diagram in the field log book indicating sample location relative to these fixed points – include distances in feet.
 - Sample matrix and type
 - Sample date and time
 - Sample identifier
 - Draw a box around the sample ID so that it stands out in the field notes
 - Information on how the sample was collected – distinguish between “grab,” “composite,” and “discrete” samples
 - Number and type of sample containers collected
 - Record of any field measurements taken (i.e. pH, turbidity, dissolved oxygen, and temperature, and conductivity)
 - Parameters to be analyzed for, if appropriate
 - Descriptions of soil samples and drilling cuttings can be entered in depth sequence, along with PID readings and other observations. Include any unusual appearances of the samples.

C. SUGGESTED FORMAT FOR RECORDING FIELD DATA

1. Use the left side border to record times and the remainder of the page to record information (see attached example).
2. Use tables to record sampling information and field data from multiple samples.
3. Sketch sampling locations and other pertinent information.
4. Sketch well construction diagrams.

V. Attachments

Example field notes.

471 MAY 12, 2003 EXAMPLE

0715 ARRIVE ON SITE AT XYZ SITE.
 CH2M HILL STAFF:
 JOHN SMITH: FIELD TEAM LEADER
 BOB BUILDER: SITE SAFETY COORD.
 WEATHER: OVERCAST + COOL, 45°F
 CHANCE OF LATE SHOWERS
 SCORE: • COLLECT GROUNDWATER SAMPLES FOR LTM WORK AT SITE 14
 • SCHEDULE SURVEY CREW
 AT SITE 17
 BB ~~arr~~ (35) Calibrates
 PID: 101 ppm/100 ppm OK
 PID Model #, SERIAL #
 BB Calibrates HORIBA METER
 Model #, SERIAL #
 → List Calibration Results
 0738 Survey Crew Arrives on Site
 → List NAMES
 0745 BB Holds H+S Talk on Slips, Trips, Falls, Ticks + Air Monitoring
 IS + Survey Crew Attend
 No H+S Issues Identified as concerns. All work s in "Level D."
 0755 IS Conducts site-wide Air Monitoring
 All readings = 0.0 ppm in

TS
5-12-03

MAY 12, 2003 EXAMPLE 48

0805 BREATHING ZONE (BZ)
 Mobilize to well MW-22 to sample / surveyors setting up
 AT SITE 17
 0815 PM (PAUL PAPER PUSHER) calls AND informs IS to collect Geo sample
 AT well MW-44 today for 24 hr TAT ANALYSIS OF VOCs
 0820 Purging MW-22
 → RECORD WATER QUALITY DATA
 0843 Collect sample AT MW-22 for total TAL Metals and VOCs. no Dissolved Metals Needed per PPT
 0905 IS + BB Mobilize to site 17 to show surveyors wells to survey.
 0942 Mobilize to well MW-22 to collect sample
 0950 Can not access well MW-22 due to BASE OPERATIONS. Contact Paul Paperpusher and he started he will check on Gateway Access with BASE contact.
 0955 Mobilize to well MW-19

TS
5-12-03

TS
5-12-03

Sediment Sampling

I. Purpose

These general outlines describe the collection and handling of sediment samples during field operations.

II. Scope

The sediment sampling procedures generally describe the equipment and techniques needed to collect representative sediment samples. Operators manual, if available, should be consulted for specific details

III. Equipment and Materials

- Sample collection device (hand corer, scoop, dredge, grab sampler, or other suitable device)
- Stainless steel spoon or spatula or plastic disposable scoop for media transfer
- Measuring tape
- Log book
- Personal protection equipment (rubber or latex gloves, boots, hip waders, etc.)
- Materials for classifying soils, particularly the percentage of fines
- Sample jars, including jars for Total Organic Carbon and pH, as appropriate

IV. Procedures and Guidelines

1. Field personnel will start downstream and work upstream to prevent contamination of unsampled areas. In surface water bodies that are tidally influenced, sampling will be performed at low tide and under low flow conditions to minimize the dilution of possible contaminants. Sediment sampling activities will not occur immediately after periods of heavy rainfall.
2. Make a sketch of the sample area that shows important nearby river features and permanent structures that can be used to locate the sample points on a map. Whenever possible, include measured distances from such identifying features. Also include depth and width of waterway, rate of flow, type and consistency of sediment, and point and depth of sample removal (along shore, mid-channel, etc).

3. Note in the field book any possible outside sources of contamination; for example, the outlet to a drainage culvert in the water body near your sampling location.
4. Transfer sample into appropriate sample jars with a stainless steel utensil or plastic disposable scoop. Be especially careful to avoid the loss of the very fine clay/silt particles when collecting the sample. The fine particles have a higher adsorption capacity than larger particles. Minimize the amount of water that is collected within the sample matrix. Decant the water off of the sample slowly and carefully to maximize retention of the very fine particles. The sampler's fingers should never touch the sediment since gloves may introduce organic interference into the sample. Classify the soil type of the sample using the Unified Soil Classification System, noting particularly the percentage of silt and clay.
5. Samples for volatile organics should immediately be placed in jars. Rocks and other debris should be removed before placement in jars.
6. For channel sampling, be on the alert for submerged hazards (rocks, tree roots, drop-offs, loss silt and muck) which can make wading difficult.
7. Sample sediment for TOC and pH also, to give context to organic and inorganic data during the risk assessment.
8. Follow the site safety plan designed for the specific nature of the site's sampling activities and locations.
9. Decontaminate all sampling implements and protective clothing according to prescribed procedures.

V. Attachments

None.

VI. Key Checks and Items

- Start downstream, work upstream.
- Log exact locations using permanent features.
- Beware of hidden hazards.

Packaging and Shipping Procedures for Low-Concentration Samples

I. Purpose and Scope

The purpose of this guideline is to describe the packaging and shipping of low-concentration samples of various media to a laboratory for analysis.

II. Scope

The guideline only discusses the packaging and shipping of samples that are anticipated to have low concentrations of chemical constituents. Whether or not samples should be classified as low-concentration or otherwise will depend upon the site history, observation of the samples in the field, odor, and photoionization-detector readings.

If the site is known to have produced high-concentration samples in the past or the sampler suspects that high concentrations of contaminants might be present in the samples, then the sampler should conservatively assume that the samples cannot be classified as low-concentration. Samples that are anticipated to have medium to high concentrations of constituents should be packaged and shipped accordingly.

If warranted, procedures for dangerous-goods shipping may be implemented. Dangerous goods and hazardous materials pose an unreasonable risk to health, safety, or property during transportation without special handling. As a result only employees who are trained under CH2M HILL Dangerous Goods Shipping course may ship or transport dangerous goods. Employees should utilize the HAZMAT ShipRight tool on the Virtual Office and/or contact a designated CH2M HILL HazMat advisor with questions.

III. Equipment and Materials

- Coolers
- Clear tape
- "This Side Up" labels
- "Fragile" labels
- Vermiculite
- Ziplock bags or bubble wrap
- Ice
- Chain-of-Custody form (completed)
- Custody seals

IV. Procedures and Guidelines

Low-Concentration Samples

- A. Prepare coolers for shipment:
 - Tape drains shut.
 - Affix "This Side Up" labels on all four sides and "Fragile" labels on at least two sides of each cooler.
 - Place mailing label with laboratory address on top of coolers.
 - Fill bottom of coolers with about 3 inches of vermiculite or absorbent pads.
- B. Arrange decontaminated sample containers in groups by sample number. Consolidate VOC samples into one cooler to minimize the need for trip blanks.
- C. Affix appropriate adhesive sample labels to each container. Protect with clear label protection tape.
- D. Seal each sample bottle within a separate ziplock plastic bag or bubble wrap, if available. Tape the bag around bottle. Sample label should be visible through the bag.
- E. Arrange sample bottles in coolers so that they do not touch.
- F. If ice is required to preserve the samples, cubes should be repackaged in zip-lock bags and placed on and around the containers.
- G. Fill remaining spaces with vermiculite or absorbent pads.
- H. Complete and sign chain-of-custody form (or obtain signature) and indicate the time and date it was relinquished to Federal Express or the courier.
- J. Close lid and latch.
- K. Carefully peel custody seals from backings and place intact over lid openings (right front and left back). Cover seals with clear protection tape.
- L. Tape cooler shut on both ends, making several complete revolutions with strapping tape. Cover custody seals with tape to avoid seals being able to be peeled from the cooler.
- M. Relinquish to Federal Express or to a courier arranged with the laboratory. Place airbill receipt inside the mailing envelope and send to the sample documentation coordinator along with the other documentation.

Medium- and High-Concentration Samples:

Medium- and high-concentration samples are packaged using the same techniques used to package low-concentration samples, with potential additional restrictions. If applicable, the sample handler must refer to instructions associated with the shipping of dangerous goods for the necessary procedures for shipping by Federal Express or other overnight carrier. If warranted, procedures for dangerous-goods shipping may be implemented. Dangerous goods and hazardous materials pose an unreasonable risk to health, safety, or property during transportation without special handling. As a result only employees who are trained under CH2M HILL Dangerous Goods Shipping course may ship or transport dangerous goods. Employees should utilize the HAZMAT ShipRight tool on the Virtual Office and/or contact a designated CH2M HILL HazMat advisor with questions.

V. Attachments

None.

VI. Key Checks and Items

- Be sure laboratory address is correct on the mailing label
- Pack sample bottles carefully, with adequate vermiculite or other packaging and without allowing bottles to touch
- Be sure there is adequate ice
- Include chain-of-custody form
- Include custody seals

Decontamination of Drilling Rigs and Equipment

I. Purpose and Scope

The purpose of this guideline is to provide methods for the decontamination of drilling rigs, downhole drilling tools, and water-level measurement equipment. Personnel decontamination procedures are not addressed in this SOP; refer to the site safety plan and SOP *Decontamination of Personnel and Equipment*. Sample bottles will not be field decontaminated; instead they will be purchased with certification of laboratory sterilization.

II. Equipment and Materials

- Portable steam cleaner and related equipment
- Potable water
- Phosphate-free detergent such as Liquinox®
- Buckets
- Brushes
- Isopropanol, pesticide grade
- Personal Protective Equipment as specified by the Health and Safety Plan
- ASTM-Type II grade water or Lab Grade DI Water
- Aluminum foil

III. Procedures and Guidelines

A. Drilling Rigs and Monitoring Well Materials

Before the onset of drilling, after each borehole, before drilling through permanent isolation casing, and before leaving the site, heavy equipment and machinery will be decontaminated by steam cleaning at a designated area. The steam-cleaning area will be designed to contain decontamination wastes and waste waters and can be an HDPE-lined, bermed pad. A pumping system will be used to convey decontaminated water from the pad to drums.

Surface casings may be steam cleaned in the field if they are exposed to contamination at the site prior to use.

B. Downhole Drilling Tools

Downhole tools will be steam cleaned before the onset of drilling, prior to drilling through permanent isolation casing, between boreholes, and prior to leaving the site. This will include, but is not limited to, rods, split spoons or similar samplers, coring equipment, augers, and casing.

Before the use of a sampling device such as a split-spoon sampler for the collection of a soil sample for physical characterization, the sampler shall be cleaned by scrubbing with a detergent solution followed by a potable water rinse.

Before the use of a sampling device such as a split-spoon sampler for the collection of a soil sample for chemical analysis, the sampler shall be decontaminated following the procedures outlined in the following subsection.

C. Field Analytical Equipment

1. Water Level Indicators

Water level indicators that consist of a probe that comes into contact with the groundwater must be decontaminated using the following steps:

- a. Rinse with tap water
- b. Rinse with de-ionized water
- c. Solvent rinse with isopropanol
- d. Rinse with de-ionized water

2. Probes

Probes, for example, pH or specific ion electrodes, geophysical probes, or thermometers that would come in direct contact with the sample, will be decontaminated using the procedures specified above unless manufacturer's instructions indicate otherwise. For probes that make no direct contact, for example, OVM equipment, the probe will be wiped with clean paper-towels or cloth wetted with isopropanol.

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

- The effectiveness of field cleaning procedures may be monitored by rinsing decontaminated equipment with organic-free water and submitting the rinse water in standard sample containers for analysis.

Decontamination of Personnel and Equipment

I. Purpose

To provide general guidelines for the decontamination of personnel, sampling equipment, and monitoring equipment used in potentially contaminated environments.

II. Scope

This is a general description of decontamination procedures.

III. Equipment and Materials

- Demonstrated analyte-free, deionized (“DI”) water (specifically, ASTM Type II water or lab-grade DI water)
- Potable water; must be from a municipal water supplier, otherwise an analysis must be run for appropriate volatile and semivolatile organic compounds and inorganic chemicals (e.g., Target Compound List and Target Analyte List chemicals)
- 2.5% (W/W) Liquinox[®] (or Alconox[®]) and water solution
- Concentrated (V/V) pesticide grade isopropanol (DO NOT USE ACETONE)
- Large plastic pails or tubs for Liquinox[®] and water, scrub brushes, squirt bottles for Liquinox[®] solution, methanol and water, plastic bags and sheets
- DOT approved 55-gallon drum for disposal of waste
- Personal Protective Equipment as specified by the Health and Safety Plan
- Decontamination pad and steam cleaner/high pressure cleaner for large equipment

IV. Procedures and Guidelines

A. PERSONNEL DECONTAMINATION

To be performed after completion of tasks whenever potential for contamination exists, and upon leaving the exclusion zone.

1. Wash boots in Liquinox[®] solution, then rinse with water. If disposable latex booties are worn over boots in the work area, rinse with Liquinox[®] solution, remove, and discard into DOT-approved 55-gallon drum.
2. Wash outer gloves in Liquinox[®] solution, rinse, remove, and discard into DOT-approved 55-gallon drum.
3. Remove disposable coveralls (“Tyveks”) and discard into DOT-approved 55-gallon drum.
4. Remove respirator (if worn).
5. Remove inner gloves and discard.
6. At the end of the work day, shower entire body, including hair, either at the work site or at home.
7. Sanitize respirator if worn.

B. SAMPLING EQUIPMENT DECONTAMINATION – GROUNDWATER SAMPLING PUMPS

Sampling pumps are decontaminated after each use as follows.

1. Don phthalate-free gloves.
2. Spread plastic on the ground to keep equipment from touching the ground
3. Turn off pump after sampling. Remove pump from well and remove and dispose of tubing. Place pump in decontamination tube.
4. Turn pump back on and pump 1 gallon of Liquinox[®] solution through the sampling pump.
5. Rinse with 1 gallon of 10% isopropanol solution pumped through the pump. (DO NOT USE ACETONE).
6. Rinse with 1 gallon of tap water.
7. Rinse with 1 gallon of deionized water.
8. Keep decontaminated pump in decontamination tube or remove and wrap in aluminum foil or clean plastic sheeting.
9. Collect all rinsate and dispose of in a DOT-approved 55-gallon drum.
10. Decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment will be disposed of in either DOT-approved 55-gallon drums or with solid waste in garbage bags, dependent on Facility/project requirements.

C. SAMPLING EQUIPMENT DECONTAMINATION – OTHER EQUIPMENT

Reusable sampling equipment is decontaminated after each use as follows.

1. Don phthalate-free gloves.
2. Before entering the potentially contaminated zone, wrap soil contact points in aluminum foil (shiny side out).
3. Rinse and scrub with potable water.
4. Wash all equipment surfaces that contacted the potentially contaminated soil/water with Liquinox[®] solution.
5. Rinse with potable water.
6. Rinse with distilled or potable water and isopropanol solution (DO NOT USE ACETONE).
7. Air dry.
8. Rinse with deionized water.
9. Completely air dry and wrap exposed areas with aluminum foil (shiny side out) for transport and handling if equipment will not be used immediately.
10. Collect all rinsate and dispose of in a DOT-approved 55-gallon drum.
11. Decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment will be disposed of in DOT-approved 55-gallon drums or with solid waste in garbage bags, dependent on Facility/project requirements.

D. HEALTH AND SAFETY MONITORING EQUIPMENT DECONTAMINATION

1. Before use, wrap soil contact points in plastic to reduce need for subsequent cleaning.
2. Wipe all surfaces that had possible contact with contaminated materials with a paper towel wet with Liquinox[®] solution, then a towel wet with methanol solution, and finally three times with a towel wet with distilled water. Dispose of all used paper towels in a DOT-approved 55-gallon drum or with solid waste in garbage bags, dependent on Facility/project requirements.

E. SAMPLE CONTAINER DECONTAMINATION

The outsides of sample bottles or containers filled in the field may need to be decontaminated before being packed for shipment or handled by personnel without hand protection. The procedure is:

1. Wipe container with a paper towel dampened with Liquinox[®] solution or immerse in the solution AFTER THE CONTAINERS HAVE BEEN SEALED. Repeat the above steps using potable water.
2. Dispose of all used paper towels in a DOT-approved 55-gallon drum or with solid waste in garbage bags, dependent on Facility/project requirements.

F. HEAVY EQUIPMENT AND TOOLS

Heavy equipment such as drilling rigs, drilling rods/tools, and the backhoe will be decontaminated upon arrival at the site and between locations as follows:

1. Set up a decontamination pad in area designated by the Facility
2. Steam clean heavy equipment until no visible signs of dirt are observed. This may require wire or stiff brushes to dislodge dirt from some areas.

V. Attachments

None.

VI. Key Checks and Items

- Clean with solutions of Liquinox[®], methanol, and distilled water.
- Do not use acetone for decontamination.
- Drum all contaminated rinsate and materials.
- Decontaminate filled sample bottles before relinquishing them to anyone.

Disposal of Waste Fluids and Solids

I. Purpose and Scope

This SOP describes the procedures used to dispose of hazardous fluid and solid materials generated as a result of the site operations. This SOP does not provide guidance on the details of Department of Transportation regulations pertaining to the transport of hazardous wastes; the appropriate Code of Federal Regulations (49 CFR 171 through 177) should be referenced. Also, the site investigation-derived waste management plan should be consulted for additional information and should take precedence over this SOP.

II. Equipment and Materials

A. Fluids

- DOT-approved 55-gallon steel drums or Baker® Tanks
- Tools for securing drum lids
- Funnel for transferring liquid into drum
- Labels
- Paint Pens
- Marking pen for appropriate labels
- Seals for 55-gallon steel drums

B. Solids

- DOT-approved 55-gallon steel drums or rolloffs
- Tools for securing drum lids
- Paint Pens
- Plastic sheets
- Labels
- Marking pen for appropriate labels

III. Procedures and Guidelines

A. Methodology

Clean, empty drums or rolloffs or Baker® Tanks will be brought to the site by the drilling subcontractor for soil and groundwater collection and storage. The empty drums will be located at the field staging area and moved to drilling locations as required. The drums will be filled with the drilling and well installation wastes, capped, sealed, and moved to the onsite drum storage area by the drilling subcontractor. The full drums will separate types of wastes by media. The drums will

be labeled as they are filled in the field and labels indicating that the contents are pending analysis affixed.

The drum contents will be sampled to determine the disposal requirements of the drilling wastes. The drum sampling will be accomplished through the collection and submittal of composite samples, one sample per 10 drums (check with disposal facility to determine sample frequency) containing the same media. Similar compositing will be performed in each rolloff to obtain a representative sample. The compositing of the sample will be accomplished by collecting a specific volume of the material in each drum into a large sample container. When samples from each of the drums being sampled in a single compositing are collected, the sample will be submitted for TCLP, ignitability, corrosivity, and reactivity analysis. The analysis will be used to determine if drilling wastes are covered by land disposal restrictions.

If rolloffs are used, compositing and sampling of soil will comply with applicable state and federal regulations.

B. Labels

Drums and other containers used for storing wastes from drilling operations will be labeled when accumulation in the container begins. Labels will include the following minimum information:

- Container number
- Container contents
- Origin (source area including individuals wells, piezometers, and soil borings)
- Date that accumulation began
- Date that accumulation ended
- Generator Contact Information
- When laboratory results are received, drum labels will be completed or revised to indicate the hazardous waste constituents in compliance with Title 40 of the Code of Federal Regulations, Part 262, Subpart C if the results indicate hazardous waste or labeled as non-hazardous if applicable.

C. Fluids

Drilling fluids generated during soil boring and groundwater discharged during development and purging of the monitoring wells will be collected in 55-gallon, closed-top drums. When a drum is filled, the bung will be secured tightly. Fluids may also be transferred to Baker® Tanks after being temporarily contained in drums to minimize the amount of drums used.

When development and purging is completed, the water will be tested for appropriate hazardous waste constituents. Compositing and sampling of fluids will comply with applicable state and federal regulations.

D. Solids

The soil cuttings from well and boring drilling will constitute a large portion of the solids to be disposed of.

The solid waste stream also will include plastic sheeting used for decontamination pads, Tyveks, disposable sampling materials, and any other disposable material used during the field operations that appears to be contaminated. These materials will be placed in designated drums.

E. Storage and Disposal

The wastes generated at the site at individual locations will be transported to the drum storage area by the drilling services subcontractor. Drums should be stored on pallets on plastic sheeting with a short berm wall (hay bales or 2 x 4 planks or equivalent) to capture small spills.

Waste solid materials that contain hazardous constituents will be disposed of at an offsite location in a manner consistent with applicable solid waste, hazardous waste, and water quality regulations. Transport and disposal will be performed by a commercial firm under subcontract.

The liquid wastes meeting acceptable levels of discharge contamination may be disposed of through the sanitary sewer system at the site. However, prior to disposal to the sanitary sewer system, approval and contract arrangements will be made with the appropriate authorities. Wastes exceeding acceptable levels for disposal through the sanitary sewer system will be disposed of through contract with a commercial transport and disposal firm.

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

- Check that representative samples of the containerized materials are obtained.
- Be sure that all state and federal regulations are considered when classifying waste for disposal.

Field Measurement of pH, Specific Conductance, Turbidity, Dissolved Oxygen, ORP, and Temperature Using a Water Quality Meter with Flow-Through Cell

I. Purpose and Scope

The purpose of this procedure is to provide a general guideline for using a water quality meter for field measurements of pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature of aqueous samples. The operator's manual should be consulted for detailed operating procedures.

II. Equipment and Materials

- Water Quality Monitoring System with flow-through cell (Horiba, YSI, In-Situ, Ion Science, etc)
- Auto-Calibration Standard Solution (provided by rental company)
- Distilled water in squirt bottle

III. Procedures and Guidelines

A. General Parameters and Specifications:

Note: the general parameters listed below may not be available for every type of meter used. Please refer to the specific meter's manual to determine meter's range of measurement and accuracy.

<u>Parameter</u>	<u>Range of measurement</u>	<u>Accuracy</u>
pH	0 to 14 pH units	+/- 0.1 pH units
Specific conductance	0 to 9.99 S/m	+/- 3 % full scale
Turbidity	0 to 800 NTU	+/- 5 % full scale
Dissolved oxygen	0 to 19.99 mg/l	+/- 0.2 mg/l
Temperature	0 to 55 °C	+/- 1.0 °C
ORP	-999 to +999 mV	+/- 15 mV
Salinity	0 to 4 %	+/- 0.3 %

B. Calibration:

Prior to each day's use, clean the probe and flow-through cell using deionized water and calibrate using the Standard Solution. Refer to the specific instrumentation manual for the proper calibration methods.

C. Sample Measurement:

The water quality probes are inserted into a flow-through cell. The purged groundwater is directed through the cell by connecting the pump discharge tubing to the bottom port on the flow through cell, allowing measurements to be collected before the water contacts the atmosphere.

As water passes through the flow-through the flow cell, press MEAS to obtain readings or the readings are displayed on the meter for each parameter (dependent on the type of meter used). Record the water quality parameter data in a field notebook. Once the parameters have stabilized (see *Low-Flow Groundwater Sampling from Monitoring Wells – EPA Region I and III* or *Low-Flow Groundwater Sampling from Monitoring Wells – EPA Region IV* depending on project site location), remove the tubing from the bottom port of the flow-through cell. Never collect a groundwater sample for laboratory analysis from the flow-through cell. Rinse the flow-through cell between wells to remove any sediment buildup within the cell.

IV. Key Checks and Preventive Maintenance

- Calibrate meter
- Clean probe with deionized water when done
- Refer to operations manual for recommended maintenance and troubleshooting
- Check batteries, and have a replacement set on hand
- Due to the importance of obtaining these parameters, the field team should have a spare unit readily available in case of an equipment malfunction.

Groundwater Sampling from Monitoring Wells – EPA Region I and III

I. Purpose and Scope

This procedure presents general guidelines for collecting groundwater samples from monitoring wells. The procedure does not address purging and sampling using “low-flow” techniques (see SOP *Low-Flow Groundwater Sampling from Monitoring Wells – EPA Region I and III*). Operations manuals should be consulted for specific calibration and operating procedures.

II. Equipment and Materials

- Peristaltic pump, pneumatic bladder pump, or electric submersible pump, pump shroud, tubing, support cables, air compressor, control box, and power supply
- Water quality meter, such as Horiba® U-22 or a combination of equivalent devices for monitoring pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature
- Flow through cell with inlet/outlet ports for purged groundwater and watertight ports for each water quality probe
- Disposable 0.45µm filters (QED® FF8100 or equivalent), if applicable
- Bailer (Teflon or stainless steel) and nylon cord, if applicable

Note: bailers and peristaltic pumps should only be used when site access or other limitations prevent the use of sampling pumps

III. Procedures and Guidelines

A. Setup and Purging

1. Obtain information on well location, diameter(s), depth, and screened interval(s), and the method for disposal of purged water.
2. A pump will be used for well purging if the well yield is adequate; otherwise, a bailer may be used depending on project requirements.
3. Sampling equipment is cleaned and decontaminated prior to sampling in accordance with SOP *Decontamination of Personnel and Equipment*.
4. Instruments are calibrated according to manufacturer's instructions.

5. The well number, site, date, and condition are recorded in the field logbook.
6. Plastic sheeting is placed on the ground, and the well is unlocked and opened.
7. Water level measurements are collected in accordance with the *Water Level Measurement SOP*.
8. The volume (v) of water in a well casing is calculated as follows:

$$v = 7.48(\pi r^2h)$$

where: $\pi = 3.14$

v = volume of water in well (gallons)

r = Radius of the well (feet)

h = height of water in well (feet)

The volume of water in common well casing diameters may be calculated as follows:

2-inch diameter well:

0.163 gal/ft x ___ (linear feet of water) = gallons

4-inch diameter well:

0.653 gal/ft x ___ (linear feet of water) = gallons

6-inch diameter well:

1.469 gal/ft x ___ (linear feet of water) = gallons

9. Attach tubing, support cable or rope, and air line (if applicable) to the pump. The support line should bear the weight of the pump. Set pump in the well at the desired sampling interval, typically mid-screen, and begin purging. If a bailer is being used, it is removed from its protective covering and attached to a cord compatible with constituents.
10. If a RediFlo or other similar electric submersible pump is to be used in a large diameter well (greater than 4 inches), a pump shroud should be used to direct the flow of water across the pump motor. Failure to use a shroud in this situation can lead to overheating of the motor and loss of volatiles from the pump discharge.
11. If a bailer is being used, it should be removed from its protective covering and attached to a cord compatible with the site contaminants. The bailer should be 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.

12. Field parameters including pH, ORP, turbidity, dissolved oxygen, specific conductance, and temperature are measured and recorded in the field logbook. The water quality probes are inserted into a flow-through cell. The purged groundwater is directed through the cell by connecting the pump discharge tubing to the bottom port on the flow through cell, allowing measurements to be collected before the water contacts the atmosphere.
13. During purging, the water quality parameters are measured at least once for each well volume. A minimum of three well volumes must be purged (up to 5 well volumes may be purged if water quality parameters do not stabilize) prior to sampling. In nonproductive wells, if the well is purged dry, it is not necessary to remove a minimum of three well volumes; however, the well should be allowed to recover sufficiently to allow collection of all samples.
14. Three to five well volumes are purged (more may be purged if parameters do not stabilize). Purging is stopped when field parameters have stabilized over three consecutive well volumes. Field Water quality parameters are considered stable when pH measurements agree within 0.1 units, specific conductance measurements agree within 3 percent, ORP measurements agree within 10 mV, dissolved oxygen measurements agree within 10 percent, and turbidity measurements agree within 10 percent or are as low as practicable given sampling conditions.

B. Sample Collection

Once purging is complete the well is ready to sample. The elapsed time between completion of purging and collection of the groundwater sample should be minimized. Typically, the sample is collected immediately after the well has been purged, but this is also dependent on well recovery.

Samples will be placed in sample containers that have been cleaned to laboratory standards and are preserved in accordance with the analytical method. The containers are typically pre-preserved, if required.

The steps to be followed for sample collection are as follows:

1. The cap is removed from the sample bottle, and the bottle is tilted slightly.
2. The sample is slowly poured from the bailer or discharged from the pump so that it runs down the inside of the sample bottle with a minimum of disturbance. The pumping rate should be reduced to approximately 100 ml per minute when sampling VOCs.
3. Inorganics, including metals, may be collected and preserved in the filtered form as well as the unfiltered form. Disposable in-line filters (0.45 micron filter), connected to the end of the sample tubing, are typically used for field filtration. Samples are field filtered as the water

is being placed into the sample container. If a bailer is used, filtration may be driven by a peristaltic pump.

4. Adequate space is left in the bottle to allow for expansion, except for VOC vials, which are filled to the top with a positive meniscus.
5. The bottle is capped and clearly labeled.
6. Samples are placed in appropriate containers and, if necessary, packed with ice in coolers as soon as practical.
7. If the sample tubing or bailer is dedicated, it is returned to the well and the well is capped and locked. Nondedicated equipment is cleaned and decontaminated in accordance with the *Decontamination of Personnel and Equipment* SOP.

The following information, at a minimum, will be recorded in the log book:

1. Sample identification (site name, location, and project number; sample name/ number and location; sample type and matrix; time and date; sampler's identity)
2. Sample source and source description
3. Field observations and measurements (appearance, volatile screening, field chemistry, sampling method), volume of water purged prior to sampling, number of well volumes purged, and field parameter measurements
4. Sample disposition (preservative; laboratory name, date and time sent; laboratory sample number, chain-of-custody number, sample bottle lot number)

Additional remarks

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

- Use of peristaltic pumps and bailers should be avoided, if possible.
- Allow the field parameters to stabilize within the specified criteria as much as possible.
- Fill bottles for VOC samples first.
- Be sure the sample identification is properly specified.
- Maintain field equipment in accordance with the manufacturer's recommendations. This may include, but is not limited to:
 - Inspect sampling pump regularly and replace as warranted

- Bring supplies for replacing the bladder and “O” rings if using a positive-displacement bladder pump
- Inspect tubing regularly and replace as warranted
- Inspect air/sample line quick-connects regularly and replace as warranted
- Verify battery charge, calibration, and proper working order of field measurement equipment prior to initial mobilization and daily during field efforts

Low-Flow Groundwater Sampling from Monitoring Wells – EPA Region I and III

I. Purpose and Scope

This SOP presents general guidelines for the collection of groundwater samples from monitoring wells using low-flow purging and sampling procedures. Operations manuals should be consulted for specific calibration and operating procedures.

II. Equipment and Materials

- Adjustable-rate positive-displacement pump, submersible pump, or peristaltic pump
- Horiba® U-22 or equivalent water quality meters to monitor pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature
- Flow-through cell with inlet/outlet ports for purged groundwater and watertight ports for each probe
- Generator or alternate power source depending on pump type
- Water-level indicator
- Disposable Teflon, Teflon-lined polyethylene tubing or polyethylene tubing for metals and other inorganics
- Plastic sheeting
- Well-construction information
- Calibrated container and stopwatch to determine flow rate
- Sample containers
- In-line disposable 0.45µm filters (QED® FF8100 or equivalent)
- Shipping supplies (labels, coolers, and ice)
- Field book

III. Procedures and Guidelines

A. Setup and Purging

1. Obtain information on well location, diameter(s), depth, and screen interval(s), and the method for disposal of purged water.
2. Calibrate instruments according to manufacturer's instructions.
3. The well number, site, date, and condition are recorded in the field logbook.

4. Plastic sheeting is placed on the ground, and the well is unlocked and opened. All decontaminated equipment to be used in sampling will be placed only on the plastic sheeting until after the sampling has been completed. To avoid cross-contamination, do not let any downhole equipment touch the ground.
5. All sampling equipment and any other equipment to be placed in the well is cleaned and decontaminated before sampling in accordance with SOP *Decontamination of Personnel and Equipment*.
6. Water level measurements are collected in accordance with the *Water Level Measurements* SOP. **Do not measure the depth to the bottom of the well at this time**; this reduces the possibility that any accumulated sediment in the well will be disturbed. Obtain depth to bottom information from well construction log.
7. Attach and secure the tubing to the low-flow pump. Lower the pump slowly into the well and set it at approximately the middle of the screen. Place the pump intake in the middle of the saturated screen length and should be at least two feet above the bottom of the well to avoid mobilization of any sediment present in the bottom.
8. Insert the measurement probes into the flow-through cell. The purged groundwater is directed through the cell, allowing measurements to be collected before the water contacts the atmosphere.
9. If using a generator, locate it 30 feet downwind from the well to avoid exhaust fumes contaminating the samples.
10. Start purging the well at 0.2 to 0.5 liters per minute. Avoid surging. Purging rates for more transmissive formations could be started at 0.5-liter to 1 liter per minute. The initial field parameters of pH, specific conductance, dissolved oxygen, ORP, turbidity, and temperature of water are measured and recorded in the field logbook.
11. The water level should be monitored during purging, and, ideally, the purge rate should equal the well recharge rate so that there is little or no drawdown in the well (i.e., less than 0.3-foot). The water level should stabilize for the specific purge rate. There should be at least 1 foot of water over the pump intake so there is no risk of the pump suction being broken, or entrainment of air in the sample. Record adjustments in the purge rate and changes in depth to water in the logbook. Purge rates should, if needed, be decreased to the minimum capabilities of the pump (0.1- to 0.2-liter per minute) to avoid affecting well drawdown.
12. During purging, the field parameters are measured frequently (every 5 minutes) until the parameters have stabilized. Field parameters are considered stable when measurements meet the following criteria:
 - pH: within 0.1 pH units

- Specific conductance: within 3 percent
- Dissolved oxygen: within 10 percent
- Turbidity: within 10 percent for values greater than 5 NTU; if 3 turbidity values are less than 5 NTU, consider the values as stabilized
- ORP: within 10 mV
- Temperature: within 3 percent

B. Sample Collection

Once purging is complete the well is ready to sample. The elapsed time between completion of purging and collection of the groundwater sample should be minimized. Typically, the sample is collected immediately after the well has been purged, but this is also dependent on well recovery.

Samples will be placed in sample containers that have been cleaned to laboratory standards and are preserved in accordance with the analytical method. The containers are typically pre-preserved, if required.

VOC samples are normally collected first and directly into pre-preserved sample containers.

During purging and sampling, the centrifugal/peristaltic pump tubing must remain filled with water to avoid aeration of the groundwater. It is recommended that ¼ or 3/8 inch inside diameter tubing be used to help insure that the sample tubing remains water filled. If the pump tubing is not completely filled to the sampling point, collect non-VOC dissolved gasses samples first, then increase flow rate slightly until water completely fills the tubing and collect the VOC/dissolved gases samples. Record new flow rate and drawdown depth.

The steps to be followed for sample collection are as follows:

1. The cap is removed from the sample bottle, and the bottle is tilted slightly.
2. The sample is slowly poured from the bailer or discharged from the pump so that it runs down the inside of the sample bottle with a minimum of splashing. The pumping rate should be reduced to approximately 100 ml per minute when sampling VOCs.
3. Inorganics, including metals, may be collected and preserved in the filtered form as well as the unfiltered form. Disposable in-line filters (0.45 micron filter), connected to the end of the sample tubing,, are typically used for field filtration. Samples are field filtered as the water is being placed into the sample container. If a bailer is used, filtration may be driven by a peristaltic pump.

4. Adequate space is left in the bottle to allow for expansion, except for VOC vials, which are filled to the top with a positive meniscus.
5. The bottle is capped and clearly labeled.
6. Samples are placed in appropriate containers and, if necessary, packed with ice in coolers as soon as practical.
7. Nondedicated equipment is cleaned and decontaminated in accordance with the *Decontamination of Personnel and Equipment* SOP.

The following information, at a minimum, will be recorded in the log book:

1. Sample identification (site name, location, and project number; sample name/number and location; sample type and matrix; time and date; sampler's identity)
2. Sample source and source description
3. Field observations and measurements (appearance, volatile screening, field chemistry, sampling method), volume of water purged prior to sampling, number of well volumes purged, and field parameter measurements
4. Sample disposition (preservative; laboratory name, date and time sent; laboratory sample number, chain-of-custody number, sample bottle lot number)
5. Additional remarks

C. Additional remarks

1. If the well goes dry during purging, wait until it recovers sufficiently to remove the required volumes to sample all parameters. It may be necessary to return periodically to the well but a particular sample (e.g., large amber bottles for semivolatile analysis) should be filled at one time rather than over the course of two or more visits to the well.
2. Disposable tubing is disposed of with PPE and other site trash.

IV. Attachments

White paper on reasons and rationale for low-flow sampling.

V. Key Checks and Preventative Maintenance

- The drawdown in the well should be minimized as much as possible (preferably no more than 0.5-foot to 1 foot) so that natural groundwater-flow conditions are maintained as closely as possible.
- The highest purging rate should not exceed 1 liter per minute. This is to keep the drawdown minimized.

- Stirring up of sediment in the well should be avoided so that turbidity containing adsorbed chemicals is not suspended in the well and taken in by the pump.
- Overheating of the pump should be avoided to minimize the potential for losing VOCs through volatilization.
- Keep the working space clean with plastic sheeting and good housekeeping.
- Maintain field equipment in accordance with the manufacturer's recommendations. This will include, but is not limited to:
 - Inspect sampling pump regularly and replace as warranted
 - Inspect quick-connects regularly and replace as warranted
 - Verify battery charge, calibration, and proper working order of field measurement equipment prior to initial mobilization and daily during field efforts

Attachment to the SOP on Low-Flow Sampling Groundwater Sampling from Monitoring Wells

White Paper on Low-Flow Sampling

EPA recommends low-flow sampling as a means of collecting groundwater samples in a way that minimizes the disturbance to the natural groundwater flow system and minimizes the introduction of contamination into the samples from extraneous sources. The following are details about these issues.

When a pump removes groundwater from the well at the same rate that groundwater enters the well through the screen, the natural groundwater-flow system around the well experiences a minimum of disturbance. Some disturbance is bound to occur because you are causing groundwater to flow to the well in a radial fashion that otherwise would have flowed past it. However, the resulting low-flow sample provides the most-representative indication we can get of groundwater quality in the immediate vicinity of the well.

Normally, when a well is pumped at an excessive rate that drops the water level in the well below the water level in the aquifer, the water cascades down the inside of the well screen when it enters the well. The turbulence from this cascading causes gases such as oxygen and carbon dioxide to mix with the water in concentrations that are not representative of the native groundwater and are higher than expected. This causes geochemical changes in the nature of the water that can change the concentrations of some analytes, particularly metals, in the groundwater sample, not mention it's effect on the dissolved oxygen levels that then will be measured in the flow-through cell. Such turbulence also may cause lower-than-expected concentrations of volatile organic compounds due to volatilization.

For wells in which the water level is above the top of the screen, the water up in the riser is out of the natural circulation of the groundwater and, therefore, can become stagnant. This stagnant water is no longer representative of natural groundwater quality because its pH, dissolved-oxygen content, and other geochemical characteristics change as it contacts the air in the riser. If we minimize the drawdown in the well when we pump, then we minimize the amount of this stagnant water that is brought down into the well screen and potentially into the pump. As a result, a more-representative sample is obtained.

Typically, wells contain some sediment in the bottom of the well, either as a residue from development that has settled out of the water column or that has sifted through the sand pack and screen since the well was installed. This sediment commonly has adsorbed on it such analytes as metals, SVOCs, and dioxins that normally would not be dissolved in the groundwater. If these sediments are picked up in the groundwater when the well is disturbed by excessive pumping, they can:

- Make filtering the samples for metals analysis more difficult
- Add unreasonably to the measured concentration of SVOCs and other organic compounds

The SOP for low-flow sampling has been modified recently and should be consulted for additional information about low-flow sampling and ways of dealing with wells in which the water level cannot be maintained at a constant level.

General Guidance for Monitoring Well Installation

I. Purpose

To provide site personnel with a review of the well installation procedures that will be performed. These procedures are to be considered general guidelines only and are in no way intended to supplement or replace the contractual specifications in the driller's subcontract.

II. Scope

Monitoring well installations are planned for shallow and/or deep unconsolidated aquifers and/or for bedrock aquifers. The SOPs *Installation of Shallow Monitoring Wells*, *Installation of Surface-Cased Monitoring Wells*, *Installation of Bedrock Monitoring Wells*, and *Installation of Monitoring Wells Using Sonic Drilling* provide more specifics.

III. Equipment and Materials

1. Drilling rig (hollow stem auger, sonic, air hammer, air rotary, or mud rotary)
2. Well-construction materials (i.e., surface casing, screens, riser, casing, caps, bottom plugs, centering guides, sand, bentonite, grout, and surface-finish materials)
3. Development equipment

IV. Procedures and Guidelines

1. Wells will be installed in accordance with standard EPA procedures. Note that USEPA Region III requires any well penetrating a confining layer to be double-cased.
2. The threaded connections will be water-tight.
3. Well screens generally will be constructed of 10-slot or 20-slot Schedule 40 PVC and will be 5 to 10 feet in length depending on saturated thickness of unconsolidated sediments. The exact slot size and length will be determined by the field team supervisor. Stainless steel may be required under certain contaminant conditions.
4. Stick-up wells will be surrounded by four concrete-filled guard posts at least 2 inches in diameter.
5. A record of the finished well construction will be compiled.

6. All soils and liquids generated during well installations will be drummed for proper disposal.

Monitoring Well Installation

- 2" monitoring wells in unconsolidated materials will be installed in at least 6-inch-diameter boreholes to accommodate well completion materials in designated locations.
- All monitoring wells penetrating a confining layer will be surface-cased from the ground surface to approximately 5 feet into the confining layer. Exceptions to this may be allowed under certain circumstances (e.g., evidence of significant natural gaps in the confining layer).
- Monitoring wells in unconsolidated materials will be constructed of 2-inch-diameter, factory manufactured, flush-jointed, Schedule 40 PVC (or stainless steel) screen with threaded bottom plug and riser.
- Screens will be filter packed with a properly sized and graded, thoroughly washed, sound, durable, well-rounded basalt or siliceous sand. When using hollow-stem augers, the filter pack will be installed by slowly pouring the sand into the annular space while simultaneously raising the augers and using a weighted tape to sound for the sand surface. For rotary-drilled wells, the height of the sand pack also will be sounded with a weighted tape.
- The primary filter sand pack (typically Morie #00 or DSI #1 for a 10-slot screen) will extend from 1 to 2 feet below the base to 2 feet above the top of the screen; filter pack will be allowed to settle before final measurement is taken. For wells deeper than 30 feet, the filter pack will be placed using a tremie pipe and flowing water.
- A secondary filter sand pack (typically a fine sand seal) 1-foot thick may be placed above the primary sand pack.
- Annular well seals will consist of 2 feet of pelletized, chip, or granular bentonite clay placed above the filter pack. If necessary the pellets will be hydrated using potable water. For wells installed using hollow-stem augers, the bentonite will be poured into the annular space while slowly raising the augers and sounding for the top of the bentonite with a weighted tape. A high-solids bentonite slurry using powdered bentonite introduced with a side-discharging tremie pipe will be used for the bentonite seals in wells greater than 30 feet deep. For rotary-drilled wells, the height of the well seal also will be sounded with a weighted tape. High-solids slurries will have solids content of at least 20 percent.
- The top of the annular seal will be measured after the bentonite seal has been allowed to hydrate and before the grout is applied. The seal will be allowed to hydrate for at least 30 minutes before work in the well continues.
- The annular space above the bentonite seal will be filled to grade with a bentonite-cement slurry grout mixture.

- The grout mixture consists of 6 to 8 gallons of water per 94-pound bag of Portland cement; 3 to 6 pounds of bentonite added per bag of cement to reduce shrinkage.
- The grout mix will be carefully applied to avoid disturbing the bentonite seal; the method of grout placement must force grout from the top of the bentonite seal to ground surface.
- After allowing the grout to settle and set up overnight, additional grout will be added to maintain grade.
- A protective steel casing equipped with keyed alike locking caps will be grouted in place for each new well; the casing will extend at least 2 feet above grade and 3 feet below grade, and will be painted a bright color.

Well Development

- New monitoring wells will be developed after the well has been completely installed and the grout has hardened (at least 24 hours)
- The well will be developed by surging and pumping.
- Equipment placed in the well will be decontaminated before use.
- If information is available, begin developing in the least-contaminated well first.
- Development will include surging the well by either abruptly stopping flow and allowing water in the well column to fall back into the well or through the use of a surge block that is slightly smaller in diameter than the well casing inner diameter.
- Pipes and pumps must not be fitted with foot valves or other devices that might inhibit the return flow of water to the well.
- Surging should continue throughout the development process.
- The air-lift method may be used to pump materials out of the well. The air compressor will be fitted with filters to remove all oil and the air lift hose used will be made of inert materials.
- Well development will continue until the water produced is free of turbidity, sand, and silt. A Horiba-U22 meter, YSI meter with separate Hanna turbidity meter, or equivalent should be used to determine when the turbidity is low and parameters have stabilized.
- Development water will be considered hazardous and placed in sealed 55-gallon U.S. DOT approved steel drums. CH2M HILL will label and date the drums as pending analysis, and transport the drums to a designated site for storage.

V. Attachments

None.

VI. Key Check and Items

- Ensure that all equipment is properly decontaminated as needed.
- Only new, sealed materials (e.g., screens, risers, and sand) will be used in constructing the well.
- Care shall be taken when making downhole measurements to ensure that proper heights of sand, seal, and grout are achieved.

Installation of Shallow Monitoring Wells

I. Purpose and Scope

The purpose of this guideline is to describe methods for drilling and installation of shallow monitoring wells and piezometers in unconsolidated or poorly consolidated materials using hollow stem augers, air rotary, or mud rotary. Installing monitoring wells in unconsolidated materials using sonic drilling is discussed in SOP *Installation of Monitoring Wells Using Sonic Drilling*. Methods for drilling and installing bedrock monitoring wells and deep, surface-cased wells in unconsolidated materials are presented in SOPs *Installation of Bedrock Monitoring Wells* and *Installation of Surface-Cased Monitoring Wells*, respectively.

II. Equipment and Materials

Drilling

- Drilling rig (hollow stem auger, air rotary or mud rotary) and associated tools and equipment

Well Riser/Screen and Associated Materials

- Polyvinyl chloride (PVC), Schedule 40, minimum 2-inch ID, flush-threaded riser; alternatively, stainless-steel riser
- PVC, Schedule 40, minimum 2-inch ID, flush-threaded, factory slotted screen; alternatively, stainless-steel screen
- PVC bottom cap, threaded to match the well screen; alternatively, stainless steel
- PVC or stainless-steel centering guides (if used)
- Above-grade well completion: PVC well cap, threaded or push-on type, vented
- Flush-mount well completion: PVC well cap, locking, leak-proof seal
- Stainless steel to be used as appropriate

Sand

- Clean silica sand, provided in factory-sealed bags, well-rounded, containing no organic material, anhydrite, gypsum, mica, or calcareous material; primary (coarse – e.g., Morie #1) filter pack, and secondary (fine sand seal) filter pack. Grain size determined based on sediments observed during drilling.

Bentonite

- Pure, additive-free bentonite pellets or chips
- Pure, additive-free powdered bentonite

- Coated bentonite pellets; coating must biodegrade within 7 days
- Cement-Bentonite Grout: proportion of 6 to 8 gallons of water per 94-pound bag of Portland cement; 3 to 6 pounds of bentonite added per bag of cement to reduce shrinkage.

Protective Casing

- Above-grade well completion: 6-inch minimum ID black iron steel pipe with locking cover, diameter at least 2 inches greater than the well casing, painted with epoxy paint for rust protection; heavy duty lock; protective posts if appropriate
- Flush-mount well completion: Morrison 9-inch or 12-inch 519 manhole cover, or equivalent; rubber seal to prevent leakage; locking cover inside of road box

Well Development

- Surge block
- Well-development pump and associated equipment
- Calibrated meters to ensure pH, temperature, specific conductance, ORP, and dissolved oxygen of development water
- Containers (e.g., DOT-approved 55-gallon drums) for water produced from well.

III. Procedures and Guidelines

A. Drilling Method

Typically, continuous-flight hollow-stem augers with a minimum 4.25-inch inside diameter (ID) will be used to drill shallow monitoring well boreholes for 2-inch diameter monitoring wells. Alternatively, air or mud rotary may be used.

The bit of the auger is placed at the ground surface and then turned with the drilling rig. To collect split spoon samples, the auger is advanced to the top of the sampling depth, and the split-spoon sample is collected from below the auger head. The split spoon is advanced through repeated blows from a 140- or 300-pound hammer dropped from a height of 30 inches. Thin-walled tube samplers are advanced by pressing down on the rods with the weight of the drilling rig. Split-spoon samples may be collected at selected intervals for chemical analysis and/or lithologic classification. Soil sampling procedures are detailed in SOPs *Soil Boring Sampling – Split Spoons* and *Soil Sampling*.

The use of water to assist in hollow-stem auger drilling for monitoring well installation will be avoided, unless required for such conditions as running sands.

Hollow-stem augers, drilling bits, rods, split-spoon samplers, and other downhole drilling tools will be properly decontaminated prior to the

initiation of drilling activities and between each borehole location. Split-spoon samplers and other downhole soil sampling equipment will also be properly decontaminated before and after each use. *SOP Decontamination of Drill Rigs and Equipment* details proper decontamination procedures.

Drill cuttings and decontamination fluids generated during well drilling activities will be contained according to the procedures detailed in the *SOP Disposal of Waste Fluids and Solids* and the Investigation Derived Waste Management Plan (IDWMP).

Air or mud rotary drilling may be used instead of hollow-stem augers. The use of added mud should be kept to a minimum.

B. Monitoring-Well Installation

Shallow monitoring wells will be constructed inside the hollow-stem augers, once the borehole has been advanced to the desired depth, or in the mudded borehole once the drilling rods have been withdrawn. If the borehole has been drilled to a depth greater than that at which the well is to be set, the borehole will be backfilled with bentonite pellets or chips or a bentonite-cement slurry to a depth approximately 1 foot below the intended well depth. Approximately 1 foot of clean sand will be placed on top of the bentonite to return the borehole to the proper depth for well installation.

The appropriate lengths of well screen, nominally 10 feet (with bottom cap), and casing will be joined watertight and lowered inside the augers to the bottom of the borehole. Centering guides, if used, will be placed at the bottom of the screen and above the interval in which the bentonite seal is placed.

Selection of the filter pack and well screen intervals for the shallow monitoring wells shall be made in the field.

A primary sand pack consisting of clean Morie No. 00 (or DSI No.1) silica sand for 10-slot screen and Morie No. 01 (or DSI No.2) for 20-slot screen silica sand will be placed around the well screen. The sand will be placed into the borehole at a uniform rate, in a manner that will allow even placement of the sand pack. The augers will be raised gradually during sand pack installation to avoid caving of the borehole wall; at no time will the augers be raised higher than the top of the sand pack during installation. During placement of the sand, the position of the top of the sand will be continuously sounded. The primary sand pack will be extended from the bottom of the borehole to a minimum height of 2 feet above the top of the well screen. A secondary, finer-grained (fine sand seal), sand pack will be installed for a minimum of 1 foot above the coarse sand pack. Heights of the coarse and fine sand packs and bentonite seal may be modified in the field to account for a shallow water table and a small saturated thickness of the surficial aquifer.

A bentonite seal at least 2 feet thick will be placed above the sand pack. The seal will be placed into the borehole in a manner that will prevent bridging. The position of the top of the bentonite seal will be verified using a weighted

tape measure. If all or a portion of the bentonite seal is above the water table, clean water will be added to hydrate the bentonite. A hydration period of at least 30 minutes will be required following installation of the bentonite seal.

Above the bentonite seal, an annular seal of cement-bentonite grout will be placed. The cement-bentonite grout will be installed continuously in one operation from the bottom of the space to be grouted to the ground surface through a tremie pipe. The tremie pipe must be plugged at the bottom and have small openings along the sides of the bottom 1-foot length of pipe. This will allow the grout to diffuse laterally into the borehole and not disturb the bentonite pellet seal.

C. Well Completion

For monitoring wells that will be completed above-grade, a locking steel protective casing set in a concrete pad will be installed. The steel protective casing will extend at least 3 feet into the ground and 2 feet above ground but should not penetrate the bentonite seal. The concrete pad will be square, approximately 2 feet per side (unless otherwise specified in the project plans), and poured into wooden forms. The concrete will be sloped away from the protective casing.

Guard posts may be installed in high-traffic areas for additional protection. Four steel guard posts will be installed around the protective casing. Guard posts would be concrete-filled, at least 2 inches in diameter, and would extend at least 2 feet into the ground and 3 feet above the ground. The protective casing and guard posts will be painted with an epoxy paint to prevent rust.

For monitoring wells with flush-mount completions, Morrison 9-inch or 12-inch 519 manhole cover or equivalent, with a rubber-sealed cover and drain will be installed. The top of the manhole cover will be positioned approximately 1 inch above grade. A square concrete pad, approximately 2 feet per side (unless otherwise specified in the project plans), will be installed as a concrete collar surrounding the road box cover, and will slope uniformly downward to the adjacent grade. The road box and installation thereof will be of sufficient strength to withstand normal vehicular traffic.

Concrete pads installed at all wells will be a minimum of 6 inches below grade. The concrete pad will be 12 inches thick at the center and taper to 6-inch thick at the edge. The surface of the pad should slope away from the protective casing to prevent water from pooling around the casing. Protective casing, guard posts, and flush mounts will be installed into this concrete.

Each well will be properly labeled on the exterior of the locking cap or protective casing with a metal stamp indicating the permanent well number.

D. Well Development

Well development will be accomplished using a combination of surging throughout the well screen and pumping, until the physical and chemical parameters of the discharge water that are measured in the field have stabilized and the turbidity of the discharge water is substantially reduced. Fine-grained materials in the surficial aquifer at the site may not allow low turbidity results to be achieved.

The surging apparatus will include a surge block. Well development will begin by surging the well screen, starting at the bottom of the screen and proceeding upwards, throughout the screened zone. Following surging, the well will be pumped to remove the fine materials that have been drawn into the well. During pumping, measurements of pH, temperature, and specific conductance will be recorded.

Development will continue by alternately surging and pumping until the discharge water is free from sand and silt, the turbidity is substantially reduced, and the pH, temperature, and specific conductance have stabilized at regional background levels, based on historical data. Development will continue for a minimum of 30 minutes and until the water removed from the well is as clear of turbidity as practicable.

Well development equipment will be decontaminated prior to initial use and after the development of each well. Decontamination procedures are detailed in *SOP Decontamination of Personnel and Equipment*. Water generated during well development will be contained and managed as detailed in the *SOP Disposal of Waste Fluids and Solids* and the Investigation Derived Waste Management Plan.

IV. Attachments

Schematic diagram of shallow monitoring-well construction (MWSingleDiag.xls)

Water-Level Measurements

I. Purpose and Scope

The purpose of this procedure is to provide a guideline for the measurement of the depth to groundwater in piezometers and monitoring wells, even where a second phase of floating liquid (e.g., gasoline) is encountered, and on staff gages in surface-water bodies. This SOP includes guidelines for discrete measurements of static water levels and does not cover the use of continuously recording loggers (see SOP *Use of Data Loggers and Pressure Transducers*).

II. Equipment and Materials

- Electronic water-level meter (Solinst® or equivalent) with a minimum 100-foot tape; the tape should have graduations in increments of 0.01 feet or less
- Interface probe (Solinst® Model 122 Interface Meter or equivalent)

III. Procedures and Guidelines

Verify that the unit is turned on and functioning properly. Slowly lower the probe on its cable into the piezometer or well until the probe just contacts the water surface; the unit will respond with a tone or light signal. Note the depth from a reference point indicated on the piezometer or well riser. Typically this is the top of the PVC casing. If no reference is clearly visible, measure the depth to water from the northern edge of the PVC casing. If access to the top of the PVC casing is difficult, sight across the top of the locking casing adjacent to the measuring point, recording the position of the cable when the probe is at the water surface.

Measure the distance from this point to the closest interval marker on the tape, and record the water level reading in the logbook. Water levels will be measured to the nearest 0.01-foot. Also when specified in the project plans, measure and record the depth of the piezometer or well. The depth of the piezometer or well may be measured using the water-level probe with the instrument turned off.

Free product light or dense nonaqueous phase liquid may be present in the piezometer or well. If the presence of free product is suspected, the thickness of the product should be determined using appropriate equipment (e.g., Solinst® Model 122 Interface Meter). The depth to water also is determined with this equipment and the water-level meter should not be used in the piezometer or well as long as product is present. Typically, a constant sound is emitted from the device when free product is encountered and an alternating on/off beep sound is emitted when water is encountered.

The apparent elevation of the water level in the well or piezometer is determined by measuring both the apparent depth to water and the thickness of free product. The corrected water-level elevation is calculated by the following equation:

$$WL_c = WL_a + (\text{Free-product thickness} \times 0.80)$$

Where WL_c = Corrected water-level elevation

WL_a = Apparent water-level elevation

0.80 = Typical value for the density of petroleum hydrocarbon products.

If free product is detected on the surface of the water in the piezometer or well, the value of sampling should be reconsidered because of the potential for contaminating the sampling equipment.

Staff gages may be installed in some surface-water bodies. These facilities typically are constructed by attaching a calibrated, marked staff gage to a wood or metal post, driving the post into the bottom of the surface-water body, and surveying the elevation of the top of the post to a resolution or 0.01-foot. The elevation of the water in the surface-water body then can be determined by reading off the distance the water level is from the top of the post. A shield or other protection may be needed to calm the fluctuations in water level if the gage is installed at a location exposed to wind or wave.

IV. Attachments

None.

V. Key Checks

- Before each use, verify that the battery is charged by pressing the test button on the water-level meter.
- Verify that the unit is operating correctly by testing the probe in distilled or de-ionized water. Leave the unit turned off when not in use.

Logging of Soil Borings

I. Purpose and Scope

This SOP provides guidance to obtain accurate and consistent descriptions of soil characteristics during soil-sampling operations. The characterization is based on visual examination and manual tests, not on laboratory determinations.

II. Equipment and Materials

- Indelible pens
- Tape measure or ruler
- Field logbook
- Spatula
- HCL, 10 percent solution
- Squirt bottle with water
- Rock- or soil-color chart (e.g., Munsell)
- Grain-size chart
- Hand lens
- Unified Soil Classification System (USCS) index charts and tables to help with soil classification (attached)

III. Procedures and Guidelines

This section covers several aspects of soil characterization: instructions for completing the CH2M HILL soil boring log Form D1586 (attached), field classification of soil, and standard penetration test procedures.

A. Instructions for Completing Soil Boring Logs

Soil boring logs will be completed in the field log books or on separate soil boring log sheets. Information collected will be consistent with that required for Form D1586 (attached), a standard CH2M HILL form (attached), or an equivalent form that supplies the same information.

The information collected in the field to perform the soil characterization is described below.

Field personnel should review completed logs for accuracy, clarity, and thoroughness of detail. Samples also should be checked to see that information is correctly recorded on both jar lids and labels and on the log sheets.

B. Heading Information

Boring/Well Number. Enter the boring/well number. A numbering system should be chosen that does not conflict with information recorded for previous exploratory work done at the site. Number the sheets consecutively for each boring.

Location. If station, coordinates, mileposts, or similar project layout information is available, indicate the position of the boring to that system using modifiers such as "approximate" or "estimated" as appropriate.

Elevation. Elevation will be determined at the conclusion of field activities through a survey.

Drilling Contractor. Enter the name of the drilling company and the city and state where the company is based.

Drilling Method and Equipment. Identify the bit size and type, drilling fluid (if used), and method of drilling (e.g., rotary, hollow-stem auger). Information on the drilling equipment (e.g., CME 55, Mobile B61) also is noted.

Water Level and Date. Enter the depth below ground surface to the apparent water level in the borehole. The information should be recorded as a comment. If free water is not encountered during drilling or cannot be detected because of the drilling method, this information should be noted. Record date and time of day (for tides, river stage) of each water level measurement.

Date of Start and Finish. Enter the dates the boring was begun and completed. Time of day should be added if several borings are performed on the same day.

Logger. Enter the first and last name.

C. Technical Data

Depth Below Surface. Use a depth scale that is appropriate for the sample spacing and for the complexity of subsurface conditions.

Sample Interval. Note the depth at the top and bottom of the sample interval.

Sample Type and Number. Enter the sample type and number. SS-1 = split spoon, first sample. Number samples consecutively regardless of type. Enter a sample number even if no material was recovered in the sampler.

Sample Recovery. Enter the length to the nearest 0.1-foot of soil sample recovered from the sampler. Often, there will be some wash or caved material above the sample; do not include the wash material in the measurement. Record soil recovery in feet.

Standard Penetration Test Results. In this column, enter the number of blows required for each 6 inches of sampler penetration and the "N" value, which is the sum of the blows in the middle two 6-inch penetration intervals. A typical standard penetration test involving successive blow counts of 2, 3, 4, and 5 is recorded as 2-3-4-5 and (7). The standard penetration test is terminated if the sampler encounters refusal. Refusal is a penetration of less than 6 inches with a blow count of 50. A

partial penetration of 50 blows for 4 inches is recorded as 50/4 inches. Penetration by the weight of the slide hammer only is recorded as "WOH."

Samples should be collected using a 140-pound hammer and 2-inch diameter split spoons. Samples may be collected using direct push sampling equipment. However, blow counts will not be available. A pocket penetrometer may be used instead to determine relative soil density of fine grained materials (silts and clays).

Sample also may be collected using a 300-pound hammer or 3-inch-diameter split-spoon samples at the site. However, use of either of these sample collection devices invalidates standard penetration test results and should be noted in the comments section of the log. The 300-pound hammer should only be used for collection of 3-inch-diameter split-spoon samples. Blow counts should be recorded for collection of samples using either a 3-inch split-spoon, or a 300-pound hammer. An "N" value need not be calculated.

Soil Description. The soil classification should follow the format described in the "Field Classification of Soil" subsection below.

Comments. Include all pertinent observations (changes in drilling fluid color, rod drops, drilling chatter, rod bounce as in driving on a cobble, damaged Shelby tubes, and equipment malfunctions). In addition, note if casing was used, the sizes and depths installed, and if drilling fluid was added or changed. You should instruct the driller to alert you to any significant changes in drilling (changes in material, occurrence of boulders, and loss of drilling fluid). Such information should be attributed to the driller and recorded in this column.

Specific information might include the following:

- The date and the time drilling began and ended each day
- The depth and size of casing and the method of installation
- The date, time, and depth of water level measurements
- Depth of rod chatter
- Depth and percentage of drilling fluid loss
- Depth of hole caving or heaving
- Depth of change in material
- Health and safety monitoring data
- Drilling interval through a boulder

D. Field Classification of Soil

This section presents the format for the field classification of soil. In general, the approach and format for classifying soils should conform to ASTM D 2488, Visual-Manual Procedure for Description and Identification of Soils (attached).

The Unified Soil Classification System is based on numerical values of certain soil properties that are measured by laboratory tests. It is possible, however, to estimate these values in the field with reasonable accuracy using visual-manual procedures (ASTM D 2488). In addition, some elements of a complete soil

description, such as the presence of cobbles or boulders, changes in strata, and the relative proportions of soil types in a bedded deposit, can be obtained only in the field.

Soil descriptions should be precise and comprehensive without being verbose. The correct overall impression of the soil should not be distorted by excessive emphasis on insignificant details. In general, similarities rather than differences between consecutive samples should be stressed.

Soil descriptions must be recorded for every soil sample collected. The format and order for soil descriptions should be as follows:

1. Soil name (synonymous with ASTM D 2488 Group Name) with appropriate modifiers. Soil name should be in all capitals in the log, for example "POORLY-GRADED SAND."
2. Group symbol, in parentheses, for example, "(SP)."
3. Color, using Munsell color designation
4. Moisture content
5. Relative density or consistency
6. Soil structure, mineralogy, or other descriptors

This order follows, in general, the format described in ASTM D 2488.

E. Soil Name

The basic name of a soil should be the ASTM D 2488 Group Name on the basis of visual estimates of gradation and plasticity. The soil name should be capitalized.

Examples of acceptable soil names are illustrated by the following descriptions:

- A soil sample is visually estimated to contain 15 percent gravel, 55 percent sand, and 30 percent fines (passing No. 200 sieve). The fines are estimated as either low or highly plastic silt. This visual classification is SILTY SAND WITH GRAVEL, with a Group Symbol of (SM).
- Another soil sample has the following visual estimate: 10 percent gravel, 30 percent sand, and 60 percent fines (passing the No. 200 sieve). The fines are estimated as low plastic silt. This visual classification is SANDY SILT. The gravel portion is not included in the soil name because the gravel portion was estimated as less than 15 percent. The Group Symbol is (ML).

The gradation of coarse-grained soil (more than 50 percent retained on No. 200 sieve) is included in the specific soil name in accordance with ASTM D 2488. There is no need to further document the gradation. However, the maximum size and angularity or roundness of gravel and sand-sized particles should be recorded. For fine-grained soil (50 percent or more passing the No. 200 sieve), the name is modified by the appropriate plasticity/elasticity term in accordance with ASTM D 2488.

Interlayered soil should each be described starting with the predominant type. An introductory name, such as “Interlayered Sand and Silt,” should be used. In addition, the relative proportion of each soil type should be indicated (see Table 1 for example).

Where helpful, the evaluation of plasticity/elasticity can be justified by describing results from any of the visual-manual procedures for identifying fine-grained soils, such as reaction to shaking, toughness of a soil thread, or dry strength as described in ASTM D 2488.

F. Group Symbol

The appropriate group symbol from ASTM D 2488 must be given after each soil name. The group symbol should be placed in parentheses to indicate that the classification has been estimated.

In accordance with ASTM D 2488, dual symbols (e.g., GP-GM or SW-SC) can be used to indicate that a soil is estimated to have about 10 percent fines. Borderline symbols (e.g., GM/SM or SW/SP) can be used to indicate that a soil sample has been identified as having properties that do not distinctly place the soil into a specific group. Generally, the group name assigned to a soil with a borderline symbol should be the group name for the first symbol. The use of a borderline symbol should not be used indiscriminately. Every effort should be made to first place the soil into a single group.

G. Color

The color of a soil must be given. The color description should be based on the Munsell system. The color name and the hue, value, and chroma should be given.

H. Moisture Content

The degree of moisture present in a soil sample should be defined as dry, moist, or wet. Moisture content can be estimated from the criteria listed on Table 2.

I. Relative Density or Consistency

Relative density of a coarse-grained (cohesionless) soil is based on N-values (ASTM D 1586 [attached]). If the presence of large gravel, disturbance of the sample, or non-standard sample collection makes determination of the in situ relative density or consistency difficult, then this item should be left out of the description and explained in the Comments column of the soil boring log.

Consistency of fine-grained (cohesive) soil is properly based on results of pocket penetrometer or torvane results. In the absence of this information, consistency can be estimated from N-values. Relationships for determining relative density or consistency of soil samples are given in Tables 3 and 4.

J. Soil Structure, Mineralogy, and Other Descriptors

Discontinuities and inclusions are important and should be described. Such features include joints or fissures, slickensides, bedding or laminations, veins, root holes, and wood debris.

Significant mineralogical information such as cementation, abundant mica, or unusual mineralogy should be described.

Other descriptors may include particle size range or percentages, particle angularity or shape, maximum particle size, hardness of large particles, plasticity of fines, dry strength, dilatancy, toughness, reaction to HCl, and staining, as well as other information such as organic debris, odor, or presence of free product.

K. Equipment and Calibration

Before starting the testing, the equipment should be inspected for compliance with the requirements of ASTM D 1586. The split-barrel sampler should measure 2-inch or 3-inch O.D., and should have a split tube at least 18 inches long. The minimum size sampler rod allowed is "A" rod (1-5/8-inch O.D.). A stiffer rod, such as an "N" rod (2-5/8-inch O.D.), is required for depths greater than 50 feet. The drive weight assembly should consist of a 140-pound or 300-pound hammer weight, a drive head, and a hammer guide that permits a free fall of 30 inches.

IV. Attachments

Soil Boring Log (Sample Soil Boring Log.xls)

CH2M HILL Form D1586 and a completed example (Soil_Log_Examp.pdf)

ASTM D 2488 *Standard Practice for Description and Identification of Soils (Visual-Manual Procedures)* (ASTM D2488.pdf)

ASTM 1586 *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils* (ASTM D1586.pdf)

Tables 1 through 4 (Tables 1-4.pdf)

V. Key Checks and Preventive Maintenance

- Check entries to the soil-boring log and field logbook in the field; because the samples will be disposed of at the end of fieldwork, confirmation and corrections cannot be made later.
- Check that sample numbers and intervals are properly specified.
- Check that drilling and sampling equipment is decontaminated using the procedures defined in SOP *Decontamination of Drilling Rigs and Equipment*.



PROJECT NUMBER DEN 22371.G5	BORING NUMBER BL-3	SHEET 1 OF 3
SOIL BORING LOG		

PROJECT Howard Ave Landslide LOCATION Howard & 24th Ave, Centennial, CO
 ELEVATION 513 1/2 Feet DRILLING CONTRACTOR Kendall Explorations, Aspen, Colorado
 DRILLING METHOD AND EQUIPMENT 4"-inch H.S. Augers, Mobil B-61 rotary drill rig
 WATER LEVELS 3.2 Feet, 8/5/89 START August 4, 1989 FINISH August 8, 1989 LOGGER J.A. Michner

DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION	COMMENTS
	INTERVAL	NUMBER AND TYPE	RECOVERY (FT)			
				6"-6"-6" (N)		
0					Surface material consist of 4 inches AC underlain by 6 inches of 3/4 inch minus base rock	Start Drilling @ 3:00
2.5						
4.0	1-S	1.5	2-3-4 (7)		POORLY-GRADED SAND WITH SILT, (SP-SM), fine, light brown, wet, loose	Driller notes water at 4 feet
5.0						Driller notes very soft drilling
5						4ft. dark grey, wet silty cuttings.
6.5	2-S	0.9	WOH/12"-1		ORGANIC SILT, (OL), very dark, gray to black, wet, very soft; strong H ₂ S odor; many fine roots up to about 1/4 inch	
8.0						
10.0	3-ST	1.3			ORGANIC SILT, similar to 2-S, except includes fewer roots (by volume)	
10						
11.5	4-S	1.3	2-2-2 (4)		SILT, (ML), very dark gray to black, wet, soft	water level @ 3.2 feet on 8/5/89 @ 0730
						Driller notes rough drilling action and chatter @ 13 ft
15						
15.0						
15.5	5-S	0.5	60/6"		SILTY GRAVEL, (GM), rounded gravel up to about 1 inch maximum observed size, wet, very dense	
20						
20.0						Driller notes smoother, firm drilling @ 19 ft
21.0	6-S	1.0	12-50/6"		LEAN CLAY WITH SAND, (CL), medium to light green, moist, very stiff	some angular rock chips @ bot tip of 6-S, poss boulders or rock
						Driller notes very hard, slow grinding, smooth drilling action from 21 to 23 ft, possibly bedrock
23.0						
23.1	7-S	0	50/1"		NO RECOVERY	
					END SOIL BORING @ 23.1 FEET	
					SEE ROCK CORE LOG FOR CONTINUATION OF BL-3	

Figure 2
EXAMPLE OF COMPLETED LOG FORM

Locating and Clearing Underground Utilities

I. Purpose

The purpose of this SOP is to provide general guidelines and specific procedures that must be followed on Navy CLEAN projects for locating underground utilities and clearing dig locations in order to maximize our ability to avoid hitting underground utilities and to minimize liabilities to CH2M HILL and its subcontractors and health and safety risks to our project staff.

This SOP shall be used by Activity Managers and Project Managers to, in-turn, develop Activity-specific and project-specific utility location procedures. The activity and project-specific procedures will become part of work plans and project instructions and will be used to prepare scopes of work (SOWs) for the procurement of utility location subcontractors to meet the needs of individual projects.

This SOP also identifies the types of utility locating services that are available from subcontractors and the various tools that are used to locate utilities, and discusses when each type of service and tool may or may not be applicable.

II. Scope

Depending on the Navy/Marine Activity we typically find ourselves in one of two scenarios:

Scenario 1

The Activity provides utility locating (or dig clearance) services through the public works department or similar organization, or has a contract with an outside utility clearance service. Some of these services are provided in the form of dig permits which are required before you can dig or drill. In other cases no official permit is required and the process is somewhat vague.

Scenario 2

The Activity does not get involved in any utility locating processes aside from possibly providing the most recent utility maps, and relies on CH2M HILL to clear the dig locations.

Table 1 provides an up to date summary of which scenarios apply to the various primary Activities served under the Navy CLEAN program.

Scenario 1 is preferred because under this scenario the Navy tends to assume the responsibility if the location is improperly cleared, a utility is struck, and property damage results. However, our experience has been that the clearance services provided by the Navy do not meet the standards that we consider to be adequate, in that they

often simply rely on available base maps to mark utilities and do not verify locations using field geophysics. And if they do use locating tools, they do not provide adequate documentation or marking to confirm that a location has been cleared. So while the Navy's process may protect us from liability for property damage, it does not adequately protect our staff and subcontractors from health risks nor does it compensate us for down time, should a utility be hit.

Therefore, regardless of what services the Navy provides, in most cases we still need to supplement this effort with clearance services from our own third party utility location subcontractor following the procedures and guideline outlined in Section IV of this SOP. The cost implications of providing this service will range from \$500 to several \$1,000 depending on the size of the project.

The scope of services that we ask our subcontractors to provide can involve utility marking/mapping or the clearing of individual dig locations. In the former we ask our subs to mark all utilities within a "site" and often ask them to prepare a map based on their work. In the later, we ask them to clear (identify if there are any utilities within) a certain radius of a proposed dig/drill location.

The appropriate requested scope of services for a project will depend on the project. Clearing individual boreholes is often less expensive and allows the sub to concentrate their efforts on a limited area. However if the scope of the investigation is fluid (all borehole locations are not predetermined) it may be best to mark and map an entire site or keep the subcontractor on call.

Clearance of individual dig locations should be done to a minimum 20 foot radius around the location.

An example SOW for a utility subcontractor procurement is provided in Attachment A.

III. Services and Equipment

This section provides a general description of the services available to help us locate subsurface utilities and describes the types of equipment that these services may (or may not) use to perform their work. It identifies the capabilities of each type of equipment to help the PM specify what they should require from our utility location subs.

Services

The services that are available to us for identifying and marking underground utilities are:

- The local public/private utility-run service such as Miss Utility
- Utility location subcontractors (hired by us)

Attachment B provides a detailed description of each type of organization. It also provides contact numbers and web sites for the various Miss-Utility-type organizations in the areas where we do work for the Navy and contacts and services provided by several subcontractors that we have used or spoken to in the past.

Equipment

Attachment C provides a summary of the various types of equipment used for subsurface utility location. It describes the capabilities and limitations of each in order to help the PM determine if the equipment being used by a subcontractor is adequate.

It is important to make the potential subcontractors aware of the possible types of utilities (and utility materials) that are at the site, and to have them explain in their bid what types of equipment they will use to locate utilities /clear dig locations, and what the limitations of these equipment are.

A list of in-house experts that can be used to help you evaluate bids or answer questions you may have is provided in **Appendix C**.

IV. Procedures and Guidelines

This section presents specific procedures to be followed for the utility location work to be conducted by CH2M HILL and our subcontractors. In addition, a PM will have to follow the procedures required by the Activity to obtain their approvals, clearances and dig permits where necessary. These “dig permit” requirements vary by Activity and must be added to the project-specific SOP, or project instructions. It is preferable that the Activity perform their clearance processes before we follow up with our clearance work.

Activity Notification and Dig Permit Procedures

Identify Activity-specific permit and/or procedural requirements for excavation and drilling activities. Contact the Base Civil Engineer and obtain the appropriate form to begin the clearance process.

Activity Specific: To be provided by Activity or Project Manager

CH2M HILL Utility Clearance Procedures

Do not begin subsurface construction activities (e.g., trenching, excavation, drilling, etc.) until a check for underground utilities and similar obstructions has been conducted by CH2M HILL as a follow-up to the services provided by the Navy. The use of as-built drawings and utility company searches must be supplemented with a geophysical or other survey by a qualified, independent survey contractor (subcontracted to CH2M HILL) to identify additional and undiscovered buried utilities.

Examples of the type of geophysical technologies include (these are further described in Attachment C):

- **Ground Penetrating Radar (GPR)**, which can detect pipes, including gas pipes, tanks, conduits, cables etc, both metallic and non-metallic at depths up to 30 feet depending on equipment. Sensitivity for both minimum object size and maximum depth detectable depends on equipment selected, soil conditions, etc.
- **Radio Frequency (RF)**, involves inducing an RF signal in the pipe or cable and using a receiver to trace it. Some electric and telephone lines emit RF naturally and can be detected without an induced signal. This method requires knowing where the conductive utility can be accessed to induce RF field if necessary.

- **Dual RF**, a modified version of RF detection using multiple frequencies to enhance sensitivity but with similar limitations to RF
- **Ferromagnetic Detectors**, are metal detectors that will detect ferrous and non-ferrous utilities. Sensitivity is limited, e.g. a 100 mm iron disk to a depth of about one meter or a 25 mm steel paper clip to a depth of about 20 cm.
- **Electronic markers**, are emerging technologies that impart a unique electronic signature to materials such as polyethylene pipe to facilitate location and tracing after installation. Promising for future installations but not of help for most existing utilities already in place.

The following procedures shall be used to identify and mark underground utilities during subsurface construction activities on the project:

- Contact utility companies or the state/regional utility protection service (such as Miss Utility) at least two (2) working days prior to intrusive activities to advise of the proposed work, and ask them to establish the location of the utility underground installations prior to the start of actual excavation: this is a law. These services will only mark the location of public-utility-owned lines and not Navy-owned utilities. In many cases there will not be any public-utility-owned lines on the Activity. There may also be Base-access issues to overcome.
- Procure and schedule the independent survey.
- The survey contractor shall determine the most appropriate geophysical technique or combinations of techniques to identify the buried utilities on the project site, based on the survey contractor's experience and expertise, types of utilities anticipated to be present and specific site conditions. *The types of utilities must be provided to the bidding subcontractors in the SOW and procedures to be used must be specified by the bidder in their bid. It is extremely helpful to provide the sub with utility maps, with the caveat that all utilities are not necessarily depicted.*
- The survey subcontractor shall employ the same geophysical techniques used to identify the buried utilities, to survey the proposed path of subsurface investigation/construction work to confirm no buried utilities are present.
- Obtain utility clearances for subsurface work on both public and private property.
- Clearances provided by both the "Miss Utility" service and the CH2M HILL-subcontracted service are to be in writing, signed by the party conducting the clearance. The Miss Utility service will have standard notification forms/letters which typically simply state that they have been to the site and have done their work. The CH2M HILL subcontractor shall be required to fill out the form provided in Attachment D (this can be modified for a particular project) indicating that each dig/drill location has been addressed. *This documentation requirement (with a copy of the form) needs to be provided in the subcontractor SOW.*
- Marking shall be done using the color coding presented in Attachment E. The type of material used for marking must be approved by the Activity prior to marking. Some base commanders have particular issues with persistent spray paint on their

sidewalks and streets. *Any particular marking requirements need to be provided in the subcontractor SOW.*

- Protect and preserve the markings of approximate locations of facilities until the markings are no longer required for safe and proper excavations. If the markings of utility locations are destroyed or removed before excavation commences or is completed, the Project Manager must notify the utility company or utility protection service to inform them that the markings have been destroyed.
- Perform a field check prior to drilling/ digging (preferably while the utility location sub is still at the site) to see if field utility markings coincide with locations on utility maps. Look for fire hydrants, valves, manholes, light poles, lighted signs, etc to see if they coincide with utilities identified by the subcontractor.
- Underground utility locations must be physically verified (or dig locations must be physically cleared) by hand digging using wood or fiberglass-handled tools, air knifing, or by some other acceptable means approved by CH2M HILL, when the dig location (e.g. mechanical drilling, excavating) is expected to be within 5 feet of a marked underground system. Hand clearance shall be done to a depth of four feet unless a utility cross-section is available that indicates the utility is at a greater depth. In that event, the hand clearance shall proceed until the documented depth of the utility is reached.
- Conduct a site briefing for employees at the start of the intrusive work regarding the hazards associated with working near the utilities and the means by which the operation will maintain a safe working environment. Detail the method used to isolate the utility and the hazards presented by breaching the isolation.
- Monitor for signs of utilities during advancement of intrusive work (e.g., sudden change in advancement of auger or split spoon during drilling or change in color, texture or density during excavation that could indicate the ground has been previously disturbed).

IV. Attachments

- A- Example SOW for Utility Location Subcontractor Procurement
- B - Services Available for Identifying and Marking Underground Utilities
- C - Equipment Used for Identifying Underground Utilities
- D - Utility Clearance Documentation Form
- E - Utility Marking Color Codes

Attachment A – Example SOW for Subcontracting Underground Utilities Locating Services

CTO-XXX

Scope of Work

Subsurface Utility Locating

Site XX

Navy Activity

City, State

A licensed and insured utility locator will be subcontracted to identify and mark out subsurface utilities for an environmental investigation/remediation project at Site XX of <<insert name of base, city, and state>>. The subcontractor will need to be available beginning at <<insert time>> on <<insert date>>. It is estimated that the work can be completed within XX days.

Proposed Scope of Work

The subcontractor will identify and mark all subsurface utilities (CHOOSE 1) that lie within a radius of 20 feet of each of XX sampling locations at Site XX shown on the attached Figure 1; (OR) that lie within the bounds of Site XX as delineated on the attached Figure 1. (If multiple sites are to be cleared, provide maps of each site with sample locations or clearance boundaries clearly delineated and a scale provided.)

Utilities will be identified using all reasonably available as-built drawings, electronic locating devices, and any other means necessary to maintain the safety of drilling and sampling personnel and the protection of the base infrastructure. The location of utilities identified from as-built drawings or other maps must be verified in the field prior to marking.

Base utility drawings for the Site(s) (CHOOSE 1) can be found at <<insert specific department and address or phone number on the base>> and should be reviewed by the subcontractor and referenced as part of the utility locating. (OR), will be provided to the subcontractor by CH2M HILL upon the award of the subcontract. (OR), are not available. Utility drawings shall not be considered definitive and must be field verified.

Field verification will include detection using nonintrusive subsurface detection equipment (magnetometers, GPR, etc) as well as opening manhole covers to verify pipe

directions. As part of the bid, the Subcontractor shall provide a list of the various subsurface investigation tools they propose to have available and use at the site and what the limitations are of each tool.

A CH2M HILL representative shall be present to coordinate utility clearance activities and identify points and features to be cleared.

Field Marking and Documentation

All utilities located within **(CHOOSE 1) a 20-ft radius of the XX proposed soil boring locations (OR) within the boundary of the site(s)** as identified on the attached figure(s) will be marked using **paint (some Bases such as the WNY may have restrictions on the use of permanent paint)** and/or pin flags color coded to indicate electricity, gas, water, steam, telephone, TV cable, fiber optic, sewer, etc. The color coding shall match the industry standard as described on the attached form. In addition, the **Buried Utility Location Tracking Form** (attached) will be completed by the Subcontractor based upon what is identified in the field during the utility locating and submitted back to CH2M HILL (field staff or project manager) within 24 hours of completing the utility locating activities.

(OPTIONAL) The subcontractor shall also provide a map (or hand sketch) of the identified utilities to the Engineer within XX days of field demobilization. The map shall include coordinates or ties from fixed surface features to each identified subsurface utility.

Bid Sheet/Payment Units

The subcontractor will bid on a time and materials basis for time spent on site and researching utility maps. Mobilization (including daily travel to the site) should be bid as a lump sum, as well as the preparation of the AHA **and any required mapping**. The per diem line item should be used if the field crew will require overnight accommodations at the project site.

Health and Safety Requirements

The utility locating subcontractor is to provide and assume responsibility for an adequate corporate Health and Safety Plan for onsite personnel. Standard personal safety equipment including: hard hat, safety glasses, steel-toed boots, gloves are recommended for all project activities. Specific health and safety requirements will be established by the Subcontractor for each project. The health and safety requirements will be subject to the review of CH2M HILL.

The subcontractor shall also prepare and provide to the Engineer, at least 48 hours prior to mobilization, an acceptable Activity Hazard Analysis (AHA) using the attached AHA form or similar.

It is also required that all subcontractor personnel who will be on site attend the daily 15-minute health and safety tailgate meeting at the start of each day in the field.

Subcontractor personnel showing indications of being under the influence of alcohol or illegal drugs will be sent off the job site and their employers will be notified.

Subcontractor personnel under the influence of prescription or over-the-counter medication that may impair their ability to operate equipment will not be permitted to do so. It is expected that the subcontractor will assign them other work and provide a capable replacement (if necessary) to operate the equipment to continue work.

Security

The work will be performed on US Navy property. CH2M HILL will identify the Subcontractor personnel who will perform the work to the appropriate Navy facility point-of-contact, and will identify the Navy point-of-contact to the Subcontractor crew. The Subcontractor bears final responsibility for coordinating access of his personnel onto Navy property to perform required work. This responsibility includes arranging logistics and providing to CH2M HILL, in advance or at time of entry as specified, any required identification information for the Subcontractor personnel. Specifically, the following information should be submitted with the bid package for all personnel that will perform the work in question (this information is required to obtain a base pass):

- Name
- Birth Place
- Birth Date
- Social Security Number
- Drivers License State and Number
- Citizenship

Please be advised that no weapons, alcohol, or drugs will be permitted on the Navy facility at any time. If any such items are found, they will be confiscated, and the Subcontractor will be dismissed.

Quality Assurance

The Subcontractor will be licensed and insured to operate in the State of <<state>> and will comply with all applicable federal, state, county and local laws and regulations. The subcontractor will maintain, calibrate, and operate all electronic locating instruments in accordance with the manufacturer's recommendations. Additionally, the Subcontractor shall make all reasonable efforts to review as-built engineering drawings maintained by Base personnel, and shall notify the CH2M HILL Project Manager in writing (email is acceptable) whenever such documentation was not available or could not be reviewed.

Subcontractor Standby Time

At certain periods during the utility locating activities, the Subcontractor's personnel may be asked to stop work and standby when work may normally occur. During such times, the Subcontractor will cease activities until directed by the CH2M HILL representative to resume operations. Subcontractor standby time also will include potential delays caused by the CH2M HILL representative not arriving at the site by the agreed-upon meeting time for start of the work day. Standby will be paid to the Subcontractor at the hourly rate specified in the Subcontractor's Bid Form attached to these specifications.

Cumulative Subcontractor standby will be accrued in increments no shorter than 15 minutes (i.e., an individual standby episode of less than 15 minutes is not chargeable).

During periods for which standby time is paid, the surveying equipment will not be demobilized and the team will remain at the site. At the conclusion of each day, the daily logs for the Subcontractor and CH2M HILL representative will indicate the amount of standby time incurred by the Subcontractor, if any. Payment will be made only for standby time recorded on CH2M HILL's daily logs.

Down Time

Should equipment furnished by the Subcontractor malfunction, preventing the effective and efficient prosecution of the work, or inclement weather conditions prevent safe and effective work from occurring, down time will be indicated in the Subcontractor's and CH2M Hill representative's daily logs. No payment will be made for down time.

Schedule

It is anticipated that the subsurface utility locating activities will occur on <<insert date>>. It is estimated that the above scope will be completed within XXX days.

Attachment B - Services Available for Identifying and Marking Underground Utilities

The services that are available to us for identifying and marking underground utilities are:

- The Activity's PWC (or similar organization)
- The local public/private utility -run service such as Miss Utility
- Utility location subcontractors (hired by CH2M HILL)

Each are discussed below.

Navy Public Works Department

A Public Works Department (PWD) is usually present at each Activity. The PWD is responsible for maintaining the public works at the base including management of utilities. In many cases, the PWD has a written permit process in place to identify and mark-out the locations of Navy-owned utilities [Note: The PWD is usually NOT responsible for the locations/mark-outs of non-Navy owned, public utilities (e.g., Washington Gas, Virginia Power, municipal water and sewer, etc.). Therefore, it is likely that we will have to contact other organizations besides the PWD in order to identify non-Navy owned, public utilities].

At some Activities, there may not be a PWD, the PWD may not have a written permit process in place, or the PWD may not take responsibility for utility locating and mark-outs. In these cases, the PWD should still be contacted since it is likely that they will have the best understanding of the utility locations at the Activity (i.e., engineering drawings, institutional knowledge, etc.). Subsequently, the PWD should be brought into a cooperative arrangement (if possible) with the other services employed in utility locating and mark-out in order to have the most comprehensive assessment performed.

At all Activities we should have a contact (name and phone number), and preferably an established relationship, with PWD, either directly or through the NAVFAC Atlantic, Midlant, or Washington NTR or Activity Environmental Office that we can work with and contact in the event of problems.

Miss Utility or "One Call" Services for Public Utility Mark-outs

Miss Utility or "One Call" service centers are information exchange centers for excavators, contractors and property owners planning any kind of excavation or digging. The "One Call" center notifies participating public utilities of the upcoming excavation work so they can locate and mark their underground utilities in advance to prevent possible damage to underground utility lines, injury, property damage and service outages. In some instances, such with southeastern Virginia bases, the Navy has entered into agreement with Ms. Utilities and is part of the response process for Miss

Utilities. Generally, a minimum of 48 hours is required for the public utility mark-outs to be performed. The “One Call” services are free to the public. Note that the “One Call” centers only coordinate with participating public utilities. There may be some public utilities that do NOT participate in the “One Call” center which may need to be contacted separately. For example, in Washington, DC, the Miss Utility “One Call” center does not locate and mark public sewer and water lines. Therefore, the municipal water and sewer authority must be contacted separately to have the sewer and water lines marked out. The AM should contact the appropriate one-call center to determine their scope of services.

For the Mid-Atlantic region, the following “One Call” service centers are available.

Name	Phone	Website	Comments
Miss Utility of DELMARVA	800-257-7777	www.missutility.net	Public utility mark-outs in Delaware, Maryland, Washington, DC, and Northern Virginia
Miss Utility of Southern Virginia (One Call)	800-552-7001	not available	Public utility mark-outs in Southern Virginia
Miss Utility of Virginia	800-257-7777 800-552-7007	www.missutilityofvirginia.com	General information on public utility mark-outs in Virginia, with links to Miss Utility of DELMARVA and Miss Utility of Southern Virginia (One Call)
Miss Utility of West Virginia, Inc	800-245-4848	none	Call to determine what utilities they work with in West Virginia
North Carolina One Call Center	800-632-4949	www.ncocc.org/ncocc/default.htm	Public Utility Markouts in North Carolina

Private Subcontractors

- Utility-locating support is required at some level for most all CH2M HILL field projects in "clearing" proposed subsurface boring locations on the project site. Utility location and sample clearance can include a comprehensive effort of GIS map interpretation, professional land surveying, field locating, and geophysical surveying. Since we can usually provide our own GIS-related services for projects and our professional land surveying services are normally procured separately, utility-locating subcontractors will normally only be required for some level of geophysical surveying support in the field. This level of geophysical surveying support can range widely from a simple electromagnetic (EM) survey over a known utility line, to a blind geophysical effort, including a ground-penetrating radar (GPR) survey and/or a comprehensive EM survey to delineate and characterize all unknown subsurface anomalies.

The level of service required from the subcontractor will vary depending on the nature of the site. At sites where utility locations are well defined on the maps and recent construction is limited, CH2M HILL may be confident with a limited effort from a traditional utility-locating subcontractor providing a simple EM survey. At sites where utility locations are not well defined, where recent constructions may have altered utility locations, or the nature of the site makes utility location difficult, CH2M HILL will require the services of a comprehensive geophysical surveying subcontractor, with a wide range of GPR and EM services available for use on an "as-needed" basis. Typical costs for geophysical surveying subcontractors will range from approximately \$200 per day for a simple EM effort (usually one crew member and one instrument) to approximately \$1,500 per day for a comprehensive geophysical surveying effort (usually a two-person crew and multiple instruments). Comprehensive geophysical surveying efforts may also include field data interpretation (and subsequent report preparation) and non-destructive excavation to field-verify utility depths and locations.

The following table provides a list of recommended geophysical surveying support subcontractors that can be used for utility-locating services:

Company Name and Address	Contact Name and Phone Number	Equipment ¹					Other Services ²		
		1	2	3	4	5	A	B	C
US Radar, Inc.* PO Box 319 Matawan, NJ 07747	Ron LaBarca 732-566-2035			4					
Utilities Search, Inc.*	Jim Davis 703-369-5758	4				4	4	4	4
So Deep, Inc.* 8397 Euclid Avenue Manassas Park, VA 20111	703-361-6005	4					4	4	4
Accurate Locating, Inc. 1327 Ashton Rd., Suite 101 Hanover, MD 21076	Ken Shipley 410-850-0280	4	4						
NAEVA Geophysics, Inc. P.O. Box 7325 Charlottesville, VA 22906	Alan Mazurowski 434-978-3187	4	4	4	4	4	4	4	4
Earth Resources Technology, Inc. 8106 Stayton Rd. Jessup, MD 20794	Peter Li 240-554-0161	4	4	4	4	4	4	4	
Geophex, Ltd 605 Mercury Street Raleigh, NC 27603	I. J. Won 919-839-8515	4	4	4	4	4	4	4	4

Notes:

*Companies denoted with an asterisk have demonstrated reluctance to assume responsibility for damage to underground utilities or an inability to accommodate the insurance requirements that CH2M HILL requests for this type of work at many Navy sites.

¹Equipment types are:

1. Simple electromagnetic instruments, usually hand-held
2. Other, more innovative, electromagnetic instruments, including larger instruments for more area coverage
3. Ground-penetrating radar systems of all kinds
4. Audio-frequency detectors of all kinds
5. Radio-frequency detectors of all kinds

²Other services include:

- A. Data interpretation and/or report preparation to provide a permanent record of the geophysical survey results and a professional interpretation of the findings, including expected accuracy and precision.
- B. Non-destructive excavation to field-verify the depths, locations, and types of subsurface utilities.
- C. Concrete/asphalt coring and pavement/surface restoration.

Attachment C – Equipment Used for Identifying Underground Utilities

This attachment provides a summary of the various types of equipment used for subsurface utility location. It describes the capabilities and limitations of each in order to help the AM and PM determine if the equipment being proposed by a subcontractor or Navy is adequate. A list of in-house experts that can be used to answer questions you may have is provided below.

CH2M HILL In-house Utility Location Experts

Tamir Klaff/WDC

Home Office Phone – 703-669-9611

Electromagnetic Induction (EMI) Methods

EMI instruments, in general, induce an electromagnetic field into the ground (the primary field) and then record the response (the secondary field), if any. Lateral changes in subsurface conductivity, such as caused by the presence of buried metal or by significant soil variations, cause changes in the secondary field recorded by the instrument and thus enable detection and mapping of the subsurface features. It should be noted that EMI only works for electrically conductive materials--plastic or PVC pipes are generally not detected with EMI. Water and gas lines are commonly plastic, although most new lines include a copper "locator" strip on the top of the PVC to allow for detection with EMI.

EMI technology encompasses a wide range of instruments, each with inherent strengths and weaknesses for particular applications. One major division of EMI is between "time-domain" and "frequency-domain" instruments that differ in the aspect of the secondary field they detect. Another difference in EMI instruments is the operating frequency they use to transmit the primary field. Audio- and radio-frequencies are often used for utility detection, although other frequencies are also used. Consideration of the type of utility expected, surface features that could interfere with detection, and the "congestion" of utilities in an area, should be made when choosing a particular EMI instrument for a particular site.

One common EMI tool used for utility location is a handheld unit that can be used to quickly scan an area for utilities and allows for marking locations in "real time". This method is most commonly used by "dig-safe" contractors marking out known utilities prior to excavation. It should be noted that this method works best when a signal (the primary field) can be placed directly onto the line (i.e., by clamping or otherwise connecting to the end of the line visible at the surface, or for larger utilities such as sewers, by running a transmitter through the utility). These types of tools also have a limited capability to scan an area for unknown utilities. Usually this requires having enough area to separate a hand held transmitter at least a hundred feet from the

receiver. Whether hunting for unknown, or confirming known, utilities, this method will only detect continuous lengths of metallic conductors.

In addition to the handheld EMI units, larger, more powerful EMI tools are available that provide more comprehensive detection and mapping of subsurface features. Generally, data with these methods are collected on a regular grid in the investigation area, and are then analyzed to locate linear anomalies that can be interpreted as utilities. These methods will usually detect *all* subsurface metal (above a minimum size), including pieces of abandoned utilities. In addition, in some situations, backfill can be detected against native soils giving information on trenching and possible utility location. Drawbacks to these methods are that the secondary signals from utilities are often swamped (i.e., undetectable) close to buildings and other cultural features, and that the subsurface at heavily built-up sites may be too complicated to confidently interpret completely.

Hand-held metal detectors (treasure-finders) are usually based on EMI technology. They can be used to locate shallow buried metal associated with utilities (e.g., junctions, manholes, metallic locators). Advantages of these tools is the ease of use and real-time marking of anomalies. Drawbacks include limited depths of investigations and no data storage capacity.

Ground Penetrating Radar (GPR)

GPR systems transmit radio and microwave frequency (e.g., 80 megaHertz to 1,000 megaHertz) waves into the ground and then record reflections of those waves coming back to the surface. Reflections of the radar waves typically occur at lithologic changes, subsurface discontinuities, and subsurface structures. Plastic and PVC pipes can sometimes be detected in GPR data, especially if they are shallow, large, and full of a contrasting material such as air in a wet soil, or water in a dry soil. GPR data are usually collected in regular patterns over an area and then analyzed for linear anomalies that can be interpreted as utilities. GPR is usually very accurate in x-y location of utilities, and can be calibrated at a site to give very accurate depth information as well. A significant drawback to GPR is that depth of investigation is highly dependant on background soil conductivity, and it will not work on all sites. It is not uncommon to get only 1-2 feet of penetration with the signal in damp, clayey environments. Another drawback to GPR is that sites containing significant fill material (e.g., concrete rubble, scrap metal, garbage) will result in complicated anomalies that are difficult or impossible to interpret.

Magnetic Field Methods

Magnetic field methods rely on detecting changes to the earth's magnetic field caused by ferrous metal objects. This method is usually more sensitive to magnetic metal (i.e., deeper detection) than EMI methods. A drawback to this method is it is more susceptible to being swamped by surface features such as fences and cars. In addition, procedures must usually be implemented that account for natural variations in the earth's background field as it changes throughout the day. One common use of the method is to measure and analyze the gradient of the magnetic field, which eliminates most of the drawbacks to the method. It should be noted this method only detects

ferrous metal, primarily iron and steel for utility location applications. Some utility detector combine magnetic and EMI methods into a single hand-held unit.

Optical Methods

Down the hole cameras may be useful in visually reviewing a pipe for empty conduits and/or vaults.

Attachment D – Utility Clearance Documentation Form

Attachment E – Utility Marking Color Codes

The following is the standard color code used by industry to mark various types of utilities and other features at a construction site.

White – Proposed excavations and borings

Pink – Temporary survey markings

Red – Electrical power lines, cables, conduits and lighting cables

Yellow – Gas, oil, steam, petroleum or gaseous materials

Orange – Communication, alarm or signal lines, cables, or conduits

Blue – Potable water

Purple – Reclaimed water, irrigation and slurry lines

Green – Sewer and storm drain lines

PMS 219

PMS 1795*

PMS 108

PMS 144*

13.5 parts process
2.5 parts reflex

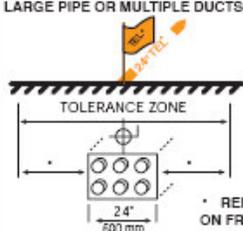
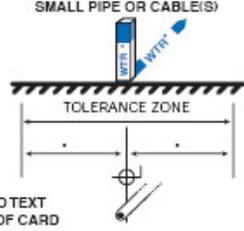
PMS 253

PMS 3415

ADWA **UNIFORM COLOR CODE**

	WHITE - Proposed Excavation
	PINK - Temporary Survey Markings
	RED - Electric Power Lines, Cables, Conduit and Lighting Cables
	YELLOW - Gas, Oil, Steam, Petroleum or Gaseous Materials
	ORANGE - Communication, Alarm or Signal Lines, Cables or Conduit
	BLUE - Potable Water
	PURPLE - Reclaimed Water, Irrigation and Slurry Lines
	GREEN - Sewers and Drain Lines

TYPICAL MARKING

LARGE PIPE OR MULTIPLE DUCTS  TOLERANCE ZONE 2.4' 600 mm	SMALL PIPE OR CABLE(S)  TOLERANCE ZONE
--	---

* REFER TO TEXT ON FRONT OF CARD

Customize with your center's phone and address information

GUIDELINES FOR UNIFORM TEMPORARY MARKING OF UNDERGROUND FACILITIES

This marking guide provides for universal use and understanding of the temporary marking of subsurface facilities to prevent accidents and damage or service interruption by contractors, excavators, utility companies, municipalities or any others working on or near underground facilities.

ONE-CALL SYSTEMS

The One-Call damage prevention system shall be contacted prior to excavation.

PROPOSED EXCAVATION

Use white marks to show the location, route or boundary of proposed excavation. Surface marks on roadways do not exceed 1.5" by 18" (40 mm by 450 mm). The facility color and facility owner identity may be added to white flags or stakes.

USE OF TEMPORARY MARKING

Use color-coded surface marks (i.e., paint or chalk) to indicate the location or route of active and out-of-service buried lines. To increase visibility, color coded vertical markers (i.e., stakes or flags) should supplement surface marks. Marks and markers indicate the name, initials or logo of the company that owns or operates the line, and width of the facility if it is greater than 2" (50 mm). Marks placed by other than line owner/operator or its agent indicate the identity of the designating firm. Multiple lines in joint trench are marked in tandem. If the surface over the buried line is to be removed, supplementary offset markings are used. Offset markings are on a uniform alignment and clearly indicate the actual facility is a specific distance away.

TOLERANCE ZONE

Any excavation within the tolerance zone is performed with non-powered hand tools or non-invasive method until the marked facility is exposed. The width of the tolerance zone may be specified in law or code. If not, a tolerance zone including the width of the facility plus 18" (450 mm) measured horizontally from each side of the facility is recommended.

ADOPT UNIFORM COLOR CODE

The American Public Works Association encourages public agencies, utilities, contractors, other associations, manufacturers and all others involved in excavation to adopt the APWA Uniform Color Code, using ANSI standard Z535.1 Safety Colors for temporary marking and facility identification.

Rev. 4/09

VOC Sampling-Water

I. Purpose

To provide general guidelines for sampling aqueous volatile organic compounds.

II. Scope

Standard techniques for collecting representative samples are summarized. Site-specific details are discussed in the Field Sampling Plan.

III. Equipment and Materials

- Sample vials pre-preserved at laboratory with hydrochloric acid (HCl)
- Surgical or latex gloves

IV. Procedures and Guidelines

1. Sample VOCs before sampling other analyte groups.
2. When sampling for VOCs, especially residential wells, evaluate the area around the sampling point for possible sources of air contamination by VOCs. Products that may give off VOCs and possibly contaminate a sample include perfumes and cosmetics, skin applied pharmaceuticals, automotive products (gasoline, starting fluid, windshield deicers, carburetor cleaners, etc.) and household paint products (paint strippers, thinners, turpentine, etc.).
3. Keep the caps off the sample vials for as short a time as possible.
4. Wear clean latex or surgical gloves.
5. Fill the sample vial immediately, allowing the water stream to strike the inner wall of the vial to minimize formation of air bubbles. **DO NOT RINSE THE SAMPLE VIALS BEFORE FILLING.**
6. Fill the sample vial with a minimum of turbulence, until the water forms a positive meniscus at the brim.

7. Replace the cap by gently setting it on the water meniscus. Tighten firmly, but DO NOT OVERTIGHTEN.
8. Invert the vial and tap it lightly. If you see air bubbles in the sample, do not add more sample. Use another vial to collect another sample. Repeat if necessary until you obtain a proper sample.

V. Attachments

None.

VI. Key Checks and Items

- Check for possible sources of contamination.
- Fill slowly, with as little turbulence as possible.
- Check for air bubbles.

STANDARD OPERATING PROCEDURE

Groundwater-Surface Water Investigation: Well Point Method Pore Water Sampling Procedures

The groundwater-to-surface water interface (GSI) zone is an area where there is a potential link between site-related groundwater and receiving water bodies (e.g., drainages, streams, rivers, lakes, ponds). Pore water sampling at the GSI can be used to determine if venting of groundwater-associated contaminants is occurring and is often used to supplement groundwater, sediment and/or surface water sampling and analysis. These data can also help evaluate potential exposures to aquatic receptors in receiving water bodies and/or evaluate the migration of contamination from a groundwater source to other media. This standard operating procedure (SOP) describes the steps for collecting a pore water sample using the “well point” method.

Materials

- Well point apparatus (**Figure 1**)
- Water quality meter (Myron L Ultrameter or similar)
- Sledge hammer, rubber mallet, poste driver or sledge hammer
- Sample tubing (¼-inch-outer- diameter polyethylene tubing connected to ¼-inch-inner- diameter silicone peristaltic tubing)
- 45 µm cellulose acetate disposable in-line filters (dissolved metals filtering)
- Pump (portable battery powered peristaltic, hand pump or syringe assembly)
- Field notebook
- Water level meter and/or measuring tape

Construction

The well point method incorporates an outer and inner screen and riser apparatus. All well point components are built or supplied by ECT Manufacturing (Hamilton, NJ; www.ectmfg.com). **Attachment A** consists of the well point materials/components and ECT pricing as of date specified. The following describes the details of the outer and inner well point components.

Outer Well Point

Outer screens are constructed using 12-inch segments of 2-inch diameter PVC piping (**Figure 1**). Each screen has a 12-inch machine slotted screen¹ (0.010 inch slot size). A pointed well cap is attached (affixed with stainless steel screw) to the bottom of the outer screened segment, and the top end of this segment is threaded (female) to accept a 2-inch-diameter male end of a threaded PVC riser segment. The threaded area of each riser segment is sealed with an internal O-ring to prevent surface water leakage at the threaded zones. The risers are attached to the screen segment in 5-foot segments to achieve enough overall well point length so the top riser segment extends above the surface water line when the top of the slotted screen area is driven to depth matching the top of the sample interval².

Inner Well Point

Inner screens (known as a Prepack well screen) are constructed using 15-inch segments of 1-inch diameter PVC piping and are capped at the bottom (**Figure 1**). Each screen has a 12-inch machine slotted area (0.010-inch slot size) and is covered by a pre-packed filter that consists of a metal mesh covering filled with coarse well-drillers sand. This filter reduces intake of particulates and facilitates collection of a pore water sample more representative of *in situ* conditions. The top end of the inner screen segment is threaded to accept 1-inch-diameter PVC riser segments. The inner screen and riser are inserted into the outer well point, and additional 1-inch-diameter risers are attached in 5-foot segments to achieve enough overall length so the top inner riser segment extends to as close as possible to match the top of the outer riser segment (**Figure 2**). The inner risers are cut so that top of the inner and outer risers are within a 1-2 inches of each other.

Installation and Sampling

1. Measure water column depth.
2. Install outer well point (screens + risers) as follows:
 - a. Attach risers to screen segment so top riser segment extends above the surface water line when top of slotted screen area is driven to depth matching the top of the sample interval;
 - b. Place solid screw plug into top of the riser segment;
 - c. Insert apparatus to position screen at study-specified depth interval by hammering into place, striking the screw plug only (**Note:** For samples collected from the top of the sediment profile, well points will be deployed such that the top of the outer well point sample screen will be at least 1-2 inch below the sediment surface. This position will better ensure there is no surface water

¹ Depending on study objectives, screen length can be adjusted to any lengths up to several feet (most common intervals for pore water sampling application are within the 6 to 24 inch interval). Additionally, multiple depths/well points might be deployed simultaneously for profile sampling (e.g., shallow [2 to 14 inches], intermediate [14-26 inches], deep [26 to 38 inches]).

² In tidally influenced areas, make sure that the high water mark at high tide does not overtop the top end of the riser segment

draw down into the well point sampler; Additionally, depending on site-specific substrate the force needed to install will dictate the tools needed. Sometimes a hand power or a rubber mallet might suffice, but often a small sledge hammer or post driver might be necessary); and

- d. Remove solid screw plug.
3. Purge initial volume of water that enters the outer well point during installation to “reset” well point and clear it of debris that entered during installation actions; Use a pump and tubing that extends to the bottom of the screen segment (move tubing vigorously at the bottom to agitate debris/particulate for removal).
4. Allow outer well point to charge with site pore water (water from discrete screen interval only) (*Note: for slow charging well points, or for initial gauging, a water level meter might be needed to monitor depth*).
5. Purge outer well point of one to two complete volumes of water using a pump and tubing that extends to the bottom of the screen segment (move tubing vigorously at the bottom to agitate debris/particulate for removal).
6. For delayed sampling:
 - a. cover/cap (do not seal) well point with 2-inch diameter lockable style well plugs or a screw cap, and let stand (equilibrate) for as long as necessary to recharge before sampling (**Figure 2**).
 - b. After equilibration, proceed to Step 7.
7. For immediate sampling, or when returning to sample after equilibration, insert inner screen/pre-pack sand filter such that the top inner riser segment will extend to as close as possible to match the top of the outer riser segment.
8. Measure surface water quality parameters³ at pore water sampling location (directly adjacent to well point).
9. Draw pore water samples from within the inner screen using a slow-flow pump and tubing method (**Figure 3**); Slowly lower tubing until the bottom end is positioned at the bottom on the inner screen segment.
10. Collect initial (pre-sampling) water quality parameter measurements (*see footnote 3; Note: Because water quality parameters are expected to differ in the pore water and the surface water environments, compare during sampling activities onsite. This comparison will also be used to verify that pore water samples do not consist of surface water drawn down through the shallow sediment during pumping*).
11. Fill sample bottles for chemical analytical parameters; Pump pore water sample directly into the appropriate sample bottle(s) according to study plans (water for dissolved metals analysis can be collected using in-line filters [45 µm cellulose

³ Parameters will include at a minimum pH, specific conductance, temperature, oxidation-reduction potential and total dissolved solids, but depending on study objectives might also include turbidity and/or dissolved oxygen.

acetate disposable in-line filters], before the total metals sample is collected [unfiltered]).

12. Collect post-sampling water quality parameter measurements (*see footnote 3; Note: Because water quality parameters are expected to differ in the pore water and the surface water environments, compare during sampling activities onsite. This comparison will also be used to verify that pore water samples do not consist of surface water drawn down through the shallow sediment during pumping.*
13. Proceed to the next sampling location (*Note: New disposable PVC screens [outer and inner], PVC risers, sample tubing, and filters [when needed] will be used for each well. After the samples have been collected, the well point will be removed from the sediment and disposed of following investigation-derived waste procedures or left in place for a future round of sampling.*

Point of Contact

Contact **Dan Lavoie/WDC** for questions, project examples and/or native files (field forms) for adjusting to specific project needs.

Well Point – Components

→ Pore water samples collected using well point method (dual PVC piezometer construction)

Inner Screen

→ 1" diameter
→ 12" prepack (sand) screen



inner riser
(outer riser
not shown)



Well points
nesting
(threads)

Outer Screen

→ 2" diameter
→ 15", 0.010" slot



Figure 1

Pore Water Sampling Apparatus

Well Point – Components

- Installation of outer piezometer with sledge/post/slide hammer
- Inner piezometer inserted after purging

Screw plug (for hammering)



Outer/inner well point nesting (non-threaded riser version)



Screw cap



Well plug



Figure 2
Installation and Capping

Well Point – Sampling



- Slow flow
- Water quality + sample collection
- in-line filter (45 μm) for dissolved metals, as necessary



Figure 3
Sampling

ECT Manufacturing Costing

Item	Description	Details	Qty
10-020-050A	Riser	2' x 5' S40 PVC RISER ASTM	1
11-020-050E1	Screen	2' x 12" S40 PVC SCREEN .010 ASTM Male x Point (Pinned in using Stainless Steel pins)	1
14-020-CAP	Cap	2" S40 PVC THR FEM CAP ASTM	1
14-020-PLUGJ	Plug	2" S40 SOLID GREY THR MALE PLUG ASTM, JOHNSON	1
10-010-050F	Riser	1" x 5' S40 PVC RISER 8P	1
15-010-05SS	PrePack	1" ID x 1.7" OD x 12" x S40 .010 8M, Stainless Steel Mesh PrePacked PVC Well Screen Male x Point	1
T2	Plug	2-inch Gripper Plug Orange Torquer, S40	1
--	Frieght	Project Dependant	1
TOTAL			

Date: August 2012

Cost	Total
\$13.19	\$13.19
\$17.25	\$17.25
\$6.00	\$6.00
\$14.00	\$14.00
\$7.75	\$7.75
\$57.25	\$57.25
\$5.75	\$5.75
\$0.00	\$0.00
	\$121.19

Surface Water Sampling

I. Purpose and Scope

This procedure presents the techniques used in collecting surface water samples. Materials, equipment, and procedures may vary; refer to the Field Sampling Plan and operators manuals for specific details.

II. Materials and Equipment

Materials and equipment vary depending on type of sampling; the Field Sampling Plan should be consulted for project-specific details. Typical equipment required includes:

- Open tube sampler
- Dip sampler
- Weighted bottle sampler
- Hand pump
- Kemmerer or Van Dorn sampler
- Depth-integrating sampler
- Peristaltic pump
- Sample containers
- Meters for specific conductance, temperature, pH, and dissolved oxygen

III. Procedures and Guidelines

Before surface water samples are taken, all sampler assemblies and sample containers are cleaned and decontaminated as described in SOP *Decontamination of Personnel and Equipment*. Surface water samples collected from water bodies tidally influenced should be collected at low tide and under low flow conditions to minimize the dilution of potential contaminants. Methods for surface water sample collection are described below.

A. Manual Sampling

Surface water samples are collected manually by submerging a clean glass, stainless steel, or Teflon container into the water body. Samples may be collected at depth with a covered bottle that can be removed with a tripline. The most common sampler types are beakers, sealable bottles and jars, pond samplers, peristaltic pumps, and weighted bottle samplers. Pond samplers have a fixed or telescoping pole attached to the sample container. Weighted bottle samplers are lowered below water surface, where the attached bottle is opened, allowed to fill, and pulled out of the water. When retrieved, the bottle is tightly capped and removed from the

sampler assembly. Specific types of weighted bottle samplers include Kemmerer or Van Dorn and are acceptable in most instances.

A sample is taken with the following specific steps:

1. The location and desired depth for water sampling are selected.
2. The sample site is approached from downstream in a manner that avoids disturbance of bottom sediments as much as possible. The sample bottle is gently submerged with the mouth pointed upstream and the bottle tilted slightly downstream. Bubbles and floating materials should be prevented from entering the bottle. If using a Peristaltic pump, lower the tubing into the water to the desired depth.
3. For weighted bottle samplers, the assembly is slowly lowered to the desired depth. The bottle stopper is unseated with a sharp tug and the bottle is allowed to fill until bubbles stop rising to the surface.
4. When the bottle is full, it is gently removed from the water. If sample transfer is required, it should be performed at this time.
5. Measure dissolved oxygen, specific conductance, temperature, and pH at the sampling location.

IV. Attachments

None.

V. Key Checks and Items

- Start downstream, work upstream
- Log exact locations using permanent features
- Beware of hidden hazards

Aquifer Slug Testing

I. Purpose and Scope

The purpose of this procedure is to outline the equipment and methods that will be used to perform variable-head tests (“slug” tests) on piezometers and monitoring wells. The guidance covers use of both air and solid displacement methods.

II. Equipment and Materials

- In-Situ data loggers or equivalent
- Well-testing assembly
 - packer
 - fittings for pressure transducers
 - fittings for air supply
 - release valve
- Compressed air
- Computer and associated equipment
- Solid displacement device with rope

III. Procedures and Guidelines

The tests to be performed are rising head tests. The tests are accomplished by lowering the head of water in the well and monitoring the recovery of the water level to the static water level. The water level will be lowered by one of two methods. One method is the use of an air displacement device. Alternatively, a solid displacement device removed from the well will be used.

The air displacement apparatus consists of a packer assembly, fittings to accommodate transducers and air pressurization, and a pressure-release valve. The packer is lowered into the upper portion of the monitoring well, secured in place and inflated, providing a seal between the apparatus and the inside of the well. Two fittings are provided for pressure transducers: one transducer is fed through the inside of the device and positioned below the water surface and the other is inserted to measure the air pressure inside the assembly. A third fitting is connected to the pressurized air supply, a compressed air tank.

The datalogger will be programmed to display the air pressure in units of head, the head measured by the submerged transducer, and the difference between the two. The difference between the two pressure transducers is the height of the water column on the submerged transducer. The readings are recorded in a field notebook, and then the assembly is pressurized. The air pressure applied will be equivalent to 3 to 7 feet

of head. The pressures are allowed to stabilize. The pressure of the air should not lower the water level to below the base of the bentonite seal installed in the well.

Each test is started by releasing the air pressure inside the assembly and allowing the water level to rise to the static water level. When the datalogger perceives a change in water level in the well above a preset trigger amount, it automatically begins to record the water levels and elapsed time. Each test will be terminated when the water level has recovered to at least 90 percent of the original equilibrium level before pressurization. Note that the test method cannot be used if the well is screened across or near the water table.

An alternate method of lowering the water level is to use a solid displacement device. A single transducer will be installed in the well below the water table. A weighted solid displacement device is added to the well and the water level allowed to stabilize at the original static water level. The test is started by rapidly removing the displacement device, which causes a drop in the water level. The data logger begins recording the water level and elapsed time when the preset trigger amount is reached. Readings are taken as above, and the test stopped when the well has recovered to 90 percent of the original level.

At least two valid tests will be performed in each well. Additional tests will be required if there is some evidence that any of the tests were unacceptable.

At the end of each test, the test results will be transferred to a laptop and the data downloaded and checked for preliminary completeness.

IV. Attachments

None.

V. Key Checks and Preventive Maintenance

- Check that the packer assembly is in good condition and not leaking. Provide a repair kit including tape and clamps. Take additional packer assembly and other spare parts.
- Check the batteries for the datalogger and computer. Check that the computer disks containing the programs for the datalogger are packed.
- Check the datalogger calculation of the well hydraulic conductivity at the end of each test to determine if these are consistent with expectations.

Mini RAE Photoionization Detector (PID)

I. Purpose

The purpose of this SOP is to provide general reference information for using the Mini RAE PID in the field. Calibration and operation, along with field maintenance, will be included in this SOP.

II. Scope

This procedure provides information on the field operation and general maintenance of the Mini RAE PID. Review of the information contained herein will ensure that this type of field monitoring equipment will be properly utilized. Review of the owner's instruction manuals is a necessity for more detailed descriptions.

III. Definitions

Volatile Organic Compound (VOC) - Expresses the VOC concentration in ppm
ppm - parts per million: parts of vapor or gas per million parts of air by volume.

IV. Procedures

The Mini RAE utilizes the principle of a detecting sensor. The PID operates on the principle that most organic compounds and some inorganic compounds are ionized when they are bombarded by high-energy ultraviolet light. These compounds absorb the energy of the light, which excites the molecules and results in a loss of electron and the formation of a positively charged ion. The number of ions formed and the ion current produced is directly proportional to mass and concentration. The amount of energy required to displace an electron is called photo ionization potential (PIP). The air sample is drawn into a UV lamp using a pump or a fan. The energy of the lamp determines whether a particular chemical will be ionized. Each chemical compound has a unique ionizing potential. When the UV light energy is greater than the ionization potential of the chemical, ionization will occur. When the sample is ionized, the electrical signal is displayed on an analog or digital output. Although the output does not distinguish between chemicals, it does detect an increase in the ion current. If only one chemical is present in the air, it is possible to use PIDs quantitatively. Chemical structure and lamp intensity affects the sensitivity of the instrument to a given contaminant. All PID readings are relative to the calibration gas, usually isobutylene. It is important to calibrate the PID in the same temperature and elevation that the equipment will be used, and to determine the background concentrations in the field before taking measurements. For

environments where background readings are high, factory zero calibration gas should be used.

Note: For volatile and semi-volatile compounds, knowing the PIP is critical in determining the appropriate instrument to use when organic vapor screening. Consult the QAPP and manufacturer's manual to determine that the proper instrument has been selected for the contaminate vapors of interest. If an expected compound at a site has a PIP less than 11.7 eV, it is possible to use a PID. If the ionization potential is greater than 11.7eV, an FID is required.

The following subsections will discuss Mini RAE calibration, operation, and maintenance. These sections, however, do not take the place of the instruction manual.

A. Calibration

Start up Instrument

- Press **Mode** button
- Observe displays:

On!.....

Version X.XX

Model Number
SN XXXX

Date Time
Temp

- After the monitor is turned on and it runs through the startup menus, the display will read "Ready". Press the [Y/+] key to start the pump.
- The pump will start, the seconds will count down to zero, and the instrument will be ready for use

Calibration Check and Adjustment

Allow instrument to warm up for 15 minutes.

- Depress the [N/-] key first, then while depressing the [N/-], depress the [Mode] key also and depress both keys for 5 seconds.
- Display will read:

Calibrate
Monitor?

- Press the [Y/+] key
- Display will read:

Fresh Air
Calibration?

- Perform the Fresh Air Calibration in an area free of any detectable vapor near your work zone.
- Press the [Y/+] key
- Display will read:

Zero....
In progress...

Wait...

Update data...

Zeroed...

Reading = X.X ppm

- Press any key and the display will go back to:

Fresh Air
Calibration?

- Press the [N/+] key
- Display will read:

Span/Cal?

- Press the [Y/+] key
- Display will read:

Isobutylene = 100 ppm

Apply Gas Now!

- Press the [Y/+] key
- Apply calibration gas - use either HAZCO Services Part Number R-SGRAE4 or Rae Systems Part Number 008-3002 - using a .5 LPM regulator and direct tubing.

Wait...30

- The display will count down showing the number of remaining seconds:

Reading = 100

Update data, span cal done.
Turn off gas!

- Calibration readings between 99 and 102 ppm are within the acceptable range.
- Display will read:

Span/Cal?

- **CALIBRATION IS COMPLETE!**
- Press any key to return to operational mode.

B. Operation

Due to the Mini RAE having many functions in terms of operation, it is recommended that you follow the operational procedures as outlined in the instruction manual from pages 2-5 to 2-14.

C. Site Maintenance

After each use, the meter should be recharged and the outside of the instruments should be wiped clean with a soft cloth.

D. Scheduled Maintenance

<u>Function</u>	<u>Frequency</u>
Check alarm and settings	Monthly/before each use
Clean screens and gaskets around sensors	Monthly
Replace sensors	Biannually or when calibration is unsuccessful

V. Quality Assurance Records

Quality assurance records will be maintained for each air monitoring event. The following information shall be recorded in the field logbook.

- Identification - Site name, date, location, CTO number, activity monitored, (surface water sampling, soil sampling, etc), serial number, time, resulting concentration, comments and identity of air monitoring personnel.
- Field observations - Appearance of sampled media (if definable).
- Additional remarks (e.g, Mini RAE had wide range fluctuations during air monitoring activities.)

VI. References

Mini RAE 2000 Portable VOC PGM-7600, RAE Systems, Revision E, May 2005.

MiniRAE 2000

**Portable VOC Monitor
PGM-7600**



OPERATION AND MAINTENANCE MANUAL

(Document No.: 011-4001-000)
Revision E, May 2005



ATTENTION!

For European Applications

- A. CE 0575 II 1G/2G
DEMKO 03 ATEX 0204759X
Eex ia IIC T4**
- B. Recharge batteries only in non-hazardous locations.**
- C. Do not connect external cable to serial interface jack in hazardous locations.**
- D. Use RAE Systems Adapter P/N 500-0072 for connection to communication port and charging jack only in a non-hazardous area.**

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 **WARNING** 

- Do NOT proceed before reading -

This manual must be carefully read by all individuals who have or will have the responsibility for using, maintaining, or servicing this product.

The product will perform as designed only if it is used, maintained, and serviced in accordance with the manufacturer's instructions.

CAUTION!!

To reduce the risk of electric shock, turn off power before removing the monitor cover. Disconnect the battery before removing sensor module for service. Never operate the monitor while the cover is removed. Remove monitor cover and sensor module only in an area known to be non-hazardous.

The model PGM-7600 equipment is classified as to intrinsic safety for use in class I, division 1, groups A, B, C, D, or non-hazardous locations only.

Special Notes

-1-

When the MiniRAE 2000 Monitor is taken out from the transport case and turned on for the first time, there may be some residual organic or inorganic vapor trapped inside the detector chamber. The initial PID sensor reading may indicate a few ppm. Enter an area known to be free of any organic vapor and turn on the monitor. After running for several minutes, the residual vapor in the detector chamber will be cleared and the reading should return to zero.

-2-

The battery of the MiniRAE 2000 monitor will discharge slowly even if it is turned off. If the monitor has not been charged for 5-7 days, the battery voltage will be low. Therefore, it is a good practice to always charge the monitor before using it. It is also recommended to fully charge the monitor FOR AT LEAST 10 HOURS before first use. See Section 7 for more information on battery charging and replacement.

WARNINGS

STATIC HAZARD: Clean only with damp cloth.

For safety reasons this equipment must be operated and serviced by qualified personnel only. Read and understand instruction manual completely before operating or servicing.

Use only RAE Systems battery packs, part nos. 012-3050, 012-3051 or 012-3052. This instrument has not been tested in an explosive gas/air atmosphere having an oxygen concentration greater than 21%. Substitution of components may impair intrinsic safety. Recharge batteries only in non-hazardous locations.

The calibration of all newly purchased RAE Systems instruments should be tested by exposing the sensor(s) to known concentration calibration gas before the instrument is put into service.

For maximum safety, the accuracy of the MiniRAE 2000 should be checked by exposing it to a known concentration calibration gas before each day's use.

AVERTISSEMENTS

**DANGER RISQUE D'ORIGINE ELECTROSTATIQUE:
Nettoyer uniquement avec un chiffon humide.**

Pour des raisons de sécurité, cet équipement doit être utilisé, entretenu et réparé uniquement par un personnel qualifié. Étudier le manuel d'instructions en entier avant d'utiliser, d'entretenir ou de réparer l'équipement.

Utiliser seulement l'ensemble de batterie RAE Systems, la référence 012-3050, 012-3051 au 012-3052. Cet instrument n'a pas été essayé dans une atmosphère de gaz/air explosive ayant une concentration d'oxygène plus élevée que 21%. La substitution de composants peut compromettre la sécurité intrinsèque. Ne charger les batteries que dans emplacements désignés non-dangereuse.

La calibration de toute instruments de RAE Systems doivent être testé en exposant l'instrument a une concentration de gaz connue par une procédure diétalonnage avant de mettre en service l'instrument pour la première fois.

Pour une securite maximale, la sensibilité du MiniRAE 2000 doit être verifier en exposant l'instrument a une concentration de gaz connue par une procédure diétalonnage avant chaque utilisation journalière.

1. GENERAL INFORMATION

MiniRAE 2000 Portable VOC Monitor (Model PGM 7600) is a compact monitor designed as a broadband VOC gas monitor and datalogger for work in hazardous environments. It monitors Volatile Organic Compounds (VOC) using a Photo-Ionization Detector (PID) with a 9.8 eV, 10.6 eV, or 11.7 eV gas discharge lamp. Features are:

- **Lightweight and Compact**
 - Compact, light weight (19 oz.) and rugged design
 - Built-in sample draw pump
- **Dependable and Accurate**
 - Up to 10 hours of continuous monitoring with rechargeable battery pack
 - Designed to continuously monitor VOC vapor at ppm levels
- **User Friendly**
 - Preset alarm thresholds for STEL, TWA, low and high level peak values. Audio buzzer and flashing LED display are activated when the limits are exceeded.
- **Datalogging Capabilities**
 - 15,000 point datalogging storage capacity for data download to PC

MiniRAE 2000 consists of a PID with associated microcomputer and electronic circuit. The unit is housed in a rugged ABS + PC case with a backlit 1 line by 8 character dot matrix LCD and 3 keys to provide easy user interface.

GENERAL INFORMATION

1.1 General Specifications

Table 1.1

Portable VOC Monitor Specification	
Size:	8.2"L x 3.0"W x 2.0"H
Weight:	19.5 oz with battery pack
Detector:	Photo-ionization sensor with 9.8, 10.6, or 11.7 eV UV lamp
Battery:	A 4.8V /1250 mAH Rechargeable Nickel Metal Hydride battery pack (snap in, field replaceable)
Battery Charging:	10 hours charge through built-in charger
Operating Hours:	Up to 10 hours continuous operation
Display:	1 line by 8 characters 5x7 dot matrix LCD (0.4" character height) with LED back light automatically in dim light
Range, Resolution & Response time (t ₉₀):	
Isobutylene (calibration gas)	
	0-99 ppm 0.1 ppm 2 sec
	100-1,999 ppm 1.0 ppm 2 sec
	2000-10,000 ppm 1.0 ppm 2 sec
Measurement Accuracy (Isobutylene):	
	0 – 2000 ppm: ± 2 ppm or 10% of reading.
	> 2000 ppm: ± 20% of reading
PID Detector:	Easy access to lamp and sensor for cleaning and replacement
Correction Factors:	Built-in 102 VOC gases
Calibration:	Two-point field calibration of zero and standard reference gas
Calibration Memory:	Store up to 8 separate calibration, alarm limits and span value
Inlet Probe:	Flexible 5" tubing
Keypad:	1 operation key and 2 programming keys

GENERAL INFORMATION

Direct Readout:	Instantaneous, average, STEL and peak value, battery voltage and elapsed time
Intrinsic Safety:	UL & cUL Class 1, Division I, Group A,B,C,D, Temperature Code T3C (US & Canada); CE 0575  II 1G DEMKO 02 ATEX 0204759 Eex ia IIC T4 (Europe)
EM Interference:	No effect when exposed to 0.43 W/cm ² RF interference (5 watt transmitter at 12 inches)
Alarm Setting:	Separate alarm limit settings for Low, High, STEL and TWA alarm
Operating Mode:	Survey or Hygiene mode
Alarm:	90 dB buzzer and flashing red LEDs to indicate exceeded preset limits, low battery voltage, or sensor failure.
External Alarm:	Optional plug-in pen-size vibration alarm or remote alarm
Alarm Mode:	Latching or automatic reset
Real-time Clock:	Automatic date and time stamps on data logged information
Datalogging:	15,000 points with time stamp, serial number, user ID, site ID, etc.
Communication:	Upload data to PC and download instrument setup from PC through RS-232 port
Sampling Pump:	Internally integrated. Flow rate: 450-550 cc/min.
Temperature:	0° to 45°C (32° to 113°F)
Humidity:	0 % to 95 % relative humidity (non-condensing)
Housing:	ABS + PC, conductive coating, splash and dust proof, will withstand 1 meter drop test with rubber boot
Attachment:	Wrist strap, rubber boot and belt clip

2. OPERATION OF MINIRAE 2000

The MiniRAE 2000 Portable VOC Monitor is a compact Monitor designed as a broadband VOC gas monitor and datalogger for work in hazardous environments. It gives real time measurements and activates alarm signals whenever the exposure exceeds preset limits. Prior to factory shipment the MiniRAE 2000 is preset with default alarm limits and the sensor is pre-calibrated with standard calibration gas. However, the user should test the instrument and verify the calibration before the first use. After the monitor is fully charged and calibrated, it is ready for immediate operation.

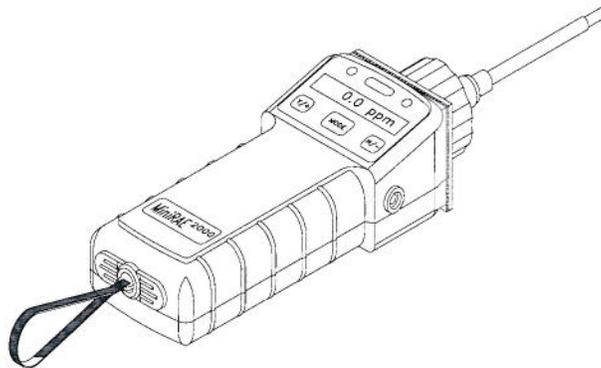


Figure 2-1 MiniRAE 2000

2.1 Physical Description

The main components of the MiniRAE 2000 Portable VOC monitor include:

- Three keys for user to interact with the monitor: 1 operation key and 2 programming keys for normal operation or programming of the monitor
- LCD display with back light for direct readout and calculated measurements
- Buzzer and red LED's for alarm signaling whenever the exposures exceed preset limits
- Wrist strap
- Charge contact for plugging directly to the charging station
- Gas entry and exit ports
- Serial communication port for PC interface
- External alarm and analog output port
- Protective rubber cover

2.2 Keys and Display

Figure 2.2 shows the LCD display and the keypad on the front panel of the monitor. The function of the 3 keys during normal operation are summarized below:

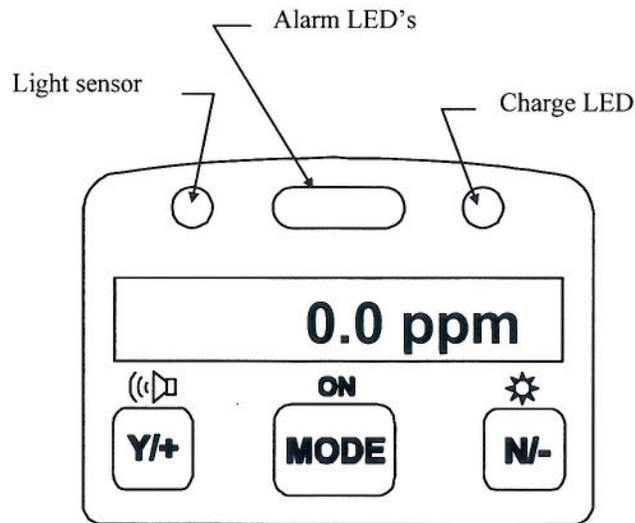


Figure 2-2 LCD Display and Keypad

Key Function in Normal Operation

[MODE]	-Turn on/off the power* and step through menu items
[N/-]	-Toggle on/off the back light, negative acknowledge, decrease value
[Y/+]	-Start measurement, positive acknowledge, increase value value

* Pressing and holding [MODE] key for 5 seconds turns off the power to the monitor. Monitor will beep once per second and display countdown timer during power-down sequence. Press [MODE] key momentarily to step through menu items. To save time, press any key during message scrolling to skip to the end of the message.

2.3 Power On/Off

To turn on the MiniRAE 2000 portable VOC monitor, press **[MODE]** key for one second and release. The audio buzzer will beep once and the air pump will turn on. The display will show “ON!..” and then “Ver n.nn” to indicate the unit’s current firmware version number. Next displayed are the serial number, the model number, Operating mode, current date and time, unit internal temperature, gas selected, high low, STEL, TWA/AVG alarm limits, battery voltage, and shut off voltage. Also displayed are internal mode settings such as User mode, Alarm mode, datalog time remaining and log periods in the respective order.

To turn off the MiniRAE 2000 portable VOC monitor, press and hold the **[MODE]** key for 5 seconds. The monitor will beep once per second during the power-down sequence with a count down timer showing the number of remaining seconds. The message “Off!..” flashes on the LCD display and the display will go blank indicating that the monitor is turned off.

Data protection during power off

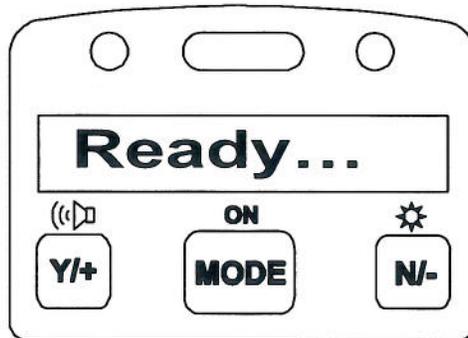
When the monitor is turned off, all the current real time data including last measured value are erased. However, the datalog data is preserved in non-volatile memory. Even if the battery is disconnected, the datalog data will not be lost. While the power is off, the real time clock will continue to operate until the battery is completely drained (usually in 4-5 days without any charging). If the battery is completely drained or is disconnected from the monitor for more than 30 minutes, the real time clock will be lost. In this case, the user needs to enter the real time clock information again, as described in Section 4, or send the PC clock during configuration through the PC communication.

2.4 Operation

The **MiniRAE 2000** VOC monitor has two operation modes: **Survey** and **Hygiene** mode. The **Survey mode** allows the user to manually start and stop the monitoring/measuring operation and display certain exposure values. In the **Hygiene mode**, the monitor runs continuously after the monitor is turned on. Refer to Section 4.7.1 for switching between the two modes.

2.4.1 Survey Mode

After the monitor is turned on, it runs through the start up menu. Then the message “Ready...” is displayed (see figure below).



At this point, the user has two options:

1. Step through the Main Menu.
2. Take a measurement.

Press the [MODE] button to step through the Main Menu. Press the [Y/+] button to proceed to take a measurement.

The Main Menu

Press the [MODE] button to enter the Main Menu. Press the [Y/+], [MODE] or [N/-] as indicated in the flow chart below to step through the Main Menu. The PID sensor and pump are turned off during this time.

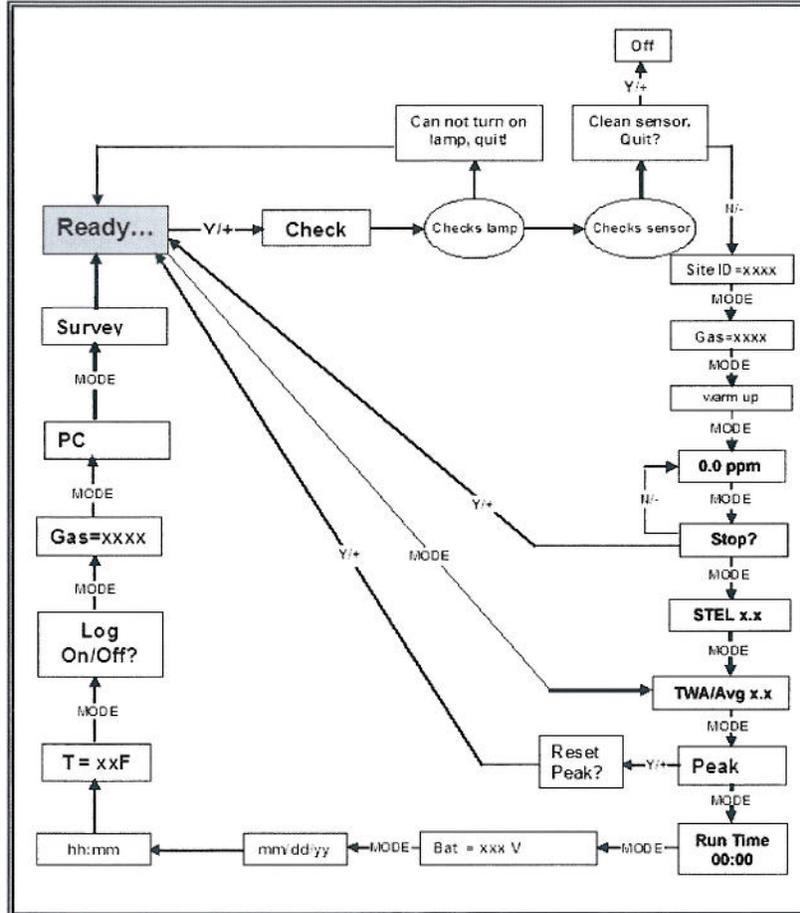
The Main Menu functions are:

- Ready...
- Check
- Site ID = xxxx
- Gas = xxxx
- Warm up
- X.x ppm
- Stop?
- TWA/Avg x.x ppm
- STEL x.x ppm
- Peak x.x ppm
- Run time hh:mm
- Bat = X.XV
- Mm/dd/yy
- hh:mm
- T = xxxF [date, time and temperature (°C or °F)]
- Log On/Off?
- PC Comm?
- Survey

OPERATION

These functions are arranged in a “round robin” order. To select a specific function, press the button as shown below until the desired function appears.

Main Menu



The Main Menu Functions

- **Ready...:** Indicates that the monitor is ready to take a measurement or to step through the Main Menu. Press the [Y/+] button to advance to taking a measurement (read “Taking a Measurement” on Page 2-12 for details).

Note: The **Ready...** screen is skipped if the menu is cycled through while a measurement is running.

- **Check...:** This message displays while the system is checking the lamp and the sensor. If the lamp test succeeds, the system will progress to checking the sensor. If the lamp test does not succeed, the display will read **Can not turn on lamp, quit!**

- **Can not turn on lamp, quit!:** This message displays when the lamp does not turn on. The system will automatically return to **Ready...** allowing the user to test the lamp again. If the lamp fails a second time, turn the monitor off and refer to Section 7.2 “**PID Sensor & Lamp Cleaning / Replacement**”.

- **Clean Sensor, Quit?:** This message displays when the sensor requires cleaning. Press the [Y/+] button to turn the monitor off and clean the sensor. Press the [N/-] button and the system will progress to the **Site ID = xx**

- **Site ID = xxxx:** This display shows the Site ID and indicates that the monitor is about to start taking measurements (read “Taking a Measurement” for details)

Note: This display appears only after a measurement has been started. It does not appear when the user is cycling through the Main Menu and the monitor is idling.

- **Gas = xxxx:** This display identifies the gas to be measured and indicates that the monitor is about to take a measurement (read “Taking a Measurement” for details)

OPERATION

Note: This display appears only after a measurement has been started. It does not appear when the user is cycling through the Main Menu and the monitor is idling.

- **x.x ppm:** (read “Taking a Measurement” for details)

Note: This display appears only after a measurement has been started. It does not appear when the user is cycling through the Main Menu and the monitor is idling.

- **TWA/Avg:** Displays (in ppm) the Time Weighted Average (TWA) or the Average since the start of the measurement. The average is recalculated every minute.
- **STEL:** Displays the Short Term Exposure Limit.
- **PEAK:** Displays (in ppm) the highest instantaneous reading since the start of the measurement. If [Y/+] is pressed while the peak reading is displayed, the unit will ask **Reset Peak?**. If [Y/+] is pressed again, the peak value will be cleared and the display will return to the **Ready...** message or instantaneous reading. The peak reading is automatically reset when a new measurement is started by pressing [Y/+] from the **Ready...** screen.
- **Run time hh:mm:** The duration of the current measurement period.
- **Bat = X.XV:** The current battery voltage.

Note: A fully charged battery pack should show 4.8 volts or higher. When the battery voltage falls below 4.4 volts, a flashing “Bat” will appear as a warning message. At that point, you have 20-30 minutes of run time remaining. When the battery voltage falls below 4.2 volts the monitor turns off automatically.

- **Mm/dd/yy:** The current date.
- **hh:mm:** The current time (24-hour format)

OPERATION

- **T = xxxF:** The internal unit temperature in degrees Fahrenheit. (see Section 4.7.13 to change temperature units)
- **Log on/Off?:** Allows the user to start datalogging of the current measurement. A superscript “L” flashes in the ppm measurement display when datalogging is on. This screen is not shown when datalogging is disabled or when the monitor is not operating in manual start/stop mode.
- **PC Comm?:** This function enables the user to upload data from the MiniRAE 2000 to a Personal Computer (PC) or send/receive configuration information between a PC and the MiniRAE 2000. Press **[MODE]** to return to **Ready... .**

To communicate with a PC, connect the monitor to the serial port of a PC and start the MiniRAE 2000 application software. Press the **[Y/+]** button and the LCD displays “**pause monitor, ok?**” Press the **[Y/+]** button one more time, and the display shows “**Comm...**” The monitor is now ready to receive commands from the PC.

- **Survey:** This function displays the Current Operating Mode (**Survey** or **Hygiene**).

Taking a Measurement

There are two ways to start a measurement.

1. Operating in Hygiene mode.
2. Manually start and stop measurement in Survey mode.

To start a measurement in Hygiene mode, please refer to Section 4.7.1, “**Change Operation Mode**”. To start a measurement in Survey Mode, the MiniRAE 2000 monitor must first be in the “Ready...” mode. This is the mode to which the monitor normally powers up.

OPERATION

Measurement phases

1. Ready
2. Start measurement
3. Measurement display and datalogging
4. Stop measurement

Ready

The display reads **Ready...** indicating the unit is ready to start a measurement.

Start Measurement

Press the [Y/+] button to start the check cycle (see above), and then the measurement cycle.

After completing the **Check** cycle, the display will show the **Site ID** and then the **Gas** selected for measurement. The pump will start and the reading will be displayed. The **Peak** and **Average** values will be automatically reset to zero.

Measurement Display and Datalog

Instantaneous readings of the gas concentration in parts per million (ppm) are updated every second. A flashing superscript **L** is displayed when datalogging is on. Datalog information is saved only after one full datalog period is completed.

OPERATION

Stop Measurement

Press the [MODE] button and the display shows Stop? Press [N/-] to continue measurement and [Y/+] to stop the measurement and datalog event. The pump stops automatically when measurement is stopped. Peak and average values for the current measurement can be read in idle mode until a new measurement is started.

Automatic Increment of Site ID

Every time a measurement is taken, the site ID will be incremented by one automatically in Survey mode.

Variable Alarm Signal

In Survey Mode, if the measurement exceeds the low alarm limit, the buzzer and flashing alarm are activated and will beep/flash once per second. The alarms will increase in frequency as the gas concentration approaches the high alarm limit reaching 8 times per second when the high alarm has been exceeded.

Press [Y/+] key to clear if latching alarm.

2.4.2 Hygiene Mode

In Hygiene Mode, the unit will continuously taking measurements, once the power is turned on. After the initial start-up sequence displaying the current monitor settings, the LCD displays the instantaneous readings.

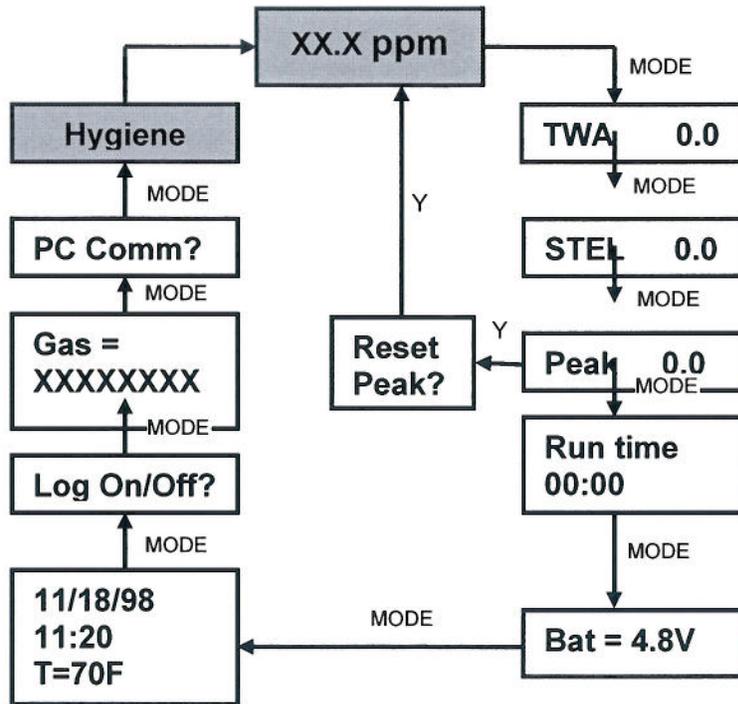
The Hygiene operation menu displays include:

- **Real time readings in ppm**
- **Current TWA/Avg, STEL and Peak values (see Section 4.6.6)**
- **Run time**
- **Current battery voltage**
- **Date, time and temperature**
- **Log on/off?**
- **Gas name**
- **PC communication?**
- **Hygiene**

Detailed description of most of these displays are the same as Section 2.4.1.

OPERATION

HYGIENE MODE MAIN MENU



To choose a specific display, press the [MODE] key one or more times until the desired display appears, or the [Y/+] key where indicated with a Y.

Note: To get back to instantaneous reading from any of the above display, press [MODE] key repeatedly until the "XX.X ppm" display appears.

2.5 Alarm Signals

During each measurement period, the gas concentration is compared with the programmed alarm limits (gas concentration alarm limit settings: Low, High, TWA and STEL). If the concentration exceeds any of the preset limits, the loud buzzer and red flashing LED are activated immediately to warn the user of the alarm condition.

In addition, the MiniRAE 2000 will alarm if one of the following conditions occurs: battery voltage falls below a pre-set voltage level (4.4 V), failure of UV lamp, pump stall, or when the datalog memory is full. When the low battery alarm occurs, there will be approximately 20-30 minutes of operating time remaining. When the battery voltage falls below 4.2 V, the monitor will turn off automatically.

OPERATION

Alarm Signal Summary:

Condition	Alarm Signal
Gas exceeds "High Alarm" limit	3 beeps/flashes per second
Gas exceeds "Low Alarm" limit	2 beeps/flashes per second
Gas exceeds "TWA" limit	1 Beeps/flashes per seconds
Gas exceeds "STEL" limit	1 Beeps/flashes per seconds
Pump failure	3 beeps/flashes per second plus "Pump" message on LCD
PID lamp failure	3 beeps/flashes per second plus "Lamp" message on LCD
Low battery	1 flash per second, 1 beep per minute plus "Bat" message on LCD
Memory full	1 flash per second plus "Mem" message on LCD

Alarm Signal Testing:

Under normal non-alarm conditions, it is possible to test the MiniRAE 2000 LED and buzzer in Special Diagnostic Mode (see Section 8 for details).

2.6 Preset Alarm Limits and Calibration

The MiniRAE 2000 portable VOC monitor is factory calibrated with standard calibration gas, and is programmed with default alarm limits. There are 102 gas settings stored in the library. Some examples of calibration and alarm limits are shown below. Refer to Section 4 on programming procedures for selecting a different gas, perform a calibration or set new alarm limits.

Factory Calibration and Preset Alarm Limits

Cal Gas	Cal Span	unit	Low	High	TWA	STEL
Isobutylene	100	ppm	50	100	100	250
Hexane, n-	100	ppm	500	750	500	750
Xylene, m-	100	ppm	100	150	100	150
Benzene	5	ppm	2	5	5	2
Styrene	50	ppm	20	40	20	40
Toluene	100	ppm	50	100	50	100
Vinyl Chloride	10	ppm	5	10	5	10
Custom	100	ppm	50	100	50	100

2.7 Integrated Sampling Pump

The MiniRAE 2000 portable VOC monitor includes an integrated sampling pump. This is a diaphragm type pump that provides a 500-600 cc per minute flow rate. Connecting a Teflon or metal tubing with 1/8 inch inside diameter to the gas inlet port of the MiniRAE 2000, this pump can pull in air samples from 200 feet away horizontally, or 90 feet vertically, at about 3 feet per second flow speed.

The pump turns on when a measurement is started, and turns off when the sample is manually stopped in Survey mode or when the unit is turned off from Hygiene Mode.

If liquid or other objects are pulled into the inlet port filter, the monitor will detect the obstruction and shut down the pump immediately. The alarm will be activated and a flashing error message "Pump" will be also displayed on the LCD display.

The user should acknowledge the pump shut off condition by clearing the obstruction and pressing the [Y/+] key to re-start the pump.

The pump stall threshold is set in the special Diagnostic Mode (Section 8).

2.8 Back Light

The LCD display is equipped with an LED back light to assist in reading the display under poor lighting conditions. Pressing and holding the [N/-] key for one second in normal operation can turn on the backlight. The backlight can be turned off by pressing [N/-] a second time. If the [N/-] key is not pressed, the back light will be turned off automatically after a pre-programmed time-out period to save power.

In addition, the ambient light is sensed and the back light will be turned on automatically if the ambient light is below a threshold level. The back light is turned off automatically when the ambient light exceeds the threshold level.

See Section 8 for instructions on how to set the light threshold level.

Note: The LED backlight consumes about 20-30% of the total average current, when the instrument is idle or not taking a measurement.

2.9 Datalogging

During datalogging, the MiniRAE 2000 Portable VOC monitor flashes a superscript “L”, on the display to indicate that datalogging is enabled. The monitor stores the time stamp, sample number, and measured gas concentration at the end of every sample period (when data logging is enabled). In addition, the following information are stored: user ID, site ID, serial number, last calibration date, and alarm limits. All data are retained (even after the unit is turned off) in non-volatile memory so that it can be down loaded at a later time to a PC.

Datalogging event

When Datalogging is enabled, measurement readings are being saved. These data are stored in “groups” or “events. A new event is created and stored each time the monitor is turned on, or a configuration parameter is changed, or datalogging is interrupted (e.g. Communication with PC during Hygiene mode). Information, such as start time, user ID, site ID, gas name, serial number, last calibration date, and alarm limits will be recorded.

Datalogging sample

After an event is recorded, the unit records a shorter form of the data. This data contains: the sample number, time (hour/minute) and gas concentration.

3. OPERATION OF ACCESSORIES

The accessories for the MiniRAE 2000 include:

- An AC Adapter (Battery Charger)
- Alkaline battery holder
- Water Trap Filter

Optional Accessories:

- Dilution Fitting
- Calibration adapter
- Calibration regulator and Flow controller
- Organic Vapor Zeroing kit

3.1 Standard Kit and Accessories

1) AC Adapter (Battery Charger)

WARNING

To reduce the risk of ignition of hazardous atmospheres, recharge battery only in area known to be non-hazardous. Remove and replace battery only in area known to be non-hazardous.

Ne charger les batteries que dans emplacements designés non-dangereuses.

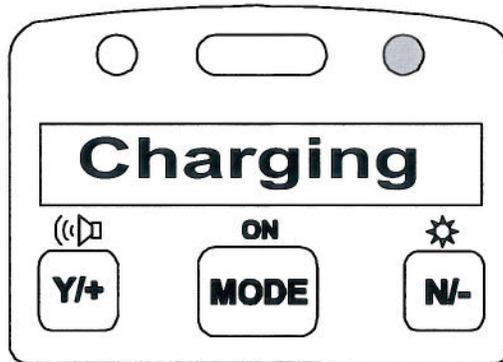
A **battery charging circuit** is built into the MiniRAE 2000 monitor. It only needs a regular AC to 12 V DC adapter (wall mount transformer) to charge the monitor.

To charge the battery inside the MiniRAE 2000 monitor:

1. Power off the Monitor.
2. Connect the AC adapter (or the optional automotive charging adapter) to the DC jack on the MiniRAE 2000 monitor. If the unit was off, it will automatically turn on.
3. The first message displayed will be “Deep discharge?” The unit will ask this question for three times. If the user wants to discharge the battery pack, affirm this query with the [Y/+] key, otherwise the unit will move on to the charge mode directly.

OPERATION OF ACCESSORIES

4. While charging, the display message will alternate between “Charging” and “Bat=x.xV” (x.x is the present battery voltage). The LED should be red in color when charging.



5. When the battery is fully charged, the LED will change from red to green and the message “Fully charged” will appear on the display. After the battery is fully charged, the unit will enter the “trickle charge” mode. In which, the red LED will turn on for several seconds every minute, to maintain the full charge.

A completely discharged MiniRAE 2000 monitor will be charged to full capacity within 10 hours. The battery will be drained slowly even if the monitor is turned off. If the monitor has not been charged for 7-10 days, the battery voltage will be low.

The factory-supplied battery is designed to last for 10 hours of normal operation (no alarm, no back light condition), for a new battery under the best condition. As the battery becomes older or is subject to adverse conditions (such as cold ambient temperature), the battery capacity will be reduced significantly.

OPERATION OF ACCESSORIES

2) Alkaline Battery Holder

An alkaline battery holder is supplied with each MiniRAE 2000. It accepts four AA size alkaline batteries and can be used in place of the Ni-MH or Ni-Cd battery pack to provide approximately 12-14 hours of operation. The adapter is intended to be used in emergency situations when there is no time to charge the Ni-Cd or Ni-MH battery pack.

To install the adapter, remove the cover of the battery compartment. Remove the Ni-Cd or Ni-MH battery pack from the battery compartment and replace with the alkaline battery adapter. Replace the battery compartment cover.

The internal charging circuit is designed to prevent damage to alkaline batteries and the charging circuit when alkaline batteries are installed inside the monitor.

Note: The AA Alkaline battery adapter supplied by RAE Systems Inc. is intrinsically safe!

3) Water Trap Filter

The water trap filter is made of PTFE (Teflon[®]) membrane with a 0.45 micron pore size to prevent water from being sucked into the sensor manifold, which would cause extensive damage to the monitor. It will also remove any dust and other particles from entering the monitor and prolong the operating life of the sensor. To install the water trap, simply insert it to the front of the inlet tube of the MiniRAE 2000 monitor.

3.2 Optional Accessories

1) Dilution Fitting

The user may wish to install a dilution fitting on the inlet to dilute the gas samples. One application for a dilution fitting is to measure organic gas when the concentration exceeds the upper limit of the sensor range.

Make sure to set the dilution ratio in the programming mode (see Section 4.7.9) so that the correct gas reading will be displayed when the dilution fitting is used.

WARNING: To use a dilution fitting, the user must have the monitor located in a clean atmosphere outside the confined space and use a remote access probe or Tygon tubing to measure the gas concentration inside the confined space.

2) Calibration Adapter

The calibration adapter for the MiniRAE 2000 is a simple 6-inch Tygon tubing with a metal adapter on one end. During calibration, simply insert the metal adapter into the regular gas inlet probe of the MiniRAE 2000 and the tubing to the gas regulator on the gas bottle.

OPERATION OF ACCESSORIES

3) Calibration Regulator and Flow Controller

The Calibration Regulator and Flow controller is used in the calibration process. It regulates the gas flow rate from the Span gas cylinder into the gas inlet of the MiniRAE 2000 monitor during calibration process. The maximum flow rate allowed by the flow controller is about 0.5L/min (500 cc per min.). Alternatively, a Demand-flow Regulator or a Tedlar gas bag may be used to match the pump flow precisely.

4) Organic Vapor Zeroing kit (Charcoal filter)

The Organic Vapor Zeroing Kit is used for filtering organic air contaminants that may affect the zero calibration reading. To use the Organic Vapor Zeroing Kit, simply connect the filter to the inlet port of the MiniRAE 2000.

4. PROGRAMMING OF MINIRAE 2000

The MiniRAE 2000 Monitor is built with a microcomputer to provide programming flexibility. Authorized users can recalibrate the monitor, change the alarm limits, change site ID, user ID, lamp type, and real time clock, etc.

Programming is menu-driven to provide intuitive end-user operation. The display shows the menu options and the key pad used for menu selection and data entry.

4.1 Programming Mode

The programming mode allows the users to change the setups in the monitor, calibrate the monitor, modify the sensor configuration and enter user information, etc. The programming mode has four menu items. Each menu item includes several sub-menus to perform additional programming functions. Appendix A shows a more detailed menu tree structure.

Programming Menu

- Calibrate/Select Gas?
- Change Alarm Limits?
- Change Datalog?
- Change Monitor Setup?

Once inside the programming mode, the LCD will display the first menu. Each subsequent menu item can be viewed by pressing the [N/-] repeatedly until the desired menu is displayed. To enter the sub-menu of a particular menu, press [Y/+] key, the sub-menu will be displayed.

Return to Operation mode: To exit the programming mode and return to operation, press the [MODE] key once at any of the programming menu displays.

4.2 Keys for Programming Mode

The three keys perform a different set of functions during the programming mode as summarized below.

Key	Function in Programming Mode
[MODE]:	Exit menu when pressed momentarily or exit data entry mode when pressed and held for 1 second
[Y/+]:	Increase alphanumerical value for data entry or confirm (yes) for a question
[N/-]:	Decrease alphanumerical value for data entry or deny (no) for a question

4.3 Entering into Programming Mode

1. Turn on the MiniRAE 2000 monitor and wait for the “**Ready..**” message or the instantaneous reading display “**0.0 ppm**” message displayed.
2. Press and hold down both [N/-] and [MODE] keys for three seconds to enter programming mode. This delay is to prevent the user from entering programming mode by accident.
3. The first menu item “Calibrate/select Gas?” will be displayed.
4. Release both [MODE] and [N/-] keys simultaneously to start the programming mode
5. Press [N/-] key to scroll to the next menu item of the programming menu. Press [Y/+] key to select the displayed menu item.

The following Sections 4.4 - 4.7 describe the details of each menu options.

4.4 Calibrate and Select Gas

WARNINGS

The calibration of all newly purchased RAE Systems instruments should be tested by exposing the sensor(s) to known concentration calibration gas before the instrument is put into service for the first time.

For maximum safety, the accuracy of the MiniRAE 2000 should be checked by exposing it to known concentration calibration gas before each day's use.

In the first menu of the programming mode, the user can perform functions such as calibration of the MiniRAE 2000 Monitor, select default cal memories, and modify cal memories (see Table 4.4).

Table 4.4

Calibrate/Select Gas Sub-Menu
Fresh Air Cal?
Span Cal?
Select Cal Memory?
Change Span Value?
Modify Cal Memory?
Change Correction Factor?

Calibrating the MiniRAE 2000 monitor is a two-point process using “fresh air “ and the standard reference gas (also known as span gas). First a “Fresh air” calibration, which contains no detectable VOC (0.0 ppm), is used to set the zero point for the sensor. Then a standard reference gas that contains a known concentration of a given gas is used to set the second point of reference.

PROGRAMMING

Note: The span value must be set prior to calibrating for fresh air or span.

The user can store calibrations for up to 8 different measurement gases. The default gas selections are as follows:

Cal Memory #0.....Isobutylene

Cal Memory #1.....Hexane

Cal Memory #2.....Xylene

Cal Memory #3.....Benzene

Cal Memory #4.....Styrene

Cal Memory #5.....Toluene

Cal Memory #6.....Vinyl Chloride

Cal Memory #7.....Custom?

Memory #0 functions differently than the other 7 memories. For Memory #0, isobutylene is always the calibration gas. When the gas is changed in Memory #0 to one of 100 other preprogrammed chemicals or to a user-defined custom gas, a correction factor is applied to all the readings. During calibration, the unit requests isobutylene gas and displays the isobutylene concentration immediately following calibration, but when the unit is returned to the normal reading mode, it displays the selected gas and applies the correction factor.

The other 7 cal memories require the same calibration gas as the measurement gas. These memories may also be modified to a preprogrammed chemical or to a user-defined custom gas. In the gas library, only the gases that can be detected by the installed UV lamp will actually be displayed. Note that although the correction factor for the new gas will be displayed and can be modified, this factor is not applied when Memories #1-7 are

PROGRAMMING

used. Therefore the factor will not affect the readings in these memories.

Once each of the memories has been calibrated, the user can switch between the calibrated gases by changing the cal memory without the need to recalibrate. Or the user can switch the measurement gas in Memory #0 and the appropriate correction factor will automatically be applied without the need to recalibrate. If the gas is changed in Memories #1-7, it is necessary to recalibrate.

To change a default gas from the list above to a library or custom gas, first go to Select Cal Memory (Section 4.4.3) and then proceed to Modify Cal Memory (Section 4.4.5) to enter the desired gas. If the desired compound does not appear in the preprogrammed library, the user can use the Custom_VOC entry in the library, or the name and correction factor of any of the existing compounds can be changed as described in Section 4.4.5. A list of some 300 correction factors is given in Technical Note 106, available at the website www.raesystems.com.

4.4.1 Fresh Air Calibration

This procedure determines the zero point of the sensor calibration curve. To perform a fresh air calibration, use the calibration adapter to connect the MiniRAE 2000 to a “fresh” air source such as from a cylinder or Tedlar bag (option accessory). The “fresh” air is clean dry air without any organic impurities. If such an air cylinder is not available, any clean ambient air without detectable contaminant or a charcoal filter can be used.

1. The first sub-menu shows: “Fresh air Cal?”
2. Make sure that the MiniRAE 2000 is connected to one of the “fresh” air sources described above.
3. Press the [Y/+] key, the display shows “zero in progress” followed by “wait..” and a countdown timer.

After about 15 seconds pause, the display will show the message “update data...zeroed... reading = X.X ppm...” Press any key or wait about 20 seconds, the monitor will return back to “Fresh air Calibration?” submenu.

4.4.2 Span Calibration

This procedure determines the second point of the sensor calibration curve for the sensor. A cylinder of standard reference gas (span gas) fitted with a 500 cc/min. flow-limiting regulator or a flow-matching regulator is the simplest way to perform this procedure. Choose the 500 cc/min. regulator only if the flow rate matches or slightly exceeds the flow rate of the instrument pump. Alternatively, the span gas can first be filled into a Tedlar Bag, or delivered through a demand-flow regulator. Connect the calibration adapter to the inlet port of the MiniRAE 2000 Monitor, and connect the tubing to the regulator or Tedlar bag.

Another alternative is to use a regulator with >500 cc/min flow but allow the excess flow to escape through a T or an open tube. In the latter method, the span gas flows out through an open tube slightly wider than the probe, and the probe is inserted into the calibration tube.

Before executing a span calibration, make sure the span value has been set correctly (see next sub-menu).

1. Make sure the monitor is connected to one of the span gas sources described above.
2. Press the [Y/+] key at the “Span Cal?” to start the calibration. The display shows the gas name and the span value of the corresponding gas.
3. The display shows “Apply gas now!” Turn on the valve of the span gas supply.

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4. Display shows “wait... 30” with a count down timer showing the number of remaining seconds while the monitor performs the calibration.
5. To abort the calibration, press any key during the count down. The display shows “Aborted!” and return to “Span Cal?” sub-menu.
6. When the count down timer reaches 0, the display shows the calibrated value.
Note: The reading should be very close to the span gas value.
7. During calibration, the monitor waits for an increased signal before starting the countdown timer. If a minimal response is not obtained after 35 seconds, the monitor displays “No Gas!” Check the span gas valve is on and for lamp or sensor failure before trying again.
8. The calibration can be started manually by pressing any key while the “Apply gas now!” is displayed.
9. After a span calibration is completed, the display will show the message “Update Data Span Cal Done! Turn Off Gas.”
10. Turn off the flow of gas. Disconnect the calibration adapter or Tedlar bag from the MiniRAE 2000 Monitor.
11. Press any key and it returns back to “Span Gas Cal?”

4.4.3 Select Cal Memory

This function allows the user to select one of eight different memories for gas calibration and measurement. For Memories #1-7, the calibration and measurement gas is the same and no correction factor is applied. For Memory #0, the calibration gas is always isobutylene and the measurement gas may be different, in which case the correction factor for that gas is automatically applied. The default gas selections are listed in Section 4.4

1. "Select Cal Memory?" is the third sub-menu item in the Calibration sub-menu. Pressing the [Y/+] key, the display will show "Gas =" gas name followed by "Mem # x?"
2. Press [N/-] to scroll through all the memory numbers and the gas selections respectively. Press [Y/+] to accept the displayed Cal Memory number.
3. After the [Y/+] key is pressed, the display shows "Save?" Press [Y/+] key to save and proceed. Press [N/-] to discard the entry and advance to the next sub-menu.
4. If the gas in a newly selected Cal Memory number is not calibrated, the display shows "CF= x.xx". A correction factor with the value "x.xx" will be applied.
5. If the gas of a newly selected cal memory number has been calibrated previously, the display shows "Last calibrated xx/xx/xx".

4.4.4 Change Span Value

This function allows the user to change the span values of the calibration gases.

1. “Change Span Value?” is the fourth sub-menu item in the Calibration sub-menu
2. Press [Y/+], display shows the gas name and the span value. A cursor will blink at the first digit of the Span value. To modify the span gas value, go to Step 3. Otherwise, press and hold the [MODE] key for 1 second to accept the previously stored span gas value and move to the next sub-menu.
3. Starting from the left-most digit of the span gas value, use the [Y/+] or [N/-] key to change the digit value and press [MODE] key momentarily to advance to next digit. Repeat this process until all digits are entered. Press and hold the [MODE] for 1 second to exit.
4. The display shows “Save?” To accept the new value, press the [Y/+] key. Press the [N/-] key or the [MODE] key to discard the change and move to the next sub-menu.

4.4.5 Modify Cal Memory

If the current cal memory number selected is not memory 0, users will be prompted whether to modify the settings of the selected cal memory. Press [Y/+] to modify the cal memory and [N/-] to go to the next sub-menu.

Once [Y/+] is pressed the LCD display will show the current memory number, current Gas selected and prompt user for acceptance of current gas selected.

1. Press [N/-] to modify the gas selection if desired. Or press [Y/+] key to skip the change of gas selection, and proceed to the next sub-menu.
2. After pressing [N/-], display shows “Copy gas from library?” Press [Y/+] to accept or [N/-] for the next sub-menu, “Enter Custom gas?”
3. In the “Copy gas from library” submenu, use [Y/+] and [N/-] keys to scroll through the selections in the library. Press [MODE] key momentarily to select the gas. The display shows “Save?” Press [Y/+] to save or [N/-] to discard the changes and proceed to next sub-menu.
4. In the Custom gas sub-menu, the user can enter the gas name. Press the [Y/+] or [N/-] key to cycle through all 26 letters and 10 numerals. Press the [MODE] key momentarily to advance to the next digit. The flashing digit will move to the next digit to the right. Repeat this process until all digits (up to 8 digits) of the custom gas name is entered.

Press and hold the [MODE] key for 1 second to exit the name entry mode. The display will show “Save?” Press [Y/+] to save the entry, or [N/-] to discard the changes.

4.4.6 Change Correction Factor

This function allows the user to change the Correction Factor of the standard calibration gas (only for Cal Memory #0).

1. "Change Correction Factor?" is the sixth sub-menu in the Calibration sub-menu.
2. Press [Y/+] key. Display shows the gas name, then the correction factor.

A cursor blinks at the left-most digit of the correction factor. If user wants to modify the correction factor, go to Step 3. Otherwise, press and hold the [MODE] key for 1 second to accept the previously stored correction factor value and return to the first sub-menu of the calibrate/select gas menu.

3. Starting from the left-most digit of the correction factor, use [Y/+] or [N/-] key to change the digit value and press [MODE] key momentarily to advance to the next digit, the cursor will move to the next digit to the right. Repeat this process until all digits are entered. Press and hold the [MODE] for 1 second to exit.
4. The display shows "Save?" To confirm the new value, press [Y/+] to accept the change. Press [N/-] or [MODE] to discard the change and return to the first sub-menu, Calibrate and Select Gas.

4.5 Change Alarm Limits

In this menu, the user can change the high and low alarm limits, the STEL limit and the TWA limit (see Table 4.5 below). Press the [Y/+] key and the display shows the current gas selected followed by the first sub-menu item below.

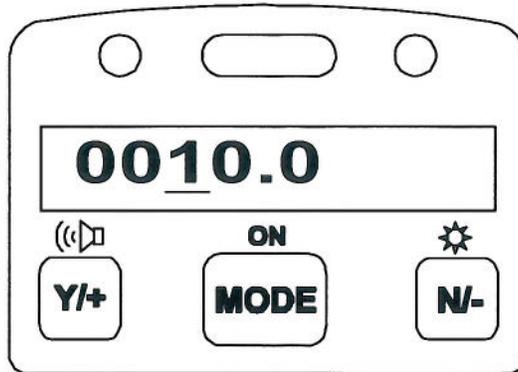
Table 4.5

Alarm Limit Sub-Menu
Change High Alarm limit?
Change Low Alarm limit?
Change STEL limit?
Change TWA limit?

1. Scroll through the Alarm Limit sub-menu using the [N/-] key until the display shows the desired limit to be changed, e.g., "High limit?", "STEL limit?", etc.

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2. Press the **[Y/+]** key to select the desired limit and the display shows a flashing cursor on the left-most digit of the previously stored alarm limit.



3. To modify this limit value, use the **[Y/+]** or **[N/-]** key to change the digit value and press the **[MODE]** key momentarily to advance to the next digit. The flashing digit will move to the next digit to its right. Repeat this process until the new limit value is entered. Press and hold the **[MODE]** key for 1 second to exit data entry mode.
4. If there is any change to the existing value, the display shows "Save?" Press **[Y/+]** to accept the new value and move to the next sub-menu. Press **[N/-]** to discard the changes and move to the next sub-menu.

4.5.1 Change Low Alarm Limit

The second sub-menu item in the Alarm Limit sub-menu allows the user to change the Low Alarm limit. The LCD displays “Low limit?” To change Low Alarm limit, press [Y/+] key, or Press [N/-] key advance to next sub-menu in Table 4.5.

1. Press [Y/+] and the display will show a flashing cursor on the left-most digit of the previously stored Low alarm limit.
2. To modify this limit value, use the [Y/+] or [N/-] key to change the digit value and press the [MODE] key momentarily to advance to the next digit. The flashing digit will move to the next digit to its right. Repeat this process until the new limit values is entered. Press and hold the [MODE] key for 1 second to exit data entry mode.
3. If there is any change to the existing value, the display shows “Save?” Press [Y/+] to accept the new value and move to the next sub-menu. Press [N/-] to discard the changes and move to the next sub-menu.

4.5.2 Change STEL Limit

This sub-menu item allows the user to change the STEL limit. The display shows “STEL limit?”

1. Press the [Y/+] key and the display will show a flashing cursor on the left-most digit of the previously stored STEL limit.
2. To modify this limit value, use the [Y/+] or [N/-] key to change the digit value and press the [MODE] key momentarily to advance to the next digit. The flashing digit will move on to next digit to its right. Repeat this process until the new limit values is entered. Press and hold the [MODE] key for 1 second to exit data entry mode.
3. If there is any change to the existing value, the display shows “Save?” Press [Y/+] to accept the new value and move to the next sub-menu. Press [N/-] to discard the changes and move to the next sub-menu.

4.5.3 Change TWA Limit

This sub-menu item allows the user to change the TWA limit. The LCD displays “TWA limit?”

1. Press [Y/+] and the display will show a flashing cursor on the left-most digit of the previously stored TWA limit.
2. To modify this limit value, use the [Y/+] or [N/-] key to change the digit value and press the [MODE] key momentarily to advance to the next digit. The flashing digit will move on to next digit to its right. Repeat this process until the new limit values is entered. Press and hold the [MODE] key for 1 second to exit data entry mode.
3. If there is any change to the existing value, the display shows “Save?” Press [Y/+] to accept the new value and move to the next sub-menu. Press [N/-] to discard the changes and move to the next sub-menu.

4.6 Change Datalog

The MiniRAE 2000 monitor calculates and stores the concentration and ID of each sample taken. In the datalog sub-menu, a user can perform the tasks and functions shown below.

Datalog Sub-Menu

Reset Peak/Minimum?

Clear Data?

Change Data Period?

Change Average Type?

4.6.1 Reset Peak

This function will reset the peak and minimum stored in the data memory. Note: this function will not clear the STEL or TWA data.

1. "Reset Peak?" is the first sub-menu item in the Datalog sub-menu (Table 4.6).
2. Press the [Y/+] key to reset the Peak/Minimum Values. The display shows "Are You Sure?"
3. Pressing the [Y/+] key again will reset the values. The display shows "Peak/Minimum Cleared" and moves to the next submenu.
4. Press the [N/-] or [MODE] key to exit without resetting the values and move to the next sub-menu.

4.6.2 Clear Data

This function will erase all data stored in the non-volatile datalog memory. Note: This function does not change STEL, TWA, Peak, Minimum and run time values, which are stored in the regular data memory.

1. "Clear Data?" is the third sub-menu item in the Datalog sub-menu.
2. Press the [Y/+] key to clear the datalog memory. The display shows "Are you sure?"
3. Press the [Y/+] key again to confirm erasure of all the datalog memory.
4. Press the [N/-] or [MODE] key to exit without clearing the datalog memory and move to the next datalog sub-menu.

4.6.3 Change Data Period

The datalog period can be programmed from 1 to 3,600 seconds (1 hour).

1. "Change Data Period?" is the fifth sub-menu item in the Datalog sub-menu.
2. Press the [Y/+] key and the display shows "Datalog Period = XXXX" with the left-most digit flashing, where "XXXX" is the previously stored data log period.
4. To modify this period, starting from the left-most digit, use the [Y/+] or [N/-] key to change the digit value and press the [MODE] key momentarily to advance to the next digit. The flashing digit will move to the next digit to the right. Repeat this process until all 4 digits of the new period are entered. Press and hold the [MODE] key for 1 second to exit data entry mode.
5. If there is any change to the existing value, the display will show "Save?" Press [Y/+] to accept the new value or [N/-] to discard the changes and move to the next sub-menu.

4.6.4 Change Average Type

The user can select either an 8-hour Time Weighted Average (TWA) or a running Average. The running average is simply the average of all instantaneous (1-second) readings since the measurement was started. This average may increase or decrease with time depending on the readings. The TWA is a cumulative value used to estimate the fraction of the 8-hour limit to which the user has been exposed since the start of the measurement. This value can only increase or remain constant, never decrease. Refer to Technical Note 119 for more information on how TWA is calculated.

1. "Change Average Type?" is the sixth sub-menu in the Datalog sub-menu.
2. Press the [Y/+] key to enter the function.
3. The display will show "Running Average?" or "Time Weighted Average?" depending on the current average type.
4. Press [N/-] key to toggle between the average types. Press [Y/+] key to select the displayed average type.
5. If there is any change to the existing setting, the display shows "Save?" Press [Y/+] to save the change. Press [N/-] or [MODE] to discard the change and return to the first sub-menu.

4.7 Change Monitor Setup

Several monitor specific variables can be changed in this menu. The following is a list of configuration data that can be modified by the user.

Monitor Setup Sub-Menu	Diagnostic Mode
Change Operation Mode?	“
Change Site ID?	Change Unit ID?
Change User ID?	Change Host ID?
Change Alarm Mode?	“
Change User Mode?	“
Change Date?	“
Change Time?	“
Change Lamp?	“
Change Pump Duty Cycle?	“
Change Unit?	“
Change Dilution Ratio?	“
Change Output?	“
Change DAC Range?	“
Set Temperature Unit?	“

4.7.1 Change Operation Mode

MiniRAE 2000 supports two operation modes: Survey and Hygiene mode.

Survey mode: Manual start/stop of measurements and display of certain exposure values.

Hygiene mode: Automatic measurements, running and datalogging continuously and calculates additional exposure values.

1. "Change Op Mode?" is the first sub-menu item in the Monitor Setup menu (Table 4.7).
2. Press the [Y/+] key and the display shows the current user mode: "Op Mode = *current mode*?"
3. Press the [Y/+] key to accept the currently displayed operation (Op) mode. Press [N/-] to toggle to the other operation mode. Press [MODE] to exit this sub-menu and move to the next monitor setup sub-menu.
4. When changing Op mode from Hygiene to Survey, the display shows the additional message "Warning! Exit Hygiene?" to prevent accidental exit from Hygiene mode. Press the [Y/+] key to acknowledge.
5. If there is any change to the existing setting, the display will show "Save?" Press the [Y/+] key to accept or the [N/-] key to discard and move to the next sub-menu.

Note: If a new Op Mode is saved, the display shows "Op Mode changed!!" when exiting the programming mode.

4.7.2 Change Site ID

The user can enter an 8-digit alphanumeric site ID in the programming mode. This site ID will be included in the datalog report.

1. "Change Site ID?" is the second sub-menu item in the Monitor Setup menu (Table 4.7).
2. Press the [Y/+] key and the display shows the current site ID: "Site ID = xxxxxxx" with the left most digit flashing.
3. Press the [Y/+] or [N/-] key to cycle through all 26 letters and 10 numerals. Press [MODE] momentarily to advance to the next digit. The flashing digit will move to the next digit to the right. Repeat this process until all 8 digits of the new site ID are entered.
4. Press and hold the [MODE] key for 1 second to exit the data entry mode.
5. If there is any change to the existing site ID, the display shows "Save?" Press the [Y/+] key to accept the new site ID. Press the [N/-] key to discard the change and move to the next sub-menu.

4.7.3 Change User ID

The user can enter an 8-digit alphanumeric user ID in the programming mode. This user ID will be included in the datalog report.

1. “Change User ID?” is the third sub-menu item the Monitor Setup menu.
2. Press the [Y/+] key and the display shows the current user ID: “User ID = xxxxxxxx” with the left most digit flashing.
3. Press the [Y/+] or [N/-] key to cycle through all 26 letters and 10 numerals. Press [MODE] momentarily to advance to the next digit. The flashing digit will move to the next digit to the right. Repeat this process until all 8 digits of the new user ID are entered.
4. Press and hold the [MODE] key for 1 second to exit the data entry mode.
5. If there is any change to the existing user ID, the display shows “Save?” Press the [Y/+] key to accept the new user ID. Or press the [N/-] key to discard the changes and move to the next sub-menu.

4.7.4 Change Alarm Mode?

There are two different alarm modes: **Latched** and **Automatic Reset** (Auto Reset) in the MiniRAE 2000 that can be selected from the programming menu.

1. “Change Alarm Mode?” is the fourth sub-menu item in the Monitor Setup menu.
2. Press the [Y/+] key; the display shows the current alarm mode.
3. Press the [Y/+] key to accept the currently displayed alarm mode. Press [N/-] key to toggle to the other alarm mode. Press [MODE] to exit this sub-menu and move to the next monitor setup sub-menu.
4. If there is any change to the existing setting, the display will show “Save?” Press [Y/+] to save the change. Press [N/-] or [MODE] to discard the change and move to the next sub-menu.

4.7.5 Change User Mode

There are two different user modes: **Display** and **Program** that can be selected from the programming menu.

1. “Change User Mode?” is the fifth sub-menu item in the Monitor Setup menu (Table 4.7).
2. Press the [Y/+] key; the display shows the current user mode selected.
3. Press the [Y/+] key to accept the currently displayed user mode. Press [N/-] key to toggle to the alternate user modes. Press [MODE] to exit this sub-menu and move to the next monitor setup sub-menu.
4. If there is any change to the existing selection, the display shows messages “Program change” and “Are you sure?” Press [Y/+] to confirm the change or press [N/-] or [MODE] to discard the changes and move to the next sub-menu.

CAUTION: If the user mode is changed to **Display** mode, the user can no longer enter the programming mode. Therefore, the user can not change the user mode back to **Program** mode in normal mode.

To restore the user mode back to **Program** mode, turn the unit off and back on in Diagnostic Mode. Next enter Program mode by holding the [MODE] and [N/-] keys for three seconds. Enter the password at the prompt (the default is 0000). Once program mode is entered, go to the “Change Monitor Setup” / “Change User Mode” and change the mode back to **Program**.

An alternative way to change Display mode back to Program mode is through the PC and the ProRAE-Suite software.

4.7.6 Change Date

The MiniRAE 2000 monitor is equipped with a real time clock (RTC). The user can enter the correct date and time (see 4.7.7) for the real time clock.

1. "Change Date?" is the sixth sub-menu item in the Monitor Setup menu.
2. Press [Y/+] and the display shows the current date "mm / dd / yy" with the left most digit of the date flashing.
5. To modify this value, use the [Y/+] or [N/-] key to change the digit value and press the [MODE] key momentarily to advance to the next digit. The flashing digit will move on to next digit to its right. Repeat this process until the new date and time values are entered. Press and hold the [MODE] key for 1 second to exit data entry mode.
4. If there is any change to the existing value, the display shows "Save?" Press [Y/+] to confirm the new value or press [N/-] or [MODE] to discard the changes and move to the next sub-menu.

4.7.7 Change Time

To change the time in the RTC of the MiniRAE 2000:

1. "Change Time?" is the seventh sub-menu item in the Monitor Setup menu.
2. Press [Y/+] and the display shows the current time in the 24-hour format "hh : mm" with the left most digit of the time flashing.
3. To modify this value, use the [Y/+] or [N/-] key to change the digit value and press the [MODE] key momentarily to advance to the next digit. The flashing digit will move on to next digit to its right. Repeat this process until the new date and time values are entered. Press and hold the [MODE] key for 1 second to exit data entry mode.
4. If there is any change to the existing value, the display shows "Save?" Press [Y/+] to confirm the new value or press [N/-] or [MODE] to discard the changes and move to the next sub-menu.

4.7.8 Change Lamp

There are three UV lamps with different photon energies available for the PID sensor: **9.8 eV**, **10.6 eV** and **11.7 eV**. The user can select any one of the lamps from the programming mode.

1. “Change Lamp Type?” is the eighth sub-menu item in the Monitor Setup menu (Table 4.7).
2. Press the **[Y/+]** key; the display shows the current PID lamp selection.
3. Press the **[Y/+]** key to accept the currently displayed lamp. Press **[N/-]** key to scroll through the sub-menu for other lamp selections. Press **[MODE]** to exit this sub-menu and return to the next sub-menu in Table 4.7.
4. If there is any change to the existing selection, the display will show “Save?” Press **[Y/+]** to save the new selection or press **[N/-]** or **[MODE]** to discard the change and return to the next sub-menu in Table 4.7.

4.7.9 Change Unit

User can change the display and datalog unit from parts per million (ppm) to milli-gram per cubic meter (mg/m^3).

1. "Change Unit?" is the ninth sub-menu item in the Monitor Setup sub-menu.
2. Press the [Y/+] key, the display should show the current unit "Display Unit = ppm?" or "Display Unit = mg?"
3. Press [Y/+] key to accept the currently displayed unit. Press [N/-] key to toggle to the other unit. Press [MODE] key to exit this sub-menu.
4. If there is any change to the existing selection, press [Y/+] to confirm the new selection or press [N/-] or [MODE] to discard the changes and move to the next sub-menu.

Caution:

1. **The correction factor in the gas library is calculated based on "ppm" unit. If "mg" unit is selected, the built-in correction factor library is not valid.**
2. **No automatic conversion between "ppm" and " mg/m^3 " reading is performed by the monitor.**
3. **When the unit name is changed from "ppm" to "mg", the unit must be recalibrated with the span gas concentration entered in mg/m^3 . The converse rule applies when the unit is changed from "mg" to "ppm".**

4.7.10 Change Dilution Ratio

If a dilution system is used upstream of the MiniRAE 2000 inlet port, the user can enter the dilution ratio (from 1 to 10) to compensate the readings. The unit will then display the actual concentration of the gas before dilution. The dilution ratio should be 1 in normal operation where no dilution gas is applied to the sample gas. Dilution improves accuracy and linearity when the concentrations are above a few thousand ppm.

1. "Change Dilution Ratio?" is the tenth sub-menu item in the Monitor Setup menu.
2. Press the [Y/+] key; the display shows the current dilution ratio: "Dilution Ratio = xx" with the left most digit flashing.
3. Press the [Y/+] or [N/-] key to increase or decrease the value of the digit. Press [MODE] momentarily to advance to the next digit. The flashing digit will move to the next digit to the right. Repeat this process until both digits of the new dilution ratio are entered.
4. Press and hold the [MODE] key for 1 second to exit the data entry mode and move to the next sub-menu.
5. If there is any change to the existing dilution ratio, the display shows "Save?" Press [Y/+] to confirm the new value or press [N/-] or [MODE] to discard the changes and move to the next sub-menu.

4.7.11 Change Output?

There are two different external output options: DAC (Analog output) and Alarm in the MiniRAE 2000 that can be selected from the programming menu. The alarm output can be used to connect to the optional vibration alarm (vibrator) only. The analog output, which is proportional to the gas concentration, can be connected a chart recorder or can be queried by a computer to download data in real time (see Technical Note 141).

1. "Change External Output?" is the eleventh sub-menu item in the Monitor Setup menu.
2. Press the [Y/+] key and the display shows the current output option selection: "Output = DAC?"
3. Press the [Y/+] key to accept the currently displayed output option. Press [N/-] to change to the other external option: "Output = Alarm?" Press [MODE] to exit this sub-menu and move to the next monitor setup sub-menu.
4. If there is any change to the existing selection the display will show "Save?" Then, press [Y/+] to save the change, press [N/-] to go back to Step 2, or press [MODE] to exit this sub-menu and move to the next monitor setup sub-menu.

4.7.12 Change DAC Range?

There are four different DAC (Digital-to-Analog Conversion) range values available in the **MiniRAE 2000: 20, 200, 2000** and **10K ppm**. The maximum 2.5V DC analog signal output from the unit will represent the range value chosen. (See for analog signal output connection.)

1. “Change DAC Range?” is the twelfth sub-menu item in the Monitor Setup menu.
2. Press the [Y/+] key, the display shows the current DAC Range value: “DAC Range = 2000 ppm?”
3. Press the [Y/+] key to accept the currently displayed value. Press [N/-] to scroll through the sub-menu for other range values. Press [MODE] to exit this sub-menu and return to the first sub-menu in Table 4.7.
4. If there is any change to the existing selection, press the [Y/+] key and the display will show “Save?” Press the [Y/+] key to save the change or press the [N/-] key to discard and return to the first sub-menu in Table 4.7.

4.7.13 Set Temperature Unit?

The temperature display can be switched between Fahrenheit and Celsius units.

1. "Set Temperature Unit?" is the thirteenth sub-menu item in the Monitor Setup menu.
2. Press the [Y/+] key, and the display shows the current setting: "Temperature Unit = Fahrenheit?"
3. Press the [Y/+] key to accept the currently displayed value. Press [N/-] to select the sub-menu "Temperature Unit = Celsius?" Press [MODE] to exit this sub-menu and return to the first sub-menu in Table 4.7.
4. If there is any change to the existing selection, press the [Y/+] key and the display will show "Save?" Press the [Y/+] key to save the change and return to the first sub-menu in Table 4.7 or press the [N/-] key to discard and return to Step 3..

4.8 Exit Programming Mode

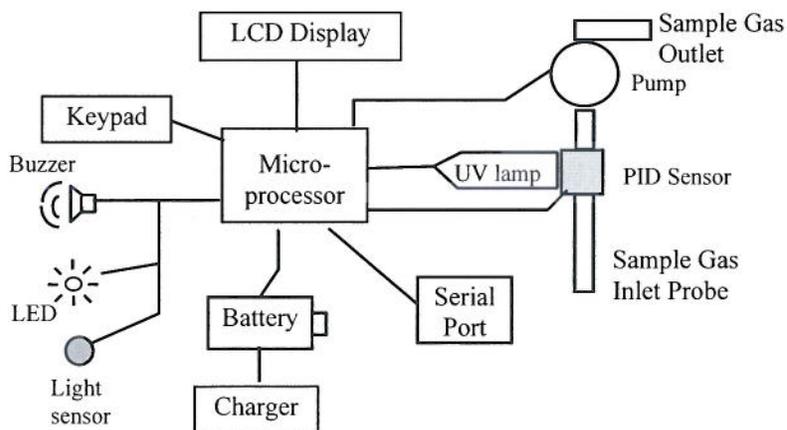
1. To exit programming mode from the first tier menu level, press the **[MODE]** key once.
2. To exit programming mode from 2nd tier sub-menu, press the **[MODE]** key twice.
3. To return to programming mode, press and hold down both the **[MODE]** and **[N/-]** keys for 3 seconds.

5. THEORY OF OPERATION

The MiniRAE 2000 monitor uses a newly developed electrodeless discharge UV lamp as the high-energy photon source for the PID. As organic vapors pass by the lamp, they are photo-ionized and the ejected electrons are detected as a current. The PID sensor with a standard 10.6 eV lamp detects a broad range of organic vapors. A lamp with high photon energy (e.g. 11.7 eV) will measure the more kinds of compounds, whereas low photon energies (e.g. 9.8 eV) are selective for easily ionizable compounds such as aromatics. In principle, any compound with an ionization energy lower than that of the lamp photons can be measured.

The PID sensor for the MiniRAE 2000 monitor is constructed as a small cavity in front of the UV lamp. A diaphragm pump draws the gas sample into the sensor and then pumps it out through the side of the instrument.

Figure 5-1 MiniRAE 2000 Block Diagram



THEORY OF OPERATION

A single chip microcomputer is used to control the operation of the alarm buzzer, LED, pump and light sensor. It measures the sensor readings and calculates the gas concentrations based on calibration to known standard gases. The data are stored in non-volatile memory so that they can be sent to a PC for record keeping. RS-232 transceivers provide a serial interface between the monitor and the serial port of a PC. An LCD display consisting of a single row of eight alpha/numeric characters is used to display the readings. The user interacts with the monitor through three keys on the front panel keypad.

A rechargeable NiMH, NiCd battery, or an alkaline battery pack powers the monitor.

6. MAINTENANCE

The major maintenance items of the MiniRAE 2000 are:

- Battery pack
- Sensor module
- PID lamp
- Sampling pump
- Inlet connectors and filters

Note: Maintenance should be performed by qualified personnel only.

NOTE: The printed circuit board of the monitor is connected to the battery pack even if the power is turned off. Therefore, it is very important to disconnect the battery pack before servicing or replacing any components inside the monitor. Severe damage to the printed circuit board or battery may occur if the battery pack is not disconnected before servicing the unit.

6.1 Battery Charging and Replacement

When the display shows a flashing message “Bat”, the battery requires recharging (see Section 3.1 for Battery charging). It is recommended to recharge the MiniRAE 2000 monitor upon returning from fieldwork. A fully charged battery runs a MiniRAE 2000 monitor for 10 hours continuously. The charging time is less than 10 hours for a fully discharged battery. The built-in charging circuit is controlled by the micro-controller to prevent over-charging. The battery may be replaced in the field (in area known to be non-hazardous) if required.

WARNING

To reduce the risk of ignition of hazardous atmospheres, recharge battery only in area known to be non-hazardous. Remove and replace battery only in area known to be non-hazardous.

Replacing Battery Pack

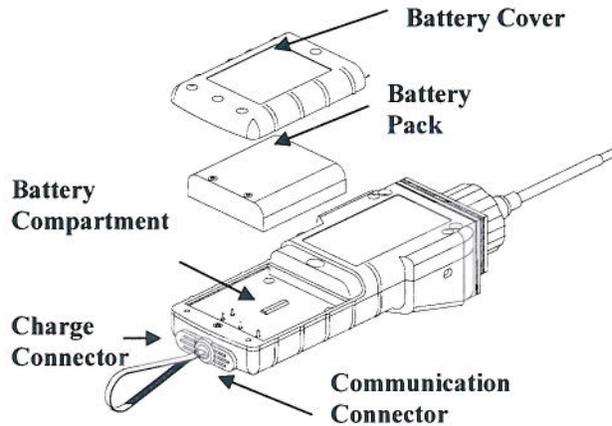


Figure 6-1 Battery Replacement

1.

MAINTENANCE

Turn off the power of the MiniRAE 2000.

2. Unscrew the two battery compartment screws, located on the bottom of the monitor, and remove the cover.
3. Remove the battery pack from the battery compartment.
4. Replace a fully charged spare battery pack inside the battery compartment. Make sure the battery pack is oriented properly inside the compartment
5. Close the battery cover and tighten the two screws.

Replacing Alkaline Battery Adapter

1. Insert four fresh AA size alkaline batteries into the alkaline battery holder. Make sure that the polarity of the batteries is correct.
2. Follow the same procedure as described above to replace the battery holder.

Note: The internal charging circuit is designed to prevent charging to alkaline batteries.

6.2 PID Sensor & Lamp Cleaning/Replacement

The sensor module is made of several components and is attached to the lamp-housing unit as shown in Figure 7-2.

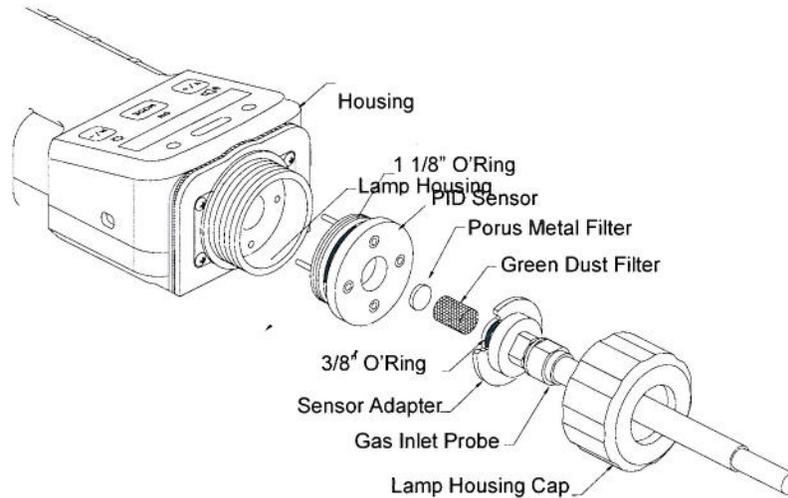


Figure 7-2 Sensor Components

Note: Normally the cleaning procedure is not needed. Clean the PID sensor module, the lamp and the lamp housing only when one of the following happened:

1. The reading is inaccurate even after calibration.
2. The reading is very sensitive to air moisture.
3. A chemical liquid has been sucked into the unit and damaged the unit.

Use of the water trap filter will help prevent contamination and accidentally drawing liquid into the sensor.

MAINTENANCE

To access the sensor components and lamp, gently unscrew the lamp-housing cap, remove the sensor adapter with the gas inlet probe and the metal filter all together. Then hold the PID sensor and pull straight out to avoid bending the electrical pins on the sensor (see Figure 7-2). A slight, gentle rocking motion helps release the sensor.

To clean the PID sensor:

Place the entire PID sensor module into GC grade methanol. It is highly recommended that an ultrasound bath to be used to clean the sensor for at least 15 minutes. Then dry the sensor thoroughly. Never touch the electrodes of the sensor by hand.

Also use a methanol-soaked cotton swab to wipe off the lamp housing where it contacts the sensor when the sensor is installed.

Turn over the sensor so that the pins point up and the sensor cavity is visible. Examine the sensor electrodes for any corrosion, damage, or bending out of alignment. The metal sensor electrode “fingers” should be flat and straight. If necessary, carefully bend the sensor fingers to ensure that they do not touch the Teflon portions and that they are parallel to each other. Make sure that the nuts on the sensor pins are snug but not overtight. If the sensor is corroded or otherwise damaged, it should be replaced.

MAINTENANCE

To clean lamp housing or change the lamp:

To clean lamp housing or change the lamp:

If the lamp does not turn on, the monitor will display an error message to indicate replacement of the lamp may be required.

1. If the lamp is operational, clean the lamp window surface and the lamp housing by wiping it with GC grade methanol using a cotton swab using moderate pressure. After cleaning, hold the lamp up to the light at an angle to detect any remaining film. Repeat the process until the lamp window is clean. Never use water solutions to clean the lamp. Dry the lamp and the lamp housing thoroughly after cleaning.

CAUTION: Never touch the window surface with the fingers or anything else that may leave a film. Never use acetone or aqueous solutions.

2. If the lamp does not turn on, remove the lamp from the lamp housing. Place the lamp O-ring onto the new lamp. Insert the new lamp, avoiding contact with the flat window surface.
3. Reinstall the PID sensor module.
4. Tighten the Lamp Housing Cap.
5. If the lamp type has been changed, adjust the lamp type setting in the programming mode (Section 4.7.8).

6.3 Sampling Pump

When approaching the end of the specified lifetime of the pump, it will consume higher amount of energy and reduce its sample draw capability significantly. When this occurs, it is necessary to replace or rebuild the pump. When checking the pump flow, make sure that the inlet connector is tight and the inlet tubing is in good condition. Connect a flow meter to the gas inlet probe. The flow rate should be above 450 cc/min when there is no air leakage.

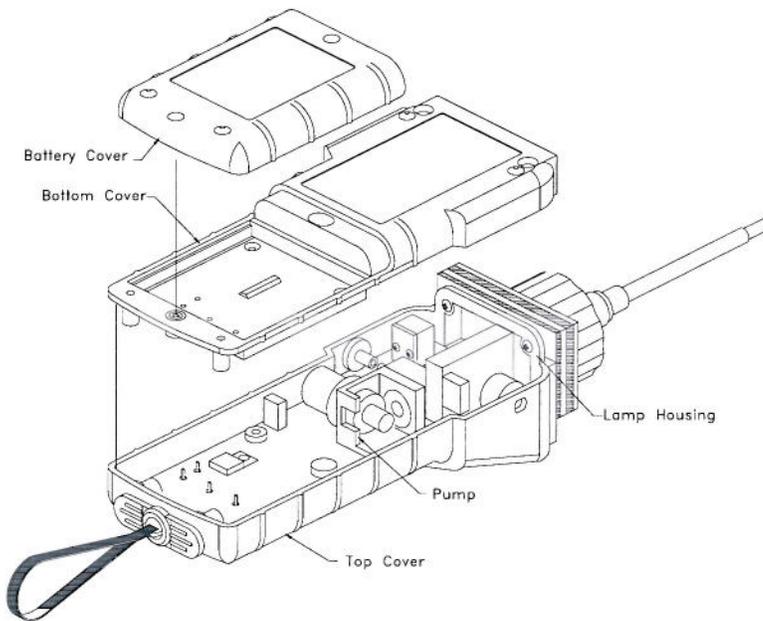


Figure 7-3 Sampling Pump

Pump Replacement

1. Turn off the MiniRAE 2000 power.
2. Open the battery cover, remove the battery pack, and carefully unscrew the six screws to open the bottom cover.
3. Unplug the pump from the PCB. Unscrew the two screws that hold the pump assembly to the PCB. Disconnect the Tygon tubing that connects the pump to the gas inlet port and gas outlet port.
4. Insert a new pump assembly. Connect the Tygon tubing to the gas inlet port. Plug the pump connector back into the PCB and screw down the pump assembly to the board.
5. Replace the bottom cover and tighten the six screws. Reconnect the battery pack. Replace the battery pack and its cover.

6.4 Turning on the UV Lamp

The UV lamp is made of a glass envelope and a UV window (salt crystal) on one end of the envelope. The inside of the lamp is filled with low pressure gases. To turn on the lamp, a high voltage electric field is applied from the outside of the glass envelope. The molecules inside the lamp are ionized and produce a glow discharge that generates the UV light. The MiniRAE 2000 has a built-in sensing mechanism to monitor the status of the UV lamp and display a “Lamp” error message if it is not on.

If the UV lamp has not been used for a long period of time (> 1 month) or is cold, it may become slightly harder to turn on. If such a condition occurs, the “Lamp” message will appear in the monitor display during the power on sequence. This phenomenon is more significant in 0.25” UV lamps used in ToxiRAE and MultiRAE Plus products, because of the relatively small lamp size. To solve this problem, simply turn on and off the monitor a few times and the lamp should turn on. After the UV lamp is turned on for the first time, it should be easier to turn on the UV lamp next time.

It is possible that the UV lamp is actually on when the lamp error message appears. This is because when the lamp becomes old, the internal threshold level to detect lamp failure may have shifted and cause a false alarm. To eliminate such possibility, simply check to see the UV lamp is actually on. This can be done easily by removing the sensor cap and observing the glow light of the UV lamp in a dark place. The user can also feed the monitor with calibration gas and observe if the sensor reading changes. If the reading changes significantly with the gas, the UV lamp is actually on.

A possible failure mechanism for the UV lamp is a leak developed along the seal of the glass envelope. When such condition occurs, the lamp will become very hard or impossible to turn on and will need to be replaced.

7. TROUBLESHOOTING

To aid the user in diagnosing the monitor, a special diagnostic mode can be used displays critical, low level parameters. Section 7.1 describes the operation of the diagnostic mode. Section 7.2 summarizes the frequently encountered problems and suggested solutions. By turning on the MiniRAE 2000 monitor in diagnostic mode and by using the troubleshooting table in Section 7.2, the user can usually correct the problem without having to return the monitor for repair.

WARNING

This function should be used by qualified personnel only! The diagnostic mode allows the user to set several low-level parameters that are very critical to the operation of the monitor. Extra care should be taken when setting these parameters. If the user is not familiar with the function of these parameters and sets them incorrectly, it may cause the monitor to shut down or malfunction.

TROUBLESHOOTING

7.1 Troubleshooting Table

Problem	Possible Reasons & Solutions
Cannot turn on power after charging the battery	<p>Reasons: Discharged battery. Defective battery. Microcomputer hang-up.</p> <p>Solutions: Charge or replace battery. Disconnect, then connect battery to reset computer.</p>
No LCD back light	<p>Reasons: Trigger level too low, the current mode is not user mode, and the mode does not support automatic turn on back light.</p> <p>Solutions: Adjust trigger level. Verify the back light can be turned on in user mode. Call authorized service center.</p>
Lost password	<p>Solutions: Call Technical Support at +1.408 .752 .0723 or +1. 888 .723 .4800</p>
Reading abnormally High	<p>Reasons: Dirty sensor module. Dirty water trap filter. Excessive moisture and water condensation.</p> <p>Solutions: Clean sensor module and lamp housing. Replace water trap filter. Blow dry the sensor module.</p>
Buzzer Inoperative	<p>Reasons: Bad buzzer.</p> <p>Solutions: Call authorized service center.</p>

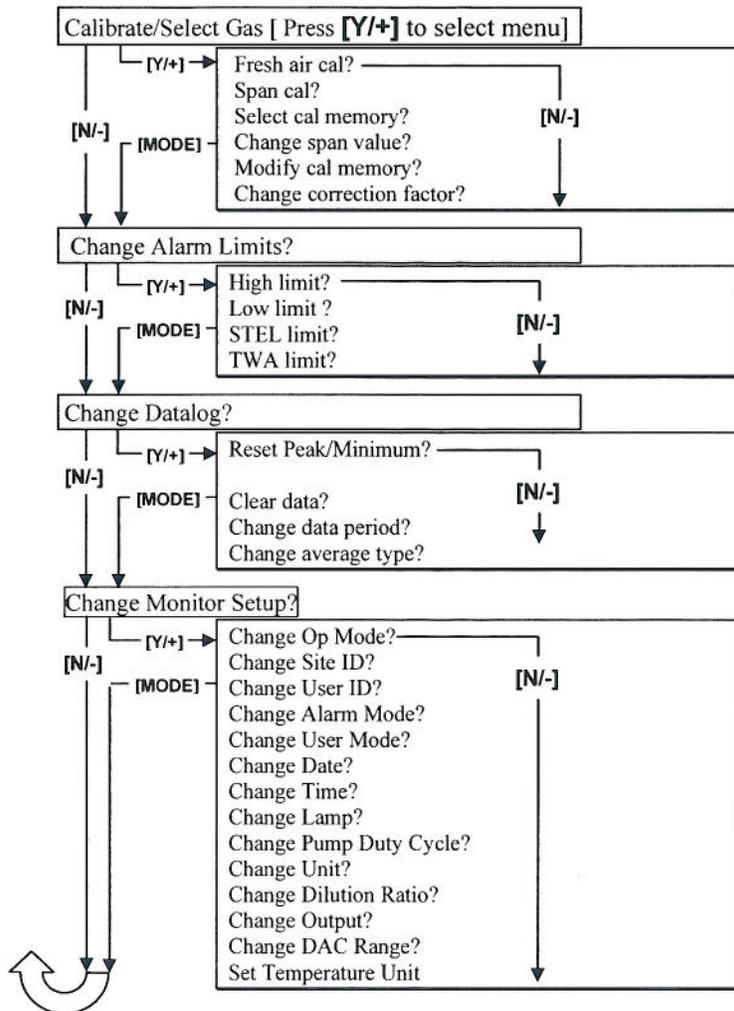
TROUBLESHOOTING

<p>Inlet flow too low</p>	<p>Reasons: Pump diaphragm damaged or has debris. Flow path leaks.</p> <p>Solutions: Check flow path for leaks; sensor module O-ring, tube connectors, Teflon tube compression fitting. Replace pump or diaphragm.</p>
<p>“Lamp” message during operation</p>	<p>Reasons: Lamp drive circuit. Weak or defective PID lamp, defective.</p> <p>Solutions: Turn the unit off and back on Replace UV lamp</p>
<p>Full scale measurement in humid environment</p>	<p>Reasons: Dirty or wet sensor.</p> <p>Solutions: Clean and dry sensor and lamp housing. Adjust sensor fingers to ensure not touching Teflon. Use water trap filter.</p>
<p>Reading abnormally low</p>	<p>Reasons: Incorrect calibration. Low sensitivity to the specific gas. Weak or dirty lamp. Air leakage.</p> <p>Solutions: Calibrate the monitor. Replace sensor. Clean or replace lamp. Check air leakage.</p>

APPENDIX A. QUICK REFERENCE GUIDE

Press [N/-] and [MODE], simultaneously, for 3 seconds, to enter Programming Mode. Press [MODE] to return to Survey Mode.

PROGRAMMING MODE



RAE Systems, Inc. Contact Information

Main Office: 3775 N. First St.
San Jose, CA 95134-1708
USA

Telephone: 408-952-8200

Fax: 408-952-8480

Instrument Sales: 877-723-2878

Email: RaeSales@raesystems.com

Website: www.raesystems.com

Technical Service: 888-723-4800
Tech@raesystems.com

Special Note

If the monitor needs to be serviced, contact either:

1. The RAE Systems distributor from whom the monitor was purchased; they will return the monitor on your behalf.
2. The RAE Systems Technical Service Department. Before returning the monitor for service or repair, obtain a Returned Material Authorization (RMA) number for proper tracking of your equipment. This number needs to be on all documentation and posted on the outside of the box in which the monitor is returned for service or upgrade. Packages without RMA Numbers will be refused at the factory.

Multi RAE Photoionization Detector (PID)

I. Purpose

The purpose of this SOP is to provide general reference information for using the Multi RAE PID in the field. Calibration and operation, along with field maintenance, will be included in this SOP.

II. Scope

This procedure provides information on the field operation and general maintenance of the Multi RAE PID. Review of the information contained herein will ensure that this type of field monitoring equipment will be properly utilized. Review of the owner's instruction manuals is a necessity for more detailed descriptions.

III. Definitions

Carbon Monoxide Sensor (CO) - Expresses the Carbon Monoxide concentration in ppm.

Volatile Organic Compound (VOC) - Expresses the VOC concentration in ppm

Lower Explosive Limit (LEL) - Combustible gas is expressed as a percent of the lower explosive limit.

Hydrogen Sulfide Sensor (H₂S) - Expresses the Hydrogen Sulfide concentration in ppm.

Oxygen Sensor (OXY) - Expresses the Oxygen concentration as a percentage.

ppm - parts per million: parts of vapor or gas per million parts of air by volume.

IV. Procedures

The Multi RAE utilizes the principle of detecting sensors. The PID operates on the principle that most organic compounds and some inorganic compounds are ionized when they are bombarded by high-energy ultraviolet light. These compounds absorb the energy of the light, which excites the molecules and results in a loss of electron and the formation of a positively charged ion. The number of ions formed and the ion current produced is directly proportional to mass and concentration. The amount of energy required to displace an electron is called photo ionization potential (PIP). The air sample is drawn into a UV lamp using a pump or a fan. The energy of the lamp determines whether a particular chemical will be ionized. Each chemical compound has a unique ionizing potential. When the UV light energy is

greater than the ionization potential of the chemical, ionization will occur. When the sample is ionized, the electrical signal is displayed on an analog or digital output. Although the output does not distinguish between chemicals, it does detect an increase in the ion current. If only one chemical is present in the air, it is possible to use PIDs quantitatively. Chemical structure and lamp intensity affects the sensitivity of the instrument to a given contaminant. All PID readings are relative to the calibration gas, usually isobutylene. It is important to calibrate the PID in the same temperature and elevation that the equipment will be used, and to determine the background concentrations in the field before taking measurements. For environments where background readings are high, factory zero calibration gas should be used.

Note: for volatile and semi-volatile compounds, knowing the PIP is critical in determining the appropriate instrument to use when organic vapor screening. Consult the QAPP and manufacturer's manual to determine that the proper instrument has been selected for the contaminate vapors of interest. If an expected compound at a site has a PIP less than 11.7 eV, it is possible to use a PID. If the ionization potential is greater than 11.7eV, an FID is required.

The following subsections will discuss Multi RAE calibration, operation, and maintenance. These sections, however, do not take the place of the instruction manual.

A. Calibration

For Multi RAE configured with O₂, LEL, H₂S, CO, sensors and a 10.6eV PID Lamp.

Start up Instrument

- Press **Mode** button
- Observe displays:

On!.....

Multi RAE
Version X.XX

Model Number
SN XXXX

Date Time
Temp

Checking Sensor
Ids....

VOC Installed

CO Installed

H₂S Installed

OXY Installed

LEL Installed

H₂S VOC CO
LEL OXY

Alarm Limits=

XX XX.X XX
XX High XX.X

XX XX.X XX
XX Low XX.X

XX XX.X XX
STEL

XX XX.X XX
TWA

Battery = X.XV
Shut off at 4.2V

User Mode=

Alarm Mode=

Datalog Time Left

Datalog Mode

Datalog Period

Unit ready in.....
10 Seconds

- The pump will start, the seconds will count down to zero, and the instrument will be ready for use

Calibration Check and Adjustment

Allow instrument to warm up for 15 minutes.

- Depress the [N/-] key first, then while depressing the [N/-], depress the [Mode] key also and depress both keys for 5 seconds.

- Display will read:

Calibrate Monitor?

- Press the [Y/+] key

- Display will read:

Fresh Air Calibration?

- If “Zero Air” is necessary, attach the calibration adapter over the inlet port of the Multi RAE Monitor and connect the other end of the tube to the gas regulator (HAZCO loaner regulator LREG.5, RAE Systems P/N 008-3011 or suitable .5 LPM regulator) on the Zero Air bottle (HAZCO P/N SGZA, RAE P/N 600-0024). If no Zero Air is available, perform the Fresh Air Calibration in an area free of any detectable vapor.

- Press the [Y/+] key

- Display will read:

Zero.... In progress...

CO Zeroed! Reading = X

VOC Zeroed! Reading = X

LEL Zeroed! Reading = X

OXY Zeroed! Reading = X

Zero Cal done! H ₂ S Zeroed! Reading = X

In each of the above screens, “X” is equal to the reading of the sensor before it was zeroed.

- Display will then read:

Multiple Sensor Calibration?

- Press the [Y/+] key
- The display shows all of the pre-selected sensors and the “OK?” question:

CO H₂S
LEL OK? OXY

- Apply calibration gas - use either HAZCO Services Part Number R-SGRAE4 or Rae Systems Part Number 008-3002 - using a .5 LPM regulator and direct tubing.
- Press the [Y/+] key. Display will read:

Apply Mixed gas

Calibration
In progress ...

- The display will count down showing the number of remaining seconds:

CO cal'ed
Reading=50

H₂S cal'ed
Reading=25

LEL cal'ed
Reading=50

OXY cal'ed
Reading=20.9

Calibration done
Turn off gas!

- Display will read:

Single Sensor
Calibration?

- Press the [Y/+] key.
- Display will read:

CO VOC H₂S
LEL pick? OXY

- Attach 100 ppm Isobutylene (HAZCO P/N r-SGISO or Rae P/N 600-0002) using a 1.0 LPM regulator (HAZCO P/N LR10HS or Rae P/N 008-3021). Open regulator.
- Press the [Mode] key once, the V of VOC will be highlighted.

- Press the [Y/+]. The display will read:

Apply VOC Gas

Calibration
In progress...

- The display will count down showing the number of remaining seconds:, then display:

VOC cal'd
Reading=100

Calibration done
Turn off gas!

Single Sensor
Calibration?

- Press [Mode] key twice to return to main screen.
- **CALIBRATION IS COMPLETE!**

B. Operation

Due to the Multi RAE having many functions in terms of operation, it is recommended that you follow the operational procedures as outlined in the instruction manual from pages 9 to 14.

C. Site Maintenance

After each use, the meter should be recharged and the outside of the instruments should be wiped clean with a soft cloth.

D. Scheduled Maintenance

<u>Function</u>	<u>Frequency</u>
Check alarm and settings	Monthly/before each use
Clean screens and gaskets around sensors	Monthly
Replace sensors	Biannually or when calibration is unsuccessful

V. Quality Assurance Records

Quality assurance records will be maintained for each air monitoring event. The following information shall be recorded in the field logbook.

- Identification - Site name, date, location, CTO number, activity monitored, (surface water sampling, soil sampling, etc), serial number, time, resulting concentration, comments and identity of air monitoring personnel.
- Field observations - Appearance of sampled media (if definable).
- Additional remarks (e.g, Multi RAE had wide range fluctuations during air monitoring activities.)

VI. References

Multi RAE Plus Multiple Gas Monitor User Manual, RAE Systems, Revision B1, November 2003.

MultiRAE Plus

PGM-50/4, PGM-50/4P, PGM-50/5P
Multiple-Gas Monitor



ISO 9001 
CERTIFIED



USER MANUAL

008-4022-000, Revision B1, November 2003

Equipment List

NUMBER	PART	PART NUMBER
	Monitor Only	
(not shown)*	Shipping case	008-3040-000
2	Monitor with wrist strap	<i>as specified</i>
2	Sensors	<i>as specified</i>
2	Rubber boot with belt clip	008-3042-000
2	Rechargeable Li-Ion battery	500-0037-100
3	Alkaline battery adapter	500-0029-000
4	120-230 V AC/DC wall adapter	<i>as specified</i>
5	Calibration adapter	008-3016-000
5	External filters	008-3022-003
5	Inlet probe	008-3012-001
5	Charcoal filters	008-3006-005
6	Training CD	008-4013-000
7	User manual	008-4022-000
	Monitor with Accessories Kit	
1	Hard transport case	002-3009-000
8	Remote sampling probe with coiled Teflon tubing	008-3015-200
9	Tool kit	081-0005-000
	Optional Calibration Kit	008-3001-000
10	Calibration gas	<i>as specified</i>
11	Regulators with tubing (male)	007-3021-000
11	Regulators with tubing (female)	002-3011-000
	Datalogging Upgrade Option	008-001-000
6	ProRAE Suite software package, for Microsoft® Windows™ 95, 98, 2000, NT, ME & XP	000-5001-000
12	Computer interface cable	008-3003-000

*Different shipping cases are used for monitor-only and single calibration gas kits.

This is a complete kit, which includes the accessories and calibration kits with a MultiRAE Plus monitor that is datalog-enabled.



Read Before Operating

This manual must be carefully read by all individuals who have or will have the responsibility of using, maintaining, or servicing this product. The product will perform as designed only if it is used, maintained, and serviced in accordance with the manufacturer's instructions.

 **Caution!**

To reduce the risk of electric shock, turn off power before removing the monitor cover. Disconnect the battery before removing sensor modules for service. Never operate this monitor while the cover is removed. Remove monitor cover and sensor modules only in an area known to be non-hazardous.

 **Special Note**

When the MultiRAE Plus monitor is taken out of the transport case and is turned on for the first time, there may be some residual vapors trapped inside the monitor and the initial toxic gas sensors may indicate a few ppm. After running the monitor for several minutes in clean air, the residual vapors should clear and readings should return to near zero.

 **Attention! For European Applications**

- A. CE 0575  II 2G
DEMKO 03 ATEX 0308256X, EEx ia d IIC T3/T4
- B. Recharge batteries in non-hazardous locations.
- C. Do not connect external cable to serial interface jack in hazardous locations.
- D. Use RAE Systems Adapter P/N 500-0072 for connection to communication port and charging jack only in a non hazardous area.

Protected by U.S. Patents 5,393,979 , 5,561,344 ,
5,773,833 , 6,225,633 , 6,313,638 , 6,333,632 , 6,320,388

Warnings

For safety reasons this equipment must be operated and serviced by qualified personnel only. Read and understand the instruction manual completely before operating or servicing.

 **Battery Pack**

Use only RAE Systems battery packs, part number 500-0029 or 500-0037. This instrument has not been tested in an explosive gas/air atmosphere having an oxygen concentration greater than 21%. Substitution of components may impair intrinsic safety. Recharge batteries only in non-hazardous atmospheres.

 **Computer Interface**

Do not transfer data by means of the computer interface cable in hazardous atmospheres.

 **Static Hazard**

Clean only with a damp cloth.

 **Calibration**

The calibration of any newly purchased RAE Systems Instrument should be tested by exposing it to known concentration calibration gases before the instrument is put into service for the first time. For safety, check the accuracy of the monitor by exposing the sensors to known concentration calibration gas(es) before each day's use.

 **Readings**

Any rapid up-scale reading followed by a declining or erratic reading may indicate a gas concentration beyond upper scale limit, which may be hazardous.

Avertissements

Pour des raisons de sécurité, cet équipement doit être utilisé, entretenu et réparé uniquement par un personnel qualifié. Étudier le manuel d'instructions en entier avant d'utiliser, d'entretenir ou de réparer l'équipement.



Ensemble de Batterie

Utiliser seulement l'ensemble de batterie RAE Systems avec numéro de série 500-0029 ou 500-0037. Cet instrument n'a pas été essayé dans une atmosphère de gaz/air explosive ayant une concentration d'oxygène plus élevée que 21%. La substitution de composants peut compromettre la sécurité intrinsèque. Ne charger les batteries que dans l'emplacement désigné non dangereux.



Câble de Computer

Connecter pas le câble externe que dans environnements non dangereux.



Danger Risque D'origine Electrostatique

Nettoyer uniquement avec un chiffon humide.



La Calibration

La calibration de toute instruments de RAE Systems doit être testé en exposant l'instrument à une concentration de gaz connue par une procédure de talonnage avant de mettre en service l'instrument pour la première fois. Pour une sécurité maximale, la sensibilité du MultiRAE Plus doit être vérifié en exposant l'instrument à une concentration de gaz connue par une procédure de talonnage avant chaque utilisation journalière.



Les Lectures

Toute lecture rapide et positive, suivie d'une baisse subite au erratique de la valeur, peut indiquer une concentration de gaz hors gamme de détection qui peut être dangereuse.

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General Information

The MultiRAE Plus is a programmable multiple-gas monitor designed to provide continuous exposure monitoring of toxic organic and inorganic gases, oxygen and combustible gases for workers in hazardous environments.

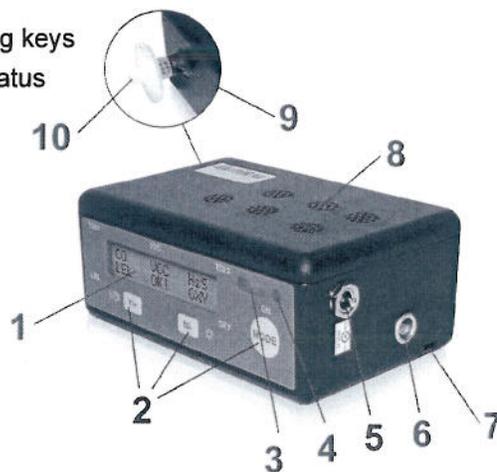
The MultiRAE Plus is an extremely flexible one-to-five sensor instrument for use in confined space, emergency response, industrial hygiene, and many other monitoring applications. The MultiRAE Plus is the only instrument available on the market today that can offer protection using both standard gas detection sensors for the detection of oxygen, combustible gas, and specific toxic gases, as well as an integrated Photo-ionization Detector (PID) for the ultimate broad-range toxic gas detection. The MultiRAE Plus is easily reconfigured and upgraded to meet your changing needs. Its versatility replaces a wide range of monitors, saving training, and maintenance costs. The MultiRAE Plus transitions quickly and easily from a sophisticated technician instrument to a simple text or display only monitor. The same monitor can be used as a personal monitor, a hand-held sniffer, or as a continuous operational area monitor.

Datalogging-Enabled Monitors

Datalog monitors are capable of storing datalog data in the instrument's non-volatile memory. When the version number appears during the power-on sequence, the "D" indicates a Datalog monitor. Call the factory to learn how to upgrade the instrument to a Datalog monitor.

Physical Description

1. Display
2. Operation/programming keys
3. Visual alarm/charge status
4. Light sensor
5. Power jack
6. RS-232 port
7. Wrist strap holder
8. Buzzer and gas outlet
9. Gas inlet
10. External filter



Operating the MultiRAE Plus

 The external filter must always be used with the monitor.

Turning the Monitor On and Off

To turn on, press . The monitor will beep once and go through a 90-second warm-up sequence as follows:

On! – English, PGM-50

Multi-Gas Monitor, Software Version

RAE Systems, Inc. (customizable using ProRAE Suite software)

Monitor Type, Serial Number

Date, Time, Temperature

Checking Sensor ID's (As the MultiRAE Plus checks each sensor, it displays the date it was last calibrated and its warranty expiration date. If a new sensor is installed, it will ask for it to be calibrated.)

Alarm Limits (for High, Low, STEL, TWA)

Instrument Calibration (The last calibration date must be within the last 30 days for safe operation.)

Battery Shut Off Voltage

User Mode

Alarm Mode

Datalog Memory

Datalog Time Left

Datalog Mode

Datalog Period

To turn off after the warm-up is complete, press and hold  for 5 seconds. The monitor beeps each second during the count-down sequence. Release when "Off!" flashes on the LCD. Plug the 110 VAC/12 VDC transformer into the monitor when not in use; the "Charging....." message appears on the screen.

User Modes

The MultiRAE Plus has three user modes: **Text**, **Display**, and **Advanced**. Each mode provides a different level of access to the monitor's features. Text mode is the simplest mode, Advanced mode is the most complex.

The table shows the features in the order in which they appear. Regardless of which user mode the monitor is in, press  to advance to the next available feature.

Features	Text Mode	Display Mode	Advanced Mode
Sensor Names & Instantaneous Readings - instantaneous readings are the actual gas concentrations for the following sensors: TOX1 (toxic gas) – parts-per-million (ppm) TOX2 (toxic gas) – ppm VOC (volatile organic compound) – ppm LEL (lower explosive limit) – percentage OXY (oxygen) - percentage	yes (with "OK" on LCD)	yes	yes
PEAK - the highest reading for each gas concentration since the monitor was turned on; updated every second.	no	yes	yes
MIN - the lowest reading for each gas concentration since the monitor was turned on; updated every second.	no	yes	yes
STEL - the Short Term Exposure Limit for VOC and toxic gases only; the average reading of the gas concentration for the last 15 minutes, which is updated every minute. NOTE: "*****" will appear for the first fifteen minutes.	no	yes	yes
TWA - the Time Weighted Average for VOC and toxic gases only; the accumulated reading of the gas concentration, divided by 8 hours, since the monitor was turned on. Updated every minute.	no	yes	yes

<p>Battery Voltage - the current battery voltage, measured in volts.</p> <p>Shut off - A fully charged battery will be 4.8 V or greater. When the battery voltage falls below 4.4 V, the "Bat" warning message appears and only 20-30 minutes of run time remain before the instrument will automatically shut down (at 4.2 V).</p>	yes	yes	yes
<p>Date & Time, Run-Time and Temp - the runtime is how long the instrument has been on in hours and minutes.</p>	no	no	yes
<p>Start/Stop Datalog - turns manual datalogging on/off.</p>	no	no	yes
<p>LEL Gas - monitor measures LEL in units of specified target gas. NOTE: Correction factor may only be changed in Program Mode.</p>	no	no	yes
<p>VOC Gas - monitor measures VOC in units of specified target gas. NOTE: Correction factor may only be changed in Program Mode.</p>	no	no	yes
<p>Print Reading - capable of printing out the gas concentration readings if a serial printer is connected to the instrument. NOTE: This feature can be turn on using ProRAE Suite.</p>	no	yes	yes
<p>PC Communication - capable of uploading data from the monitor to a computer or downloading configuration information from a computer to the monitor via a serial port.</p>	yes	yes	yes

Calibrating the Monitor

⚠ While all instruments are calibrated prior to leaving the factory, temperature extremes and/or shocks during shipment can cause sensor drift. Therefore, the accuracy of any newly purchased RAE Systems monitor should be tested by exposing the sensor(s) to known concentration calibration gas before the monitor is used or put into service. For maximum safety, the accuracy of the monitor should be checked by exposing the sensor(s) to known concentration calibration gas before each day's use.

When should you calibrate the monitor?

The monitor should be calibrated no less than every 30 days, or if it does not pass a fresh air reading, or if it does not pass a field verification.

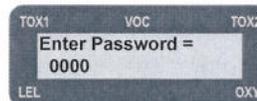
Calibration

The sensors are calibrated in a two-step process using fresh air and span gas (a span gas contains a known concentration of a given gas). Some sensors may show sensitivity to other gases - this is called "cross sensitivity". Therefore, it is important to choose the gas mixture carefully. We recommend the standard RAE Systems MultiRAE Plus 4-gas calibration mix (50% LEL methane, 20.9% oxygen, 25 ppm H₂S, 50 ppm CO in a single gas cylinder) to calibrate the LEL, H₂S and CO sensors, and isobutylene (100 ppm) for the PID. You will also need a calibration adapter in order to connect the monitor (with external filter!) to the outlet of the gas cylinder. For the calibration of other toxic sensors, you will need the specific gas for that sensor.

Getting Started

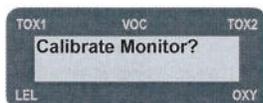
To calibrate the monitor, the instrument must be in Program Mode. To enter Program Mode, press and hold **MODE** and **N/-** for 5 seconds.

If the monitor is in Text or Display Mode, you will be prompted for a password. Use **Y/+** to change the number. Use **MODE** to move on to the next digit. The default password is "0000". Press and hold **MODE** to submit the password.



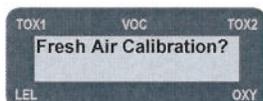
Fresh Air Calibration

The first step of calibration is a Fresh Air Calibration:



Calibrate Monitor?

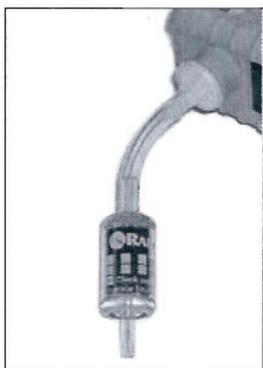
Press **Y/+** .



Fresh Air Calibration?

Press **Y/+** .

The monitor will cycle through each sensor. When the process is complete, the display will read, "Zero Cal Complete!".



Zero Organic Filters for Zeroing PID

Use an optional external zero organic filter (P/ N 008-3024-000, 3-pack) when the ambient air may be contaminated with hydrocarbons.

Attach the filter to the MultiRAE Plus during fresh air calibration. The filter can be used up to 20 times before disposing. This filter removes most heavier organic and inorganic compounds, but may not completely remove lighter compounds such as methane, propane, and CO.

Span Gas Calibration

To complete step two of calibration, a Span Gas Calibration must be performed for each sensor.

The instructions below are for a standard confined space entry instrument utilizing CO, H₂S, LEL, Oxygen sensors.

For this calibration you will need the standard RAE Systems MultiRAE Plus 4-gas calibration mix (50% LEL methane, 20.9% oxygen, 25 ppm H₂S, 50 ppm CO in a single gas cylinder). For the calibration of other toxic sensors, or to calibrate a single sensor, please go to the Program Mode section of this manual.

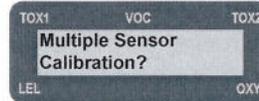
Multiple Sensor Calibration

Press **Y/+**.

The monitor will assume you want to calibrate the CO, H₂S, LEL and Oxygen sensors.

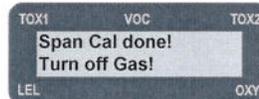
Press **Y/+**.

Apply the RAE Systems 4-gas span gas mixture and start the gas flow.



The 60-second countdown timer appears.

"Span Cal Done! Turn Off Gas" message appears. The readings should be very close to the span gas values shown on the gas cylinder.



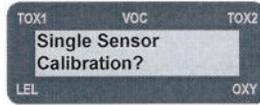
Turn off the gas flow and disconnect the calibration adapter from the monitor. If calibration fails, an error message appears instead. Refer to *Troubleshooting: "Calibration Error Message"* on page 38.

NOTE: If calibration is accidentally started and gas has run out or has been disconnected, press **MODE** repeatedly. Calibration will stop and revert back to the previous calibration values.

Calibrating the PID Sensor

The single sensor method used to calibrate the PID can also be used to calibrate single toxic sensors. For the PID, use isobutylene (100ppm) span gas. For other toxic sensors, use the appropriate gas, e.g., ammonia sensor - use ammonia gas, etc.

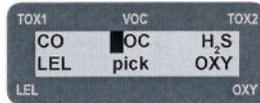
Single Sensor Calibration



Press **Y/+**.

When the installed sensors appear on the display use **MODE** to move from sensor to sensor.

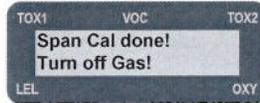
Press **Y/+** to select the highlighted sensor and start calibration.



Apply span gas mixture and start gas flow.

The 60-second countdown timer appears.

NOTE: Some sensors (Cl_2 , PH_3 , NH_3 , HCN) require a special “presoak” period prior to starting calibration. Turn the gas on to the MultiRAE Plus for this time period. **Refer to Range, Resolution and Response Time chart on page 41 BEFORE starting the calibration procedure.** When calibration has started and if the MultiRAE Plus displays “No gas flow...” apply gas or hit any key to start. Press **Y/+** to start calibration.



Calibration is complete when the sensor name and its span value appear, confirmed by a “Span Cal Done! Turn Off Gas” message. If no gas has reached a sensor after sixty seconds, calibration will abort. The readings should be relatively close to the span gas values.

Turn off the gas flow and disconnect the calibration adapter from the monitor. If calibration fails, an error message appears instead. *Refer to Troubleshooting: “Calibration Error Message” on page 38.*

Calibration Time Stamp

A time stamp is created and stored each time a sensor calibration is performed, which is included in the datalog report.

Press **MODE** twice to exit calibration mode and return to the main display.

NOTE: Residual gas may linger on the sensors for up to 60 seconds.

If the sensors do not return to zero, repeat fresh air calibration.

MultiRAE Plus Usage Overview

Storage

Always keep the MultiRAE Plus on charge in a dry indoor area when not in use.

 **If the MultiRAE Plus is to be stored more than 2 weeks off the charger, it is recommended to remove the Li-ion battery. Upon reinstalling the battery, it will need a complete charge and some sensors (like NO and NH₃) may require time to warm up, anywhere from 20 minutes to 24 hours. Refer to Technical Note-114 Sensor Specifications and Cross Sensitivities. The clock will also need to be reset.**

Confined Space Pre-Entry Test

Test the atmosphere in the confined space by sampling air at 3 levels (Top, Middle and Bottom) in the Confined Space. Give the instrument time to sample the gas at each level - the correct sampling time is 60 seconds plus 1 second per every foot of hose.

Alarms

If there are any gas **ALARMS** at any level in the confined space it is not safe. **DO NOT ENTER!**

Identify the alarm condition and then start your preventive actions according to your company's Confined Space Entry procedures.

No Alarms

If there are no alarms, the Confined Space may be safe for entry. Disconnect the hose before carrying the MultiRAE Plus into the Confined Space. If monitoring is to be done by a Confined Space attendant, they should continue to monitor while you enter the area.

If the unit alarms and "BAT" is displayed, the battery needs to be charged. There is 15 minutes or less of run time remaining. **Leave the Confined Space immediately!** See the *Applications and Technical Notes Guide* for more information regarding Confined Space Entry and other applications.

After Usage

Turn the MultiRAE Plus off by pressing and holding . The buzzer will beep and count down 5-4-3-2-1 and read "OFF". Return the MultiRAE Plus to the dry, indoor storage area and connect the charger to the MultiRAE Plus.

Alarm Signals

When an alarm condition occurs, the monitor will provide audible and visual alarms to alert users of unsafe conditions. *Refer to the Alarm Signals table on page 11 for a complete list of alarm conditions.*

 **The alarm signals are disabled while in the following modes: Communicate with PC, Print Reading, Calibrate Monitor. To reduce the risk of exposure to hazardous atmospheres, use these modes only in an area known to be non-hazardous.**

The alarm system can be set up in one of two ways:

Auto Reset Alarm (default): The alarm signals automatically reset when the alarm condition is no longer present. **NOTE:** Not all alarm conditions have this option.

Latched Alarm: The alarm signal remains on even when the alarm condition is no longer present; press  to acknowledge and reset alarm signals.

Testing Alarm Signals

Press  . If functional, the buzzer will beep once and the backlight will flash once.

Alarm Condition	Alarm Signal			Screen Message	Reset Alarm
	beep/sec	flash/sec	vibration*		
Gas concentration exceeds High Alarm	3	3	yes	sensor name "HIGH"	move away from gas
Gas concentration exceeds Low Alarm	2	2	yes	sensor name "LOW"	move away from gas
Gas concentration exceeds STEL	1	1	yes	sensor name "STEL"	move away from gas & wait 15 minutes
Gas concentration exceeds TWA	1	1	yes	sensor name "TWA"	move away from gas & turn unit OFF/ON
Gas concentration exceeds sensor range	3	3	yes	sensor name "OVR"	move away from gas
Unit short circuits or Reading over max range	3	3	yes	sensor name "MAX"	indicates possible sensor failure. calibrate sensor to verify performance
Excessive sensor negative drift	1	1	yes	sensor name "NEG"	perform zero calibration
Blocked inlet or Pump failure	3	3	yes	"PUMP"	unblock inlet; press (Y/+) to restart pump
PID lamp fails to light	3	3	yes	"LAMP"	turn off/on or wait; lamp may turn on by itself
Excessive LEL gas or LEL sensor is OFF	3	3	yes	sensor name "OFF"	move away from gas & turn LEL sensor ON (press (Y/+))
Low battery	1/min	1/min	no	"Bat"	charge battery
Datalog memory full	1	1	yes	"Mem"	clear datalog memory or turn on "wrap-around"
Datalog memory write error	1	1	yes	"EEm"	turn unit OFF/ON

*The external vibration alarm is an optional feature.

Preset Alarm Limits and Calibration

The monitor is factory calibrated with standard calibration gas and is programmed with default alarm limits as listed:

Gas	Cal Gas/Balance	Unit	TWA	STEL	Low	High
CO	50/Air	ppm	35	100	35	200
H ₂ S	25/N ₂	ppm	10	15	10	20
SO ₂	5/N ₂	ppm	2	5	2	10
NO	25/N ₂	ppm	25	25	25	50
NO ₂	5/Air	ppm	1	1	1	10
Cl ₂	10/N ₂	ppm	0.5	1	0.5	5
O ₂	20.9/N ₂	%Vol	-	-	19.5	23.5
CH ₄	50/Air	%LEL	-	-	10	20
HCN	10/N ₂	ppm	5	5	5	50
NH ₃	50/N ₂	ppm	25	35	25	50
PH ₃	5/N ₂	ppm	0.3	1	1	2
VOC*	100/Air	ppm	10.0	25.0	50.0	100

*Note: 100 ppm isobutylene gas is used for VOC gas calibration

Back Light

The backlight assists reading the LCD in poor lighting conditions and automatically turns on anytime the MultiRAE Plus is in alarm.

To manually turn on, press , and it will automatically turn off after 60 seconds. The backlight can also be set to automatically turn on in low lighting conditions, and likewise turn off in adequate lighting conditions.

NOTE: The backlight can shorten the operating time by 20-30%.

Sampling Pump

The integrated sampling pump automatically turns on when the monitor is turned on and remains on during normal operation. The pump speed is adjustable between the default low setting (~200 cc/min) and the high setting (~300 cc/min). Use the low setting to save battery and filter life. Use the high setting for reactive gases and remote sampling in applications like Wingtank entry and HazMat.

The monitor can detect any obstructions in the external filter that causes a pump stall. The alarm will activate and a “Pump” error message will appear. To acknowledge the pump stall, press **Y/+** to start the pump again.

Refer to Pump Stall on page 29 for details on how to adjust the pump stall threshold for either the high or low settings.

Datalogging

A small “L” at the center of the screen means the monitor is datalogging. Datalogging-enabled monitors can calculate and store hours of gas readings based on the time-interval and type of gas measurement specified. The time-interval can be set to between 1 and 3600 seconds in 1-second increments. The average and peak gas concentrations are the two types of gas measurements that can be stored for each sensor. **NOTE:** STEL and TWA values will only be logged if average is selected. All data is stored in non-volatile memory that can be downloaded to a computer. Users may select one of two types of memory storage: wrap-around or stop. *Refer to Select Memory Full Type on page 23.*

NOTE: Datalogging pauses upon entering Program Mode or PC Communication Standby Mode. Upon exiting Program Mode datalogging will resume. Upon exiting PC Communication Standby Mode, datalogging will resume only if datalogging mode was set to “Automatic”.

Maximum Datalog Time for 5 Sensors

Log Interval	1 sec	60 sec	300 sec (5 min)
Tmax	80 minutes	80 hours	400 hours

Datalog Options

Automatic: Datalogging automatically starts/stops when the monitor is turned on/off.

Manual: If the MultiRAE Plus is in Advanced mode, press **Y/+** at the “Start Datalog” screen. Set a timer to specify the maximum datalogging time using ProRAE Suite software.

Periodic: Set a daily start/stop time to datalog using ProRAE Suite.

Scheduled: Set a monthly start/stop time to datalog using ProRAE Suite.

Charging the Battery Pack

To charge the battery pack plug the transformer supplied with the monitor into the power jack on the monitor.

When a Li-Ion battery pack is installed, charging automatically begins. The LED appears red during charging, and once the battery is fully charged, the LED turns green. The display also indicates the charge status. A completely drained battery pack charges to full capacity in less than 10 hours. When the "Bat" message appears on the LCD, the battery pack needs to be recharged.

NOTE: A fully charged battery pack will switch to trickle charge to maintain battery life. Repeatedly turning the power to the transformer on and off will reset the charge and possibly burn out the battery.

To change the battery pack or to use the alkaline battery adapter, *refer to Replacing the Battery Pack or Emergency Alkaline Battery Adapter on page 32.*

 **If the MultiRAE Plus is to be stored more than 2 weeks off the charger, it is recommended to remove the Li-ion battery.**

Accessories

External Filters

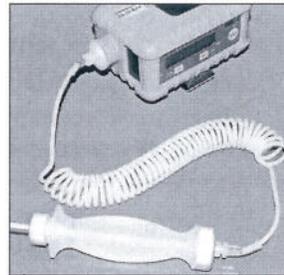
The external filter is a PTFE (Teflon®) membrane with a 0.2 micron pore that reduces the amount of liquid and dust that can contaminate the sensor. Using the external filter prolongs sensor and pump life.

Change the external filter whenever it becomes discolored, clogged with particles, or draws in liquid.

NOTE: Do not use the external filter when calibrating reactive gases. Instead, use the High Pump Speed setting and a short Teflon® tube. Although this shortens battery life, it provides a faster response.

Remote Sampling Probe

When searching in hard-to-reach areas, use the standard remote sampling probe (P/N 008-3015-200) with a telescoping handle and 6 feet of Teflon tubing. For longer distances, attach a length of Teflon tubing. The monitor is capable of drawing samples from over 100 feet.



Optional Dilution Fitting

When gas samples have less than 10% oxygen, the dilution fitting (P/N 008-3025/3026) will increase the oxygen concentration. The dilution fitting can also measure combustible, VOC or toxic gases when the concentration exceeds the upper limit of the sensor range. In Program Mode, set the dilution ratio to obtain the correct gas reading when the dilution fitting is used. The dilution fitting attaches directly to the meter and the sample tubing attaches to the dilution fitting. *Refer to Technical Note-167 Proper Use of Dilution Fittings on Pumped Monitors for more information.*

⚠ The monitor and the dilution air inlet must be located in a clean atmosphere outside the confined space. Use either a remote sampling probe or Tygon tube test gas samples.

Calibration Adapter

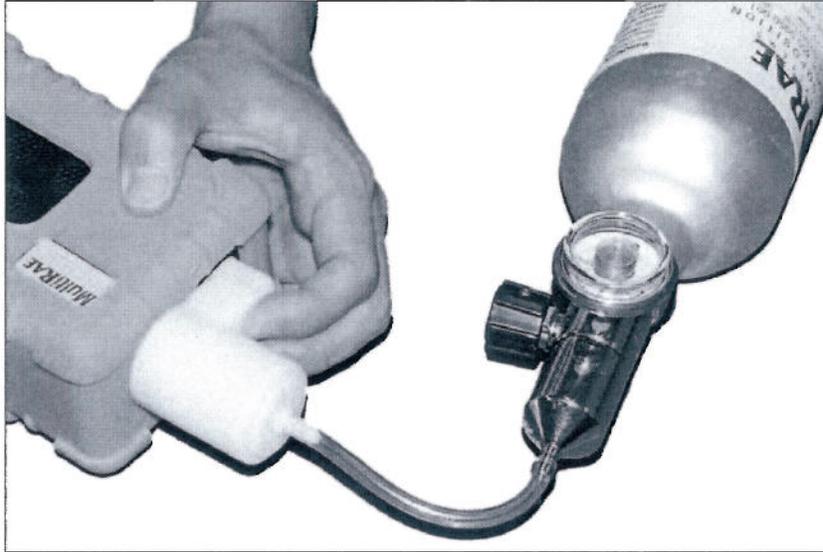
The calibration adapter is a 6-inch Tygon tube with a male Luer connector on the end. During calibration, connect one end of the tube to the external filter (on the monitor) and the other end to the calibration gas.



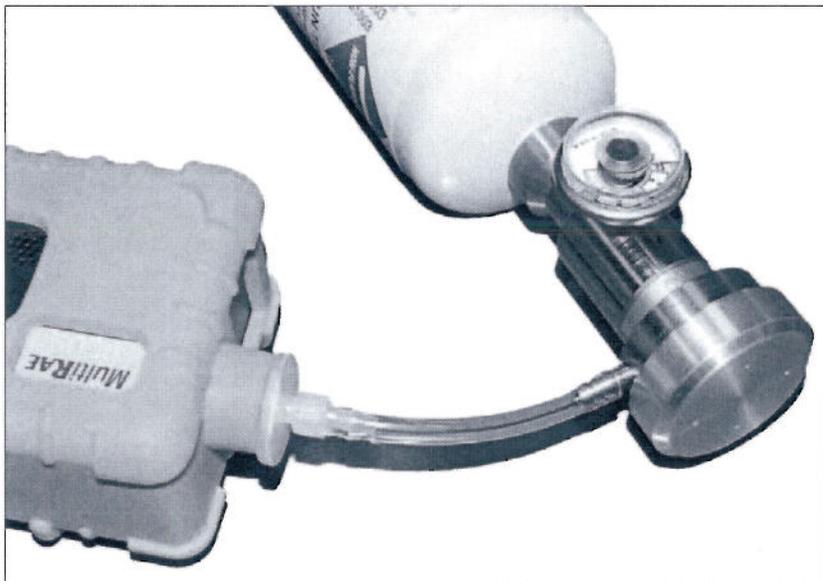
Alternatively, the calibration gas can be sampled from:
an optional **Tedlar gas bag** (P/N 500-0003-000) filled with calibration gas,



an optional **open cup** (P/N 007-3002-000) with calibration gas flow exceeding the pump demand,



or an optional **demand flow regulator** (P/N 002-3051-000, female or P/N 008-3052-000, male) directly from the gas cylinder.

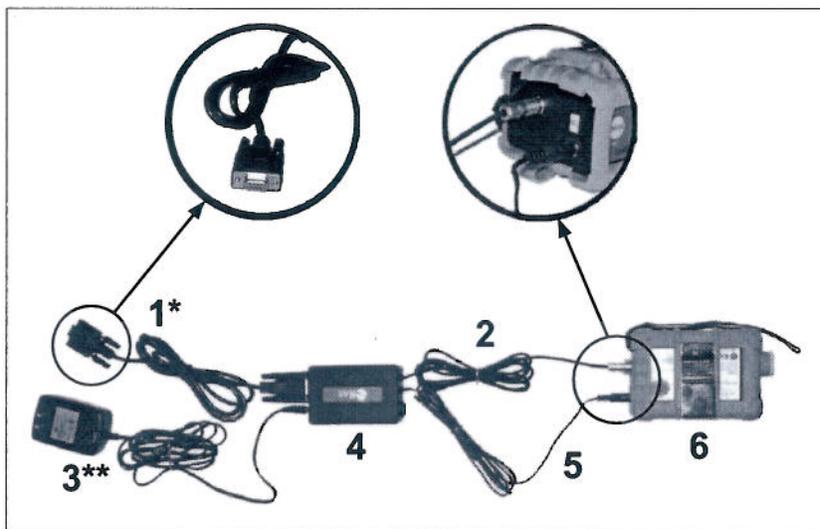


Using the Intrinsically Safe Barrier Box

⚠ This does NOT ship with UL/cUL-approved monitors. The barrier box is only for ATEX European approved MultiRAE monitors.

To conform to ATEX European safety standard, the barrier box **must be used** when utilizing an RS-232 cable and/or transformer.

1. RS-232 cable (detachable)*
2. Computer interface cable
3. Transformer (detachable)**
4. Intrinsically safe barrier
5. Power cable
6. MultiRAE Plus monitor



Communicating with a Computer

* This connection is not necessary during normal charging.

Connect the RS-232 cable from the barrier box to the monitor.

Connect the computer interface cable to the barrier box.

Plug the computer interface cable into a computer.

Charging the Monitor

** Connection is optional during computer communication.

Connect the power cable from the barrier box to the monitor.

Connect the transformer to the barrier box.

Plug the transformer into an appropriate outlet.

Programming Mode

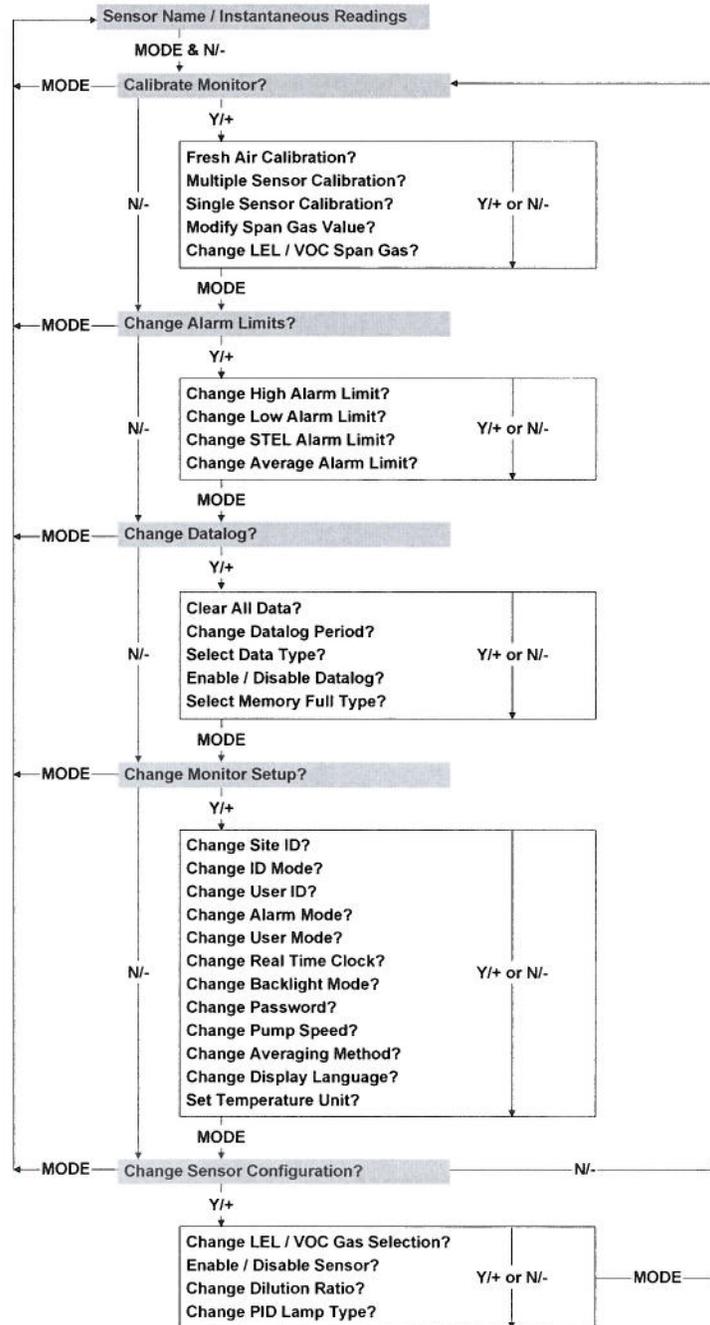
In addition to calibration, authorized users may change the monitor settings to their requirements using the Programming Mode.

NOTE: Monitoring gas concentrations continues during Programming Mode, but pauses during Calibration. Datalogging also pauses during Programming Mode, but resumes when programming is finished.

Press 	for desired menu to answer "no" to decrease a digit
Press 	for desired submenu to answer "yes" to increase a digit
Press 	to return to the sensor name/ instantaneous reading display to exit a submenu to advance digits

To enter the Program Mode, press  and  together until the first program menu appears: "Calibrate Monitor?" Refer to *Getting Started on page 5*. The figure on the following page summarizes the programming menus and how to navigate through them.

Programming Menus



Security Levels

Security levels are setup via computer using ProRAE Suite. The default password is: 0000. **NOTE:** For security purposes "0000" always appears instead of actual password.

No changes will be saved unless the user is in the correct mode with the correct security level.

User Mode Security Level	Text			Display			Advanced		
	0	1	2	0	1	2	0	1	2
Calibrate Monitor?									
Fresh Air Calibration?	✓*	✓*	✓*	✓*	✓*	✓*	✓	✓*	✓
Multiple Sensor Calibration?	✓*	✓*	✓*	✓*	✓*	✓*	✓	✓*	✓
Single Sensor Calibration?	✓*	✓*	✓*	✓*	✓*	✓*	✓	✓*	✓
Modify Span Gas Value?	✓**	✓*	✓*	✓**	✓*	✓*	✓#	✓*	✓
Change LEL/VOC Span Gas?	✓**	✓*	✓*	✓**	✓*	✓*	✓#	✓*	✓
Change Alarm?									
Change High Alarm Limit?	✓**	✓*	✓*	✓**	✓*	✓*	✓#	✓*	✓
Change Low Alarm Limit?	✓**	✓*	✓*	✓**	✓*	✓*	✓#	✓*	✓
Change STEL Alarm Limit?	✓**	✓*	✓*	✓**	✓*	✓*	✓#	✓*	✓
Change Average Alarm Limit?	✓**	✓*	✓*	✓**	✓*	✓*	✓#	✓*	✓
Change Datalog?									
Clear All Data?	✓*	✓*	✓*	✓*	✓*	✓*	✓	✓*	✓
Change Datalog Period?	✓**	✓*	✓*	✓**	✓*	✓*	✓#	✓*	✓
Select Data Type?	✓**	✓*	✓*	✓**	✓*	✓*	✓#	✓*	✓
Enable/Disable Datalog?	✓*	✓*	✓*	✓*	✓*	✓*	✓	✓*	✓
Select Memory Full Type?	✓*	✓*	✓*	✓*	✓*	✓*	✓	✓*	✓
Change Monitor Setup?									
Change Site ID?	✓*	✓*	✓*	✓*	✓*	✓*	✓	✓*	✓
Change ID Mode?	✓*	✓*	✓*	✓*	✓*	✓*	✓	✓*	✓
Change User ID?	✓*	✓*	✓*	✓*	✓*	✓*	✓	✓*	✓
Change Alarm Mode?	✓**	✓*	✓*	✓**	✓*	✓*	✓#	✓*	✓
Change Alarm Mode?	✓**	✓*	✓*	✓**	✓*	✓*	✓#	✓*	✓
Change User Mode?	✓**	✓*	✓*	✓**	✓*	✓*	✓#	✓*	✓
Change Real Time Clock?	✓**	✓*	✓*	✓**	✓*	✓*	✓#	✓*	✓
Change Backlight Mode?	✓*	✓*	✓*	✓*	✓*	✓*	✓	✓*	✓
Change Password?	✓**	✓*	✓*	✓**	✓*	✓*	✓#	✓*	✓
Change Pump Speed?	✓**	✓*	✓*	✓**	✓*	✓*	✓#	✓*	✓
Change Averaging Method?	✓**	✓*	✓*	✓**	✓*	✓*	✓#	✓*	✓
Change Display Language?	✓**	✓*	✓*	✓**	✓*	✓*	✓#	✓*	✓
Set Temperature Unit?	✓**	✓*	✓*	✓**	✓*	✓*	✓#	✓*	✓
Change Sensor Configuration?									
Change LEL/VOC Gas Selection?	✓**	✓*	✓*	✓**	✓*	✓*	✓#	✓*	✓
Enable/Disable Sensor?	✓*	✓*	✓*	✓*	✓*	✓*	✓	✓*	✓
Change Dilution Ratio?	✓**	✓*	✓*	✓**	✓*	✓*	✓#	✓*	✓
Change PID Lamp Type?	✓**	✓*	✓*	✓**	✓*	✓*	✓#	✓*	✓

* Need password

No change allowed

Calibrate Monitor

Fresh Air Calibration? Refer to *Calibrating the Monitor* on page 5.

Multiple Sensor Calibration? Refer to *Calibrating the Monitor*.

Single Sensor Calibration? Refer to *Calibrating the Monitor*.

Oxygen Sensor Calibration: The oxygen sensor calibration is slightly different from other sensors; span calibration at 20.9% O₂ is performed during fresh air calibration. During single sensor calibration, the oxygen sensor can be calibrated to 0% O₂ with pure nitrogen gas, by pressing **Y/+** when asked "0%? Oxygen?" To calibrate at a different concentration specified in Modify Span Gas Value, press **N/-**.

NOTE: After a single sensor oxygen calibration, perform fresh air calibration to ensure the oxygen sensor is calibrated correctly.

Modify Span Gas Value?

The span gas is the second point of reference for calibration. Users may modify the span values of the standard calibration gases to use other calibration gases. However, DO NOT modify the span values when using the RAE Systems calibration gas supplied with the monitor.

Change LEL/VOC Span Gas?

Change the type of calibration gas from methane (LEL) and isobutylene (VOC) to be used as the span gas during LEL or VOC gas calibration. However, DO NOT modify the span gases when using the RAE Systems calibration gas supplied with the monitor.

Change Alarm Limits

Users may change the alarm limits for each sensor. Use **N/-** to cycle through the submenu options. Press **Y/+** to enter a submenu. To modify the limit, use **Y/+** and **N/-** to change the value. Use **MODE** to move from character to character.

To escape the submenu without saving changes, press **MODE**. To save, press **MODE** until "Save?" appears. Press **Y/+** to save changes, otherwise press **N/-** to discard changes.

Change High Alarm Limit?

Change Low Alarm Limit?

Change STEL Alarm Limit? (Short Term Exposure Limit)

Change Average Alarm Limit? (TWA – Time Weighted Average)

Change Datalog Setting

The monitor calculates and stores the gas readings at specified intervals, which can be reviewed by the user. Users may also program additional datalog options for the monitor through the computer.

Clear All Data?

Erase all data stored in the non-volatile memory, but does not delete the PEAK, MIN, STEL, TWA displayed values, which are stored separately.

Change Datalog Period?

Program the datalog period from 1 second to an hour (3,600 seconds).

Select Data Type?

Store either the average (TWA) or peak value for each datalog interval. If peak values are selected, average values like STEL and TWA will not be selected.

Enable/Disable Datalog?

Enable or disable the datalogging function for each sensor. If a * is displayed next to a sensor name, data will be recorded. Use **MODE** to move from sensor to sensor. An asterisk (*) means the sensor is enabled; no asterisk means the sensor is disabled. Press **Y/+** to select or press **N/-** to deselect. To save changes, press **MODE** until "Save?" appears. Then press **Y/+** to accept. Otherwise, hold **MODE** to escape and cancel changes.

Select Memory Full Type?

The instrument's memory can store about 3 days' worth of data, as a result of continuous monitoring at 1-minute intervals. Users may select one of two types of memory storage:

Wrap-around: after the memory becomes full, the latest data overwrites the oldest data. e.g. the most recent 3 days' worth of data is stored.

Stop: halts datalogging when the memory is full, and the "MEM" alarm sounds. e.g. the first 3 days' worth of data is stored.

Change Monitor Setup

Change the monitor setup or enter user information for the monitor. Use **MODE** to move the cursor from character to character. Use **Y/+** and **N/-** to toggle up and down the alphabet and numbers. To save, press **MODE** until "Save?" appears. Press **Y/+** to save changes, otherwise, press **N/-** to discard changes. To escape this menu without saving changes, press and hold **MODE**.

Change Site ID?

Enter an eight-character alphanumeric site identification, which is included in datalog reports.

Change ID Mode?

Set up an identification code to use during start-up or to access a previously saved customized ID.

Change User ID?

Enter an eight-character alphanumeric user identification, which is included in datalog reports.

Change Alarm Mode?

Choose either latched or automatic reset. The user must manually acknowledge a latched alarm by pressing **Y/+**.

Change User Mode?

The three different user modes are: Text, Display and Advanced.

Change Real Time Clock?

Change or update the real time clock and calendar.

Change Back Light Mode?

Automatic – the monitor turns the back light on/off when ambient light falls below/above the threshold or **Manual** – press **N/-** to turn the back light on/off.

Change Password?

Modify the password.

Change Pump Speed?

Low – (default) use when operating conditions are slow to change; prolongs pump motor life, LEL sensor life and battery run time.

High – use for long lengths of tubing or when rapid changes in input conditions are expected, such as HazMat response or when used for measuring heavy, low vapor pressure compounds like jet fuel.

Change Averaging Method?

Choose: **TWA** (default) – an eight-hour Time Weighted Average or **AVG** – the running average

Change Display Language?

Choose English or Spanish.

Set Temperature Unit?

Choose Celsius or Fahrenheit to measure temperature.

Change Sensor Configuration

Change LEL/VOC Gas Selection?

Choose an LEL or VOC gas listed in the monitor to calculate its correction factor relative to the LEL or VOC calibration gas. *Refer to Correction Factors on page 26.* The correction factor allows the unit to display the equivalent concentration of the selected LEL or VOC gas. To create a custom factor for a specific gas or mixture of gases, modify the relative correction factor to increase or decrease the gas reading.

Enable/Disable Sensor?

Enable or disable sensor(s); a disabled sensor will not measure or display the gas concentration. Use if a sensor has failed or is providing erroneous readings. Use **MODE** to move from sensor to sensor. An asterisk (*) means the sensor is enabled; likewise, no (*) means the sensor is disabled. Press **Y/+** to select or press **N/-** to deselect. To save changes, press **MODE** until "Save?" appears. Then press **Y/+** to accept. Otherwise, hold **MODE** to escape and cancel changes.

Change Dilution Ratio?

Attach an optional dilution fitting on the gas inlet port to dilute the gas sample. Enter a dilution ratio (from 1 to 10) to compensate the reading for the actual gas concentration.

Change PID Lamp Type?

This only applies to PID monitors. The PID sensor can utilize either a 10.6 eV or an 11.7eV UV. Since each lamp type has a different correction factor table, it is important to select the correct lamp type.

Correction Factors

VOC and LEL sensors respond to a broad range of gases and show a different sensitivity to different gases; correction factors allow measurement of a specific gas (the measurement gas) while using a different gas for calibration (the calibration gas). The correction factor (CF) for a measurement gas is defined as:

$$\text{CF} = \text{Sensitivity to a Calibration Gas} \div \text{Sensitivity to a Measurement Gas}$$

To convert the monitor reading of the calibration gas to the true concentration of a measurement gas, use the following equation:

$$\text{True Concentration (ppm)} = \text{CF} \times \text{Monitor Reading (ppm)}$$

The monitor has three sets of correction factors, one for the LEL and two for the VOC (10.6 eV and 11.7 eV) Each set consists of 20 to 40 different gases. Specify the PID lamp type (e.g. 10.6 eV or 11.7 eV) to access the proper VOC correction factor.

To set up a correction factor, first choose a calibration gas in the Calibrate Monitor program menu and then choose a measurement gas in the Change Sensor Configuration menu. If the calibration gas is different from methane for LEL or isobutylene for PID, then the new CF is calculated and the displayed value will be different from the values in Technical Notes 106 or 156.

NOTE: Correction factors provide an estimate of the measurement gas concentration. For greatest accuracy, it is necessary to calibrate the LEL or VOC sensor directly with the measurement gas.

Refer to Technical Note-106 Correction Factors and/or Technical Note-156 LEL Correction Factors.

Diagnostic Mode

The monitor is equipped with a diagnostic mode that can display critical, low level parameters to help users identify problems. *Refer to Troubleshooting on page 38.*

 The diagnostic mode allows the user to set several low level parameters which are very critical to the operation of the monitor. Extra care should be taken when setting these low level parameters. If the user is unfamiliar with these parameters and sets them incorrectly, it may cause the monitor to shut down or malfunction. The diagnostic mode should only be used by qualified personnel.

To switch the monitor to diagnostic mode, turn the monitor off.

Press and hold  and  together; release both keys when the unit beeps. The monitor is now in diagnostic mode.

Press  until the desired diagnostic parameter appears:

Sensor Name and Raw Sensor Readings

If a sensor is programmed and is properly installed, the sensor name should appear. If the sensor name does not appear, then the sensor may be improperly programmed or defective. The raw sensor reading is the uncalibrated output for each sensor. When fresh air is applied, the raw sensor readings should be 200 to 700 for toxic gas and VOC sensors; 100 to 1300 for the LEL sensor; and 1200 to 2300 for the oxygen sensor. When calibration gas is applied, the raw sensor readings should increase or decrease by the amounts listed in Technical Note - 123 Special Diagnostic Modes. If the raw sensor readings are outside the normal range or do not change when gas is applied, the sensor or monitor may be defective.

RF Test (Radio Frequency)

This feature applies when the monitor is used with the RAELink Remote package. The RF test shows the successful rate of communication.

Adjust Lamp Failure Threshold

If the lamp physically appears fine, but the "Lamp" error message appears during normal operation, the lamp failure threshold may be set too high.

To adjust the level:

Turn the monitor on in diagnostic mode and go to the "Lamp = xxx, Fail = yyy +/-" display. ("xxx" is the lamp current reading; "yyy" is the value of the lamp failure threshold.)

Decrease the "yyy" value until it is about 10 counts below the "xxx" value. Press  to exit.

Then press  to save changes, or press  to discard changes.

Battery Type and Bias

The type of battery (Lithium-Ion battery pack or alkaline battery adapter) used to charge the monitor is displayed. Some toxic gas sensors require a bias voltage of a few hundred millivolts for the sensor to function properly. These include NO and NH₃ sensors.

To manually switch the bias voltage supply on, *refer to Special Bias Voltage for Toxic Sensors on page 35.*

Install a biased sensor in the TOX1 socket. If the bias voltage is switched on, the bias reading should be below 182, otherwise it may be defective.

Show x1 and x10 Range of PID Sensor (PID detectors only)

The PID sensor is connected to two amplifiers with two different gains: unity gain and gain of ten; these are the raw outputs of both amplifiers. When fresh air is applied, both amplifier outputs should be 200 to 500. When a VOC gas is applied, both amplifier outputs should increase; the amount of increase for the unity gain (x1) should be 1/10 of the increase for the gain of ten (x10). If the increase does not agree with the expected value, then the gain switch of the amplifier may be defective.

Display Contrast

Press  to increase the contrast and  to decrease the contrast. The LCD contrast bar indicates the current setting. If the display appears to have dark lines, press  a few times to see the display more clearly. **NOTE:** In extreme temperatures, the display may fade or bleed out.

LEL Power

The top line indicates the instantaneous reading of raw counts from the LEL sensor. The bottom line shows if the LEL sensor is on or off. Press  to turn the power off, and press  to turn the power on.

Clock, Time, Battery, and Temperature

This display shows the real time clock, the date, the battery voltage in raw count and temperature sensor reading.

Sensor Expiration Date

The expiration date (month and year) for each installed sensor is based on the manufacturing date and expected life of each sensor. If the current date exceeds the expiration date for any sensor, the performance of the given sensor cannot be guaranteed. It is strongly recommended to replace the sensor immediately to ensure proper operation.

Pump Stall

The "Pump = 20/20" reading is the minimum and maximum pump raw count (RC), and "Stall = 40 +/-" is the pump stall threshold. The pump stalls if the maximum raw count reaches the pump stall threshold, which causes the pump to shut off. To determine the pump stall threshold:

$$[(\text{max RC when pump is free} + \text{max RC when pump is blocked})] \div 2$$

To adjust the pump stall threshold, press to increase or to decrease the numerical value.

Back Light Threshold

Adjust the threshold for the LCD backlight to automatically turn on/off; verify the threshold is 100, which is suitable for most situations.

Serial Number and Pump

Displays the monitor's serial number and the pump status. If a pump is installed and a pump speed control circuit is available, toggle the display "Pump=Low/High" by pressing . **NOTE:** Changes made are only for testing the pump condition and are not saved to the nonvolatile memory. *Refer to Change Pump Speed on page 25.*

Battery Duration Time

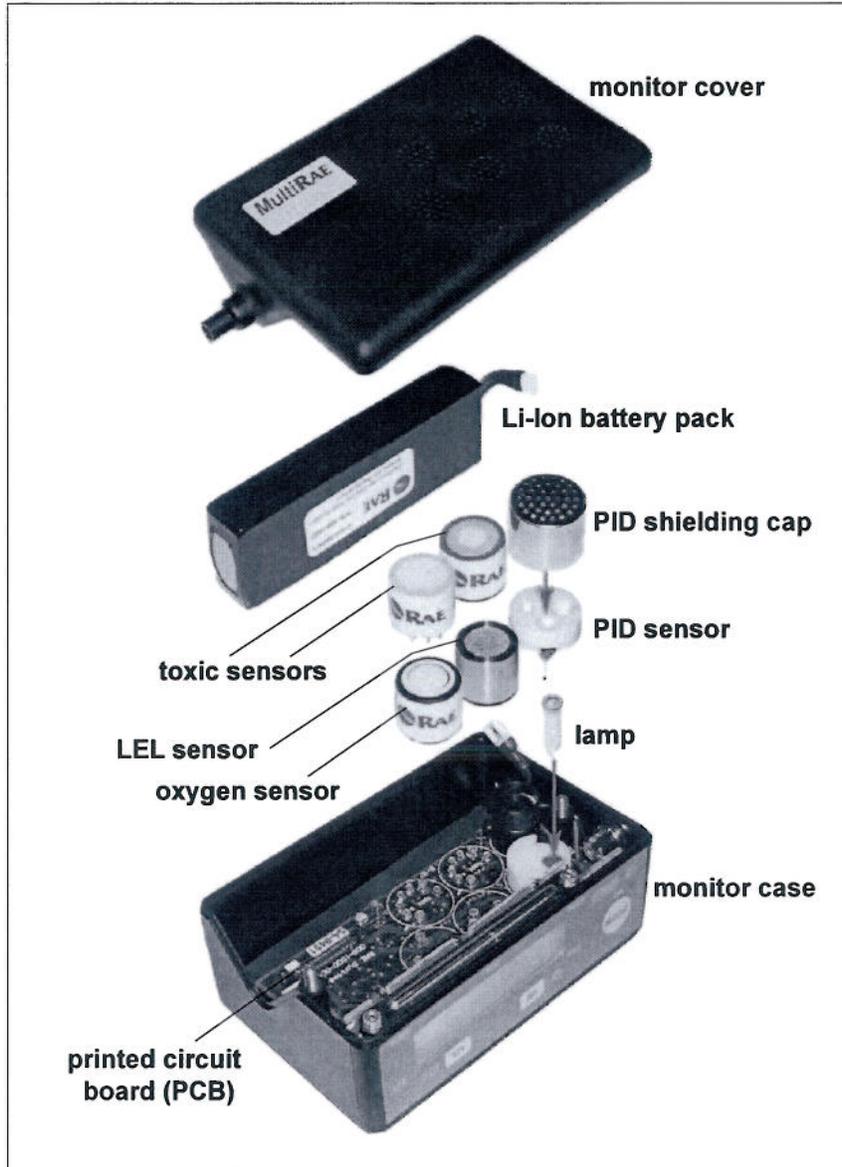
Use to test battery life and displays the last run time before the unit turned itself off due to low battery.

Communicate with PC

Connect monitor to a personal computer to upload a configuration file or download stored data.

Maintenance

⚠ Power from the battery is flowing to the printed circuit board (PCB) and sensors even when the power is off. Therefore, it is very important to disconnect the battery pack before servicing or replacing sensors or any components inside the monitor. Severe damage to the PCB may occur if the battery pack is not disconnected before servicing the unit.



Li-Ion Battery Pack

The factory supplied Li-Ion battery pack is designed to last for 10 hours of normal operation (without alarm or backlight conditions). The rechargeable batteries have a 1-year warranty. Age, ambient temperature, and heavy useage may impact battery life. Battery packs will slowly drain even if the monitor is turned off. If the battery packs have not been charged for 10 days, the battery voltage will be low. It is recommended to fully charge the battery packs before going into the field, and recharge the battery pack upon returning from the field.

⚠ To reduce the risk of ignition of hazardous atmospheres, recharge battery only in areas known to be non-hazardous. Remove and replace battery only in areas known to be non-hazardous. Ne charger les batteries que dans emplacements désignés non dangereux.

Replacing the Battery Pack

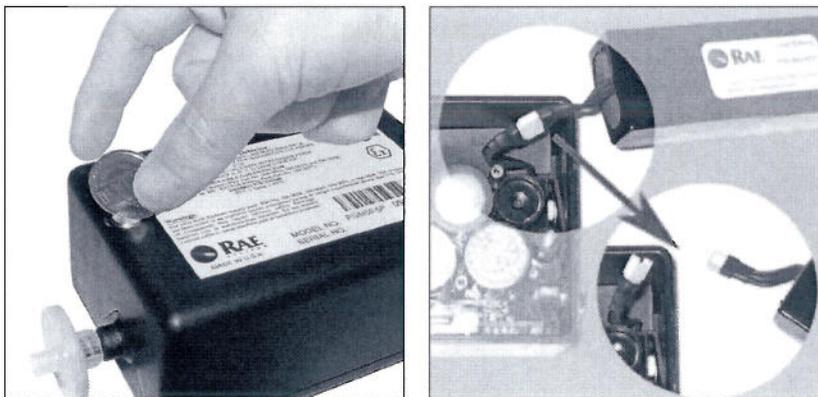
⚠ To reduce the risk of ignition of hazardous atmospheres, recharge battery only in areas known to be non-hazardous. Remove and replace battery only in areas known to be non-hazardous. Ne charger les batteries que dans emplacements désignés non dangereux.

Remove the monitor cover by loosening the two case screws, and then unplug the battery pack from the battery jack.

Place a fully charged spare battery pack into the monitor.

Make sure the battery plug is connected securely.

Reattach the cover and tighten the screws.



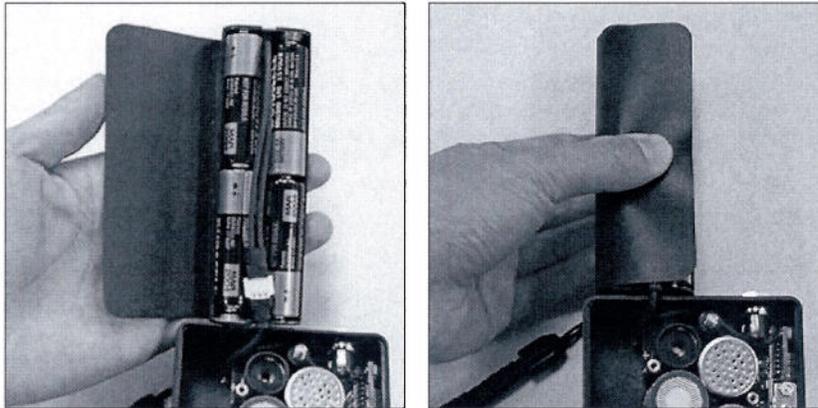
Emergency Alkaline Battery Adapter

⚠ The alkaline battery adapter supplied by RAE Systems is intrinsically safe. The adapter is intended to be used in emergency situations when there is no time to recharge the Li-Ion battery pack. The adapter accepts 4-AA alkaline batteries to provide approximately 12-14 hours of operation.

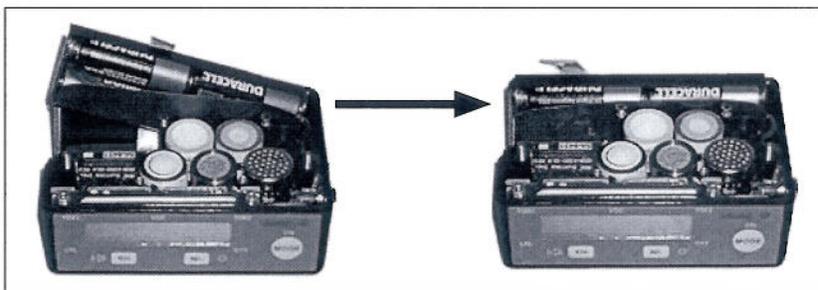
To **install** the adapter, remove the monitor cover. Remove the Li-Ion battery pack from the monitor by carefully disconnecting the wires.

Install four AA alkaline batteries into the battery adapter, making sure the battery polarity is correct.

Connect the battery adapter to the monitor. Make sure the wires are placed inside the adapter, running between the batteries. Close the flap over.



Install the battery adapter in the monitor.



The monitor automatically detects the alkaline batteries and will run for 8-10 hours. Use the monitor once the alkaline battery adapter is installed. Replace the alkaline batteries when spent.

Sensor Replacement

Under normal operating conditions, most sensors will lose their original sensitivity after the expected operating life and eventually need to be replaced. Each sensor has a non-volatile memory that has the manufacturing and expiration dates, which appear during the warm-up period or can be looked up in the diagnostic mode.

Warranties: Oxygen (O₂), combustible gas (LEL), hydrogen sulfide (H₂S) and carbon monoxide (CO) sensors all have a 2-year warranty. All other toxic sensors have a 1-year warranty.

NOTE: The Oxygen and the LEL sensors have assigned sockets. These are identified on the PCB. High bias toxic sensors should be installed in socket 1/A. Refer to *Special Bias Voltage for Toxic Sensors on page 35*. Any toxic sensor can be installed in socket 2/B.

Replace the sensor when it fails to calibrate.

To replace sensor(s), turn the monitor off and remove the cover.

Using the sensor puller, remove the sensor to be replaced by carefully pulling straight out.

Plug a new sensor into the empty socket. Make sure the sensor pins are aligned with the socket holes before firmly pushing the sensor all the way down.

Replace the monitor cover.

Turn on the power of the monitor and the newly installed sensors should be recognized. Let the monitor run for 15 minutes before calibration.

Some sensors, like NO and NH₃, require up to 24 hours on-bias in the monitor prior to calibration and use. Refer to *Technical Note 114 Sensor Specifications and Cross Sensitivities*.

NOTE: Calibrate all sensors prior to use!

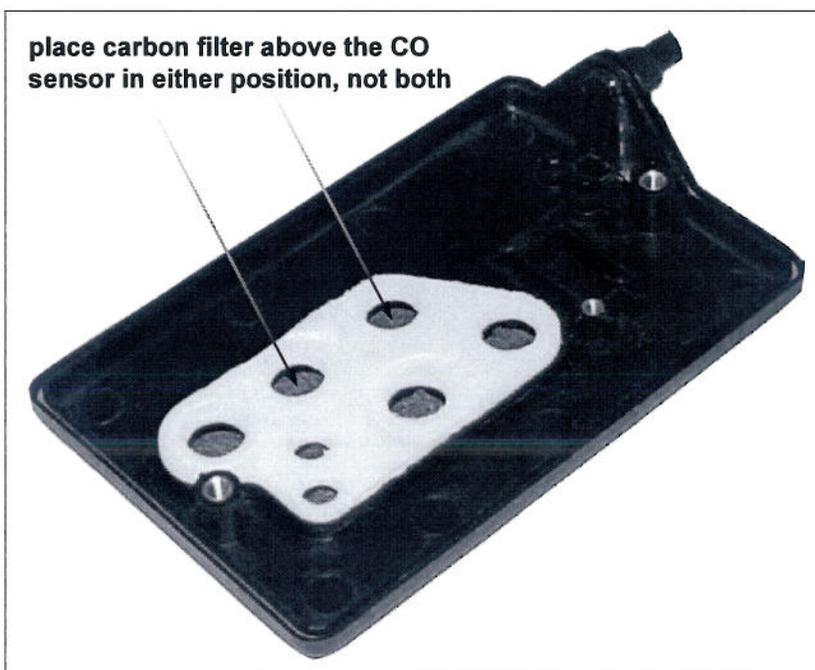


CO Sensor Charcoal Filters

CO sensors can be sensitive to hydrocarbons. To reduce or eliminate this cross sensitivity, a charcoal filter is installed in the gas plate above the CO sensor. The charcoal filter removes organic vapor cross-sensitivity and will last 4-6 weeks under normal operation conditions before it needs to be replaced. However, if the monitor is exposed to high concentrations of VOC gases, the carbon filter needs to be replaced more frequently. (P/N 008-3006-005, 5-pack; keep unused filters sealed during storage.)

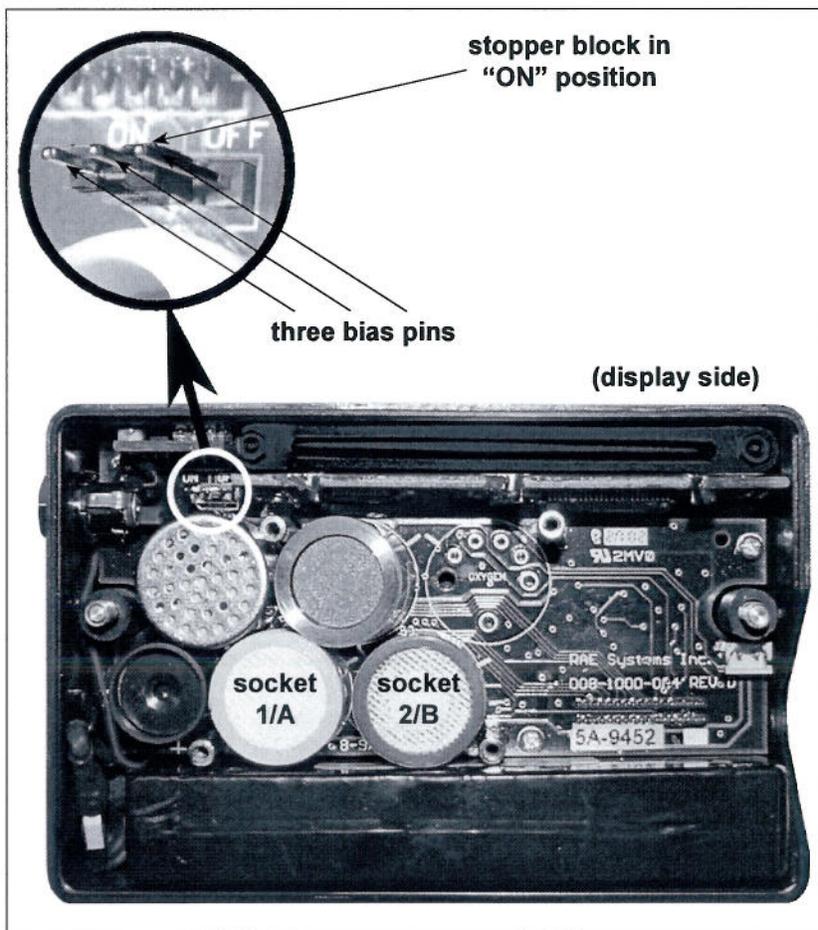
Refer to Technical Note-121 CO Sensor Cross-Sensitivity and Removal with Charcoal Filter for cross-sensitivity data.

- ⚠ The carbon filter used for CO sensors may lower the reading if used on other sensors. Remove the filter if another sensor is replacing a CO sensor in the monitor.



Special Bias Voltage for Toxic Gas Sensors

NO and some NH₃ sensors require a special high bias. The bias pins are located next to the PID sensor socket. Using the sensor puller, move the stopper block from the "OFF" pins to the "ON" pins. The sensor ID and bias voltage will be checked during the power on sequence. An error message appears if the sensors are plugged into the wrong socket, or if the bias voltage is disabled. Biased sensors require 24 hours on bias before calibration.



PID Sensor Cleaning/Replacement

During the course of normal operation, a film of gas vapor may build up inside the PID sensor module and the lamp; the rate of build-up depends on the type and concentration being sampled. As a guide, it is recommended to clean the PID sensor module and lamp only when the PID is malfunctioning.

Periodically cleaning the lamp window also removes film deposits and restores lamp sensitivity. Exercise with care when cleaning the window surface to avoid damage.

Turn the monitor off and remove the cover.

Remove the stainless steel shielding cap for the PID sensor. Using the sensor puller, remove the PID sensor by carefully pulling straight out.

Dip the entire PID sensor into RAE Systems' lamp cleaning solution (supplied in the Lamp Cleaning Kit, P/N 081-0002-000).

⚠ DO NOT store the methanol from the lamp cleaning kit in the same case as the MultiRae Plus, as long-term exposure to methanol can damage electrochemical sensors.

It is highly recommended to use an ultrasound bath for at least three minutes. Then thoroughly air-dry the sensor.

⚠ DO NOT use heat to dry sensors.

DO NOT disassemble PID sensor.

If the lamp is operational, use a cotton swab or lens tissue to clean the flat window surface with GC grade methanol. If the lamp does not turn on replace with a new lamp. Avoid contact with the flat window surface.

Reinstall the PID sensor. Install the shielding cap. Replace the monitor cover.



Taking Care of the Lamp

⚠ Never touch the window surface with fingers or anything which may leave a film. Water will degrade window surfaces, especially the 11.7 eV lamp window.

The 10.6 eV PID lamp has a 1-year warranty. The "Lamp" error is an indication of a problem with the lamp current. A dirty or contaminated sensor often causes high readings of the VOC sensor. A weak or inoperative lamp often causes low readings or no response to test gas. If the UV lamp is on while the error message persists, then it is necessary to adjust the lamp threshold. *Refer to Adjust Lamp Failure Threshold on page 27.*

Sampling Pump Replacement

The sampling pump is a positive displacement piston pump, which needs to be replaced as it approaches the end of its life span. The pump's draw capability reduces significantly as it consumes a greater amount of energy to keep running. The sampling pump has a 1-year warranty. **To replace** the pump:

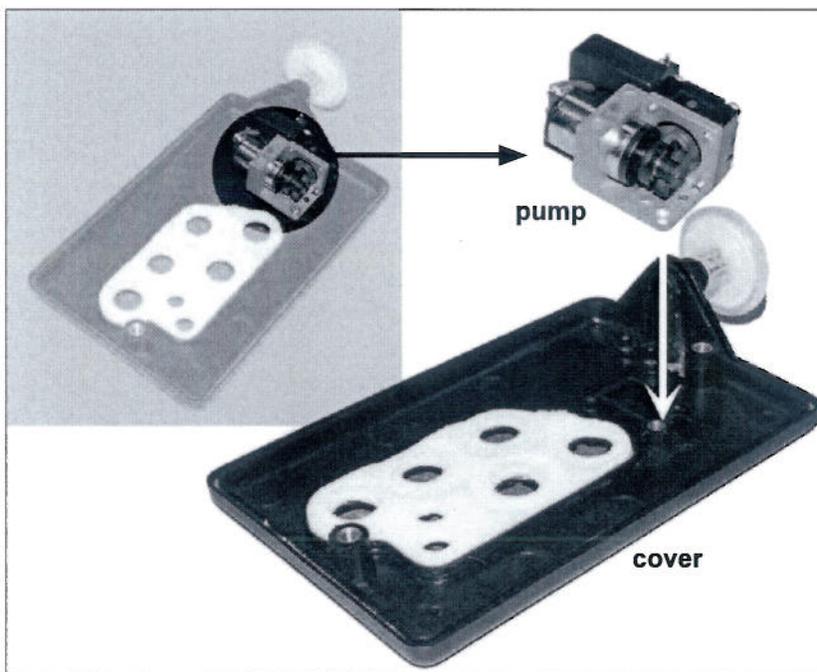
Turn the monitor OFF and remove the cover.

The sampling pump is attached to the cover.

Remove the single screw holding the pump to the cover.

Gently pull the pump assembly off the cover.

Replace with a new pump assembly and reassemble.



Troubleshooting

Technical Service: 1.888.723.4800 or email: Tech@raesystems.com

Problem	Possible Reason(s)	Possible Solution(s)
Cannot turn on after charging battery.	Defective battery. Microprocessor hang-up.	Charge or replace battery. Disconnect then reconnect battery to reset computer. Otherwise, install alkaline battery pack. If that still does not work, then call Service.
"Incorrect Year - Check Clock!" error message.	Battery has died and there is a mismatch between the date code on the sensors and its internal clock.	Press  and reset clock.
Cannot turn off. Corrupted characters.	Microprocessor hang-up.	Disconnect and reconnect battery to reset computer. Reload firmware.
No LED or LCD backlight.	Defective LED or LCD backlight.	Check if backlight is in manual mode. Otherwise, call service center.
Lost password.	Forgot.	Use ProRAE Suite to reset password.
Buzzer inoperative.	Bad buzzer. Setting could be in special run silent mode.	Call authorized service center.
Calibration error message.	No calibration gas input. Low sensitivity to calibration gas.	Check standard gas flow path or cylinder pressure. Change calibration gas or sensor.
"Voltage too high" error message, while charging.	Battery fuse blown. Wrong AC adapter. AC adapter not fully plugged in.	Check battery and adapter.
"Bat" error message.	Battery low.	Recharge battery.

High pump noise. No inlet suction.	Leaky inlet path. Defective pump.	Check inlet connection. Clean or replace pump.
Abnormally low reading.	Bad calibration. Low sensitivity to calibration gas. Wrong span value. Bad sensor. Low flow.	Recalibrate. Use stronger span gas. Check span value. Replace sensor. Replace filters. Check flow.
Abnormally high reading.	Bad calibration. Wrong span value. Dirty PID sensor. Dirty filters. Excessive moisture.	Recalibrate. Check span value. Clean PID sensor in methanol in ultrasound bath. Replace filters. Dry PID sensor.
Reading jumping around.	Incorrect calibration gas. Wrong span value.	Calibrate the sensors. Use different calibration gas. Change sensor.
Read a small background value.	Small background gas level present. Sensor zero drift or newly installed.	Run fresh air calibration. Wait for newly installed sensor to stabilize.
"Lamp" error message.	Wrong threshold. Weak lamp. Dirty Sensor.	Adjust threshold. Clean or replace lamp. Clean PID sensor.
VOC reading plateaus at certain level.	Weak PID lamp. Dirty PID sensor.	Replace lamp. Clean lamp & PID sensor. Replace filters.
Full scale measurement in humid environment.	Dirty or wet sensor.	Clean and dry sensor. Replace external filter.

Specifications

Size	4.65"L x 3.0"W x 1.9"H (11.8 x 7.6 x 4.8 cm)
Weight	16 oz with battery (454g)
Sensors	Up to 5 sensors including: <ul style="list-style-type: none"> • Photo-ionization detector for VOCs, 10.6 eV lamp standard • Protected catalytic bead for combustible gases • Interchangeable electrochemical sensors for oxygen and toxic gases (2)
Battery	<ul style="list-style-type: none"> • Interchangeable Li-Ion and alkaline battery packs • Rechargeable units include lithium-ion battery pack with internal smart charging, 120V AC/DC wall adapter, and spare alkaline battery pack
Operating Hours	<ul style="list-style-type: none"> • 14 hours continuous with Li-Ion (typical) • Unit will run and charge simultaneously
Display	2 line, 16 digit LCD with LED backlighting automatically in dim light or alarm condition
Keypads	1 operation and 2 programming keys
Direct Readout	Instantaneous (up to 5) values: <ul style="list-style-type: none"> • Oxygen as percentage by volume • Combustible gas as percentage of lower explosive level (LEL) • Toxic gases and VOCs as parts per million by volume (VOC scaleable using correction factors) • High and low values for all gases • STEL and TWA values of toxic gases and VOCs • Battery and shut down voltage • Date, time, elapsed time, temperature
Alarms	90 dB buzzer and flashing red LED to indicate exceeded preset limits: <ul style="list-style-type: none"> • High: 3 beeps and flashes per second • Low: 2 beeps and flashes per second • STEL and TWA: 1 beep and flash per second • Automatic reset or latching with manual override • Additional diagnostic alarms and display messages for low battery and pump stall
Datalogging	20,000 points (80 hours, 5 channels at one minute intervals) download to PC with serial number of unit, user ID, site number, and calibration date

Calibration	Two-point field calibration for zero and span gas
Sampling Pump	Internal two-speed pump. Flow rates: • Low: ~200 cc/min • High: ~300 cc/min
Low Flow Alarm	Auto shut-off pump at low flow condition
Temperature	-4° to 113°F (-20° to 45°C)
Humidity	0% to 95% relative humidity (non-condensing)
Attachment	Wrist strap and high-visibility rubber boot
Warranty	Lifetime on non-consuming components (per RAE Standard Warranty). 2 years for O ₂ , LEL, CO, and H ₂ S sensors. 1 year all other sensors. 1 year pump, 1 year battery, 1 year for 10.6eV PID lamp.
EMI Immunity	No effect when exposed to 0.43 mW/cm RF interference (5 watts at 12 inches)
Intrinsic Safety	U.S.A. and Canada: UL & cUL Class I, Division I, Groups A, B, C, D, hazardous locations, Temperature Code T3C Europe: DEMKO 03 ATEX 0308256X; EEx ia d IIC T4 (w/ Battery P/N 500-0029); EEx ia d IIC T3 (w/ Battery P/N 500-0037)

Range, Resolution & Response Time

(t₉₀ for pump-equipped instruments)

Sensor	Range	Resolution	t ₉₀ (sec)	Presoak Time for 60-sec Cal
LEL	0-100% LEL	1%	15	None
VOC	0-200 ppm	0.1 ppm	10	None
VOC	200-2000 ppm	1 ppm	10	None
O ₂	0-30%	0.1%	15	None
CO	0-500 ppm	1.0 ppm	40	None
H ₂ S	0-100 ppm	1.0 ppm	35	None
SO ₂	0-20 ppm	0.1 ppm	35	None
NO	0-250 ppm	1.0 ppm	30	None
NO ₂	0-20 ppm	0.1 ppm	25	None
Cl ₂	0-50 ppm	0.1 ppm	60	60 sec
PH ₃	0-5 ppm	0.1 ppm	60	60 sec
NH ₃	0-50 ppm	1.0 ppm	150	90 sec
HCN	0-100 ppm	1.0 ppm	200	170 sec

Notes



RAE Systems World Headquarters

3775 N. First St.
San Jose, CA 95134-1708 USA
Phone: 408.952.8200
Fax: 408.952.8480

E-mail: customerserv@raesystems.com

Web Site: www.raesystems.com

RAE Systems Technical Support

Monday through Friday, 7:00AM to 5:00PM Pacific Time
+1.888.723.4800 (toll-free)
email: tech@raesystems.com

RAE Systems Tubes: 888.RAE.TUBE (888.723.8823)

RAE Systems Europe ApS

Orestads Boulevard 69
DK-2300 Copenhagen, DENMARK
Phone: +45.8652.5155
Fax: +45.8652.5177

RAE Systems (Hong Kong) Ltd.

Room 8, 6/F, Hong Leong Plaza
33 Lok Yip Road
Fanling, N.T. HONG KONG
Phone: +852.2669.0828
Fax: +852.2669.0803

P/N 008-4022-000

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Seep Groundwater Sample Collection

I. Purpose

To provide a general guideline for the collection of groundwater samples from seeps, which have either limited flow or are manifested simply by damp areas on the surface of the ground.

II. Scope

The SOP covers sampling seeps with drive points, similar to the equipment used in direct-push groundwater sampling. The assumption is that, even if there is a small amount of flow at the surface, a representative sample of the groundwater discharging at the seep must be taken from below the ground surface with a drive point rather than from the water at the surface. This avoids chemical changes to the groundwater, such as volatilization of organic compounds that may occur when the groundwater comes in contact with the atmosphere.

III. Equipment and Materials

- Stainless steel or PVC drive points and extra drive rods (if needed)
- Slide hammer or sledge hammer
- Peristaltic pump with dedicated polyethylene sampling tubing or small bailer
- Pre-cleaned sample containers
- Personal Protective Equipment as specified by the Health and Safety Plan.

IV. Procedures and Guidelines

1. Decontaminate the drive point and any other non-dedicated downhole equipment (e.g., extra drive rods) in accordance with the *Decontamination of Personnel and Equipment* SOP.
2. Drive the slotted interval of the drive point to the desired sampling depth using the drive hammer or sledge hammer. The desired depth is that at which there is sufficient groundwater in the drive point to obtain a sample. It should be recognized that the recharge to the small-diameter (1 to 1.25 inch ID) drive point may be slow.
3. In cases where the drive point must be pumped, insert the polyethylene sampling tubing into the drive point. Alternatively, a small-diameter bailer may be used.

4. In cases where the drive point is emplaced in a near-horizontal orientation, such as it may have when it is driven into a seepage area in the bank of a stream, be prepared for groundwater to flow from the drive point under the force of gravity. In this situation, the screen interval of the drive point must be fully embedded in the ground for groundwater to flow from the top of the drive point.
5. Fill all sample containers, beginning with the containers for VOC analysis.
6. Remove polyethylene sampling tubing, if used, from the drive point.
7. Decontaminate all non-dedicated downhole equipment in accordance with the *Decontamination of Personnel and Equipment SOP*.
8. Abandon drive point hole (as necessary) per project specifications.

V. Key Checks and Items

1. Verify that the drive points and any extra drive rods are clean.
2. When the drive point is emplaced in a near-horizontal orientation, be sure that the screen interval is completely embedded in the ground so that groundwater will flow through the embedded screen instead of through the exposed upper screen interval.

Installation of Surface-Cased Monitoring Wells

I. Purpose and Scope

The purpose of this procedure is to outline equipment and methods that will be used to install surface casings to isolate shallow intervals from deeper drilling. The guideline only addresses installation in unconsolidated materials. Installation of monitoring wells in bedrock is discussed in SOP *Installation of Bedrock Monitoring Wells* and installation of shallow, single-cased monitoring wells is discussed in SOP *Installation of Shallow Monitoring Wells*.

II. Equipment and Materials

Drilling

- Drilling rig (hollow stem auger, sonic, air rotary, or mud rotary).

Surface Casing

- 8-inch to 12-inch ID steel or Schedule 80 polyvinyl chloride (PVC) surface casing, depending upon application.
- Temporary bottom plug.
- Bentonite for grout: pure, additive-free powdered bentonite.
- Cement-Bentonite Grout. Proportion: 6 to 8 gallons of water per 94-pound bag of Portland cement; 3 to 6 pounds of bentonite added per bag of cement to reduce shrinkage.

Well Installation

- PVC, Schedule 40, minimum 2-inch ID, flush-threaded well riser; alternatively, stainless-steel riser.
- PVC, Schedule 40, minimum 2-inch ID, flush-threaded, factory slotted well screen; alternatively, stainless-steel screen.
- PVC or stainless steel bottom cap, threaded to match the well screen.
- Centering guides (if used); same material as the casing, except stainless steel may be used in lieu of PVC.
- Clean silica sand, provided in factory-sealed bags, well-rounded, containing no organic material, anhydrite, gypsum, mica, or calcareous material; primary (coarse – e.g., Morie #1) filter pack, and secondary (fine sand seal) filter pack. Grain size determined based on sediments observed during drilling.
- Bentonite seal: Pure, additive-free bentonite pellets or chips.

- Bentonite for grout: Pure, additive-free powdered bentonite.
- Cement-Bentonite Grout: Proportion 6 to 8 gallons of water per 94-pound bag of Portland cement; 3 to 10 pounds of bentonite added per bag of cement to reduce shrinkage.
- Above-grade well completion: PVC or stainless-steel well cap, threaded or push-on type, vented.
- Flush-mount well completion: PVC or stainless-steel well cap, locking, leak-proof seal.
- Above-grade protective casing: Permanent isolation casing with heavy duty locking cover, painted with epoxy paint for rust protection, industrial lock.
- Flush-mount protective casing: Morrison 9-inch or 12-inch 519 manhole cover; rubber seal for cover; heavy duty locking cap on permanent isolation casing.

Well Development

- Surge block.
- Pump and associated development equipment.
- Calibrated meters to ensure pH, temperature, specific conductance, Eh, and dissolved oxygen of development water.
- Containerization for water produced from well.

III. Procedures and Guidelines

A. Drilling Methods

Boreholes for the surface casing can be drilled with hollow-stem auger, air rotary, or mud rotary. Boreholes will be drilled to various diameters, depending upon applications. In the case of temporary surface casing, where grout will not be used to install the casing, the borehole for the casing will be drilled with a method by which the borehole will be as close to the diameter of the surface casing as possible to minimize the size of the annular space. This may be by a rotary method or by using a hollow-stem auger with as small an inside diameter as possible. For permanent surface casing, typically hollow-stem auger will be used.

1. Hollow-Stem Auger Drilling

Hollow-stem auger (HSA) drilling techniques can be used to drill boreholes for installation of surface casing. The borehole will be drilled into a clay layer of significant thickness. Minimum 8-1/4-inch ID HSA will be used to drill the borehole a minimum of 5 feet into a clay layer of significant thickness.

The use of water or other fluid to assist in hollow-stem auger drilling is to be avoided.

The bit of the auger is placed at the ground surface and then turned with the drilling rig. To collect split-spoon or other samples, the auger is advanced to the top of the sampling depth, and the sample is collected from below the auger head. The split spoon is advanced through repeated blows from a 140-pound or 300-pound hammer dropped from a height of 30 inches. Thin-walled tube samplers are advanced by pressing down on the rods with the weight of the drilling rig. Split-spoon samples will be collected at selected intervals for chemical analysis and/or lithologic classification. Soil sampling procedures are detailed in SOPs *Soil Boring Sampling – Split Spoons* and *Soil Sampling*.

Material brought to the surface on the outside of the augers should be containerized at a convenient space away from the working area. Material may be stored on plastic sheeting and containerized at the completion of activities at the drilling location. Such material will be disposed of according to SOP *Disposal of Waste Fluids and Solids* and the Investigation Derived Waste Management Plan (IDWMP).

Drilling equipment will be decontaminated before drilling in accordance with the procedures detailed in SOP *Decontamination of Drilling Rigs and Equipment*.

2. Rotary Drilling

Mud rotary or other rotary drilling techniques can be used to install surface casing.

To collect split spoon samples, the drill bit is advanced to the depth to be sampled, the bit is removed from the borehole, and the split-spoon sample is collected from the borehole.

Drill cuttings and fluids generated during rotary drilling activities will be contained until completion of activities at the drilling location. Such material will be disposed of according to SOP *Disposal of Waste Fluids and Solids* and the IDWMP.

Drilling equipment will be decontaminated before drilling in accordance with the procedures detailed in SOP *Decontamination of Drilling Rigs and Equipment*.

B. Surface-Casing Installation

Surface casing will be constructed of minimum 6-inch ID black iron steel with a minimum wall thickness of 0.20 inches or Schedule 80 PVC. Casing lengths for permanent surface casings will be welded or connected by threaded connections sealed with Teflon tape, while casing lengths for temporary surface casings will be either threaded connections of casing installed as part of the rotary-drilling method. The steel casing and threaded couplings must be free of paint, varnish, or coatings of any kind, both inside and outside. Threaded

connections must be free of oils or grease. Welding of the casing is permissible provided that the welds meet the Standards of the American Welding Society.

Surface casing will be decontaminated prior to installation in accordance with the procedures detailed in SOP *Decontamination of Drilling Rigs and Equipment*.

Surface casing will be installed at least 5 feet into a significant clay layer, if adequate thickness is available.

Permanent surface casing will be placed in the bottom of the borehole and the surface casing will be pressed into the clay up to 1 foot. The surface casing will be grouted in place by installing the grout through a tremie pipe from the bottom of the annulus to the ground surface.

Alternatively, the surface casing may be installed and grouted in place by a grout displacement method. The bottom of the surface casing is fitted with a tight, drillable plug. The borehole is then filled with the estimated volume of cement-bentonite grout to fill the annular space, and the casing is lowered to the bottom of the borehole (displacement method). If the weight of the casing is not sufficient to displace the grout and allow the casing to sink to the bottom of the borehole, the casing may be filled with clean water.

Well installation will proceed in the surface casing once the grout has been allowed to set up for approximately 16 to 24 hours. All water in the surface casing will be removed before drilling resumes in order to prevent carrying contamination downward into deeper intervals of the water-bearing unit. All water in the casing will be disposed of according to SOP *Disposal of Waste Fluids and Solids* and the IDWMP before drilling is resumed.

Temporary surface casing installed independently of the drilling process also will be placed in the bottom of the borehole and the surface casing will be pressed into the clay. However, it will not be grouted into place.

C. Monitoring-Well Installation

Typically, the well is completed within the surface casing using mud rotary. Sonic drilling methods may also be used through permanent surface casings.

If the borehole has been drilled to a depth greater than that at which the well is to be set, the borehole will be backfilled with bentonite pellets or chips or a bentonite-cement slurry to a depth approximately 1 foot below the intended well depth. Approximately 1 foot of clean sand will be placed on top of the bentonite to return the borehole to the proper depth for well installation.

The appropriate lengths of well screen, nominally 10 feet (with bottom cap), and casing will be joined watertight, and lowered to the bottom of the borehole. Centering guides, if used, will be placed at intervals around the well casing, at the base of the screen, and 5 feet above the top of the well screen.

Selection of final filter pack and well screen depths for the wells shall be made in the field.

A primary sand pack consisting of clean Morie No. 00 (or DSI No.1) silica sand for 10-slot screen and Morie No. 01 (or DSI No.2) for 20-slot screen silica sand will be placed around the well screen. The sand will be placed into the borehole at a uniform rate, in a manner that will allow even placement of the sand pack. During placement of the sand, the position of the top of the sand will be continuously sounded using a stainless steel weight attached to a fiberglass tape measure. The primary sand pack will be extended from the bottom of the borehole to a minimum height of 2 feet above the top of the well screen. A secondary (fine sand seal) sand pack will then be installed to a minimum of 1 foot above the primary sand pack.

A non-additive bentonite seal at least 2 feet thick will be placed above the sand pack. The seal will be placed into the borehole in a manner that will prevent bridging. The position of the top of the bentonite seal will be verified using a weighted tape measure. A hydration period of at least 30 minutes will be allowed following installation of the bentonite seal.

Above the bentonite seal, an annular seal of cement-bentonite grout will be placed. The cement-bentonite grout will be installed continuously in one operation from the top of the bentonite seal to the ground surface. The cement-bentonite grout will be installed through a tremie pipe. The tremie pipe must be plugged at the bottom. Small openings along the bottom 1-foot length of pipe will allow the grout to diffuse laterally into the borehole and to avoid disturbance the bentonite seal.

D. Monitoring-Well Completion

For monitoring wells that will be completed above-grade, the surface casing itself may serve as the protective casing. However, a separate steel protective casing may be used instead. The protective surface casing will be finished 2 to 3 feet above grade and fitted with a locking steel cap. A concrete pad with four guard posts will be installed.

The concrete pad will be square, approximately 2 feet per side (unless otherwise specified in the project plans), and poured into wooden forms. The concrete will be sloped away from the protective casing. The concrete pad will extend at least 6 inches below and 6 inches above the ground surface.

Four steel guard posts will be installed around the locking casing. Guard posts would be concrete-filled, at least 2 inches in diameter, and would extend at least 2 feet into the ground and 3 feet above the ground. The protective casing and guard posts will be painted with an epoxy paint to prevent rust.

For monitoring wells with flush-mount completions, a Morrison 519 manhole cover with a rubber-sealed cover and drain will be installed. The top of the manhole will be positioned approximately 1 inch above grade. A square concrete pad, approximately 2 feet per side (unless otherwise specified in the project plans), will be installed as a concrete collar surrounding the road box cover, and will slope uniformly downward to the adjacent grade. The road box and installation thereof will be of sufficient strength to withstand normal

vehicular traffic. The concrete pad will extend at least 12 inches below the ground surface.

Inside the manhole, a locking cap will be placed over the permanent casing.

Each well will be labeled on the exterior of the locking cap with a metal stamp indicating the permanent well number.

E. Well Development

Well development will be accomplished using a combination of surging throughout the well screen and pumping, until the physical and chemical parameters of the discharge water that are measured in the field have stabilized and the turbidity of the discharge water is substantially reduced. Fine-grained materials in the surficial aquifer at the site may not allow low turbidity results to be achieved.

The surging apparatus will include a surge block. Well development will begin by surging the well screen, starting at the bottom of the screen and proceeding upwards, throughout the screened zone. Following surging, the well will be pumped to remove the fine materials that have been drawn into the well. During pumping, measurements of pH, temperature, and specific conductance will be recorded.

Development will continue by alternately surging and pumping until the discharge water is free from sand and silt, the turbidity is substantially reduced, and the pH, temperature, and specific conductance have stabilized at regional background levels, based on historical data. Development will continue for a minimum of 30 minutes and until the water removed from the well is as clear of turbidity as practicable.

Well development equipment will be decontaminated prior to initial use and after the development of each well. Decontamination procedures are detailed in SOP *Decontamination of Personnel and Equipment*. Water generated during well development will be contained and managed as detailed in the SOP *Disposal of Waste Fluids and Solids* and the IDWMP.

IV. Attachments

Schematic diagram of double-cased monitoring-well construction
(MWDDoubleDiag.xls)

Trenching for Landfill Delineation

I. Purpose

To provide reference material and general guidance on test pitting using a backhoe during landfill boundary confirmation activities.

II. Equipment and Materials

- Backhoe
- Shovels, picks, scoops
- Camera, slate (or other erasable material) board
- Plastic sheeting and stakes and/or sand bags to cover test pits and excavated soil
- Barricades to secure area around excavation
- Onsite decontamination pad
- Level D personnel protection equipment and onsite site safety officer

III. Procedures and Guidelines

A. General Considerations

Test pits will be excavated along the landfill boundary as indicated by the results of soil borings and/or geophysical surveys.

The onsite crew will photograph any significant features exposed by the test pit. Photographs will include a slate board (or other marker) marked with (at a minimum) test pit number, date and time of photograph, description of feature. Other observations (including soil descriptions) will be recorded in the logbook and/or the test-pit log.

Once test pitting is complete, the pits will be backfilled with the stockpiled soil and re-graded to mimic the original ground surface contour.

B. Trenching Activities

1. Establish work zone according to the site safety plan
2. Calibrate all air quality monitoring instruments
3. Using a clean backhoe (decontaminated following SOP *Decontamination of Personnel and Equipment*), begin excavating perpendicular to and just outside of the area defined as the landfill boundary during the geophysical survey. Carefully excavate towards the boundary, recording all observations in the logbook, until buried material is encountered. Remove only enough soil to identify the landfill boundary.

4. Monitor the air quality in the breathing zone at 5-minute intervals during trenching activities to ensure the proper level of respiratory protection is being worn by all field team members.
5. Photograph and document the trenching activities as appropriate. Backfill and regrade the test pit, discard plastic sheeting, decontaminate the backhoe, and set up at the next trenching location.

IV. Attachments

Test pit or trenching log (TESTPIT_DIAGRAM.XLS)

V. Key Checks and Items

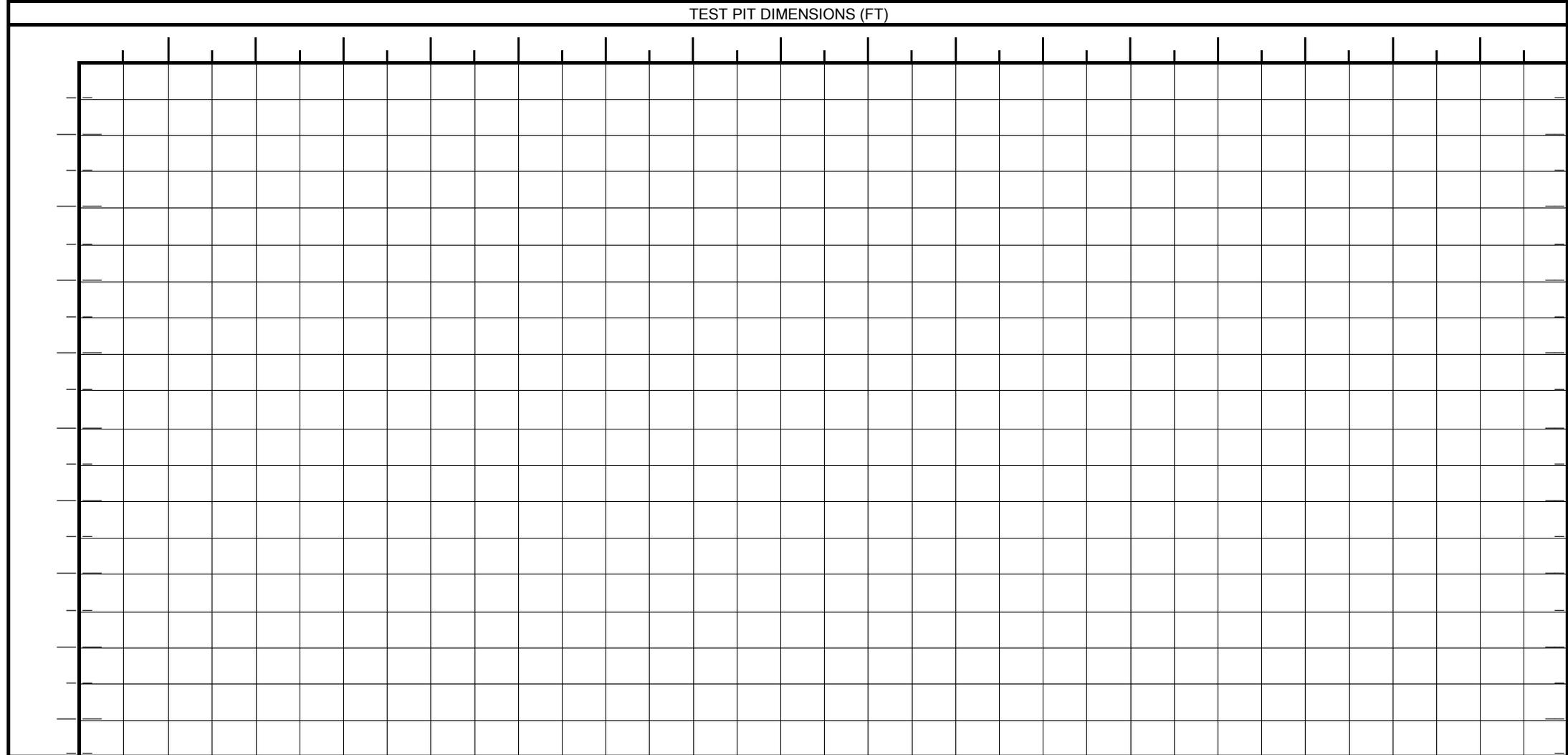
Ensure that personnel are not allowed to enter the trench when it exceeds depth limitations specified by OSHA.



PROJECT NUMBER	TEST PIT NUMBER	SHEET __ OF __
TEST PIT LOG		

PROJECT : _____ LOCATION : _____ LOGGER : _____
ELEVATION : _____ CONTRACTOR : _____
EXCAVATION EQUIPMENT USED : _____ DATE EXCAVATED: _____
WATER LEVEL : _____ APPROX. DIMENS: Length: _____ Width: _____ Max. Depth: _____

DESCRIPTION	COMMENTS
SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	DIFFICULTY IN EXCAVATION, RUNNING GRAVEL, CONDITION, COLLAPSE OF WALLS, SAND HEAVE, DEBRIS ENCOUNTERED, GRADATIONAL CONTACTS, TESTS, INSTRUMENTS, WATER SEEPAGE



Appendix B
Department of Defense
Laboratory Accreditation Letter



PERRY JOHNSON LABORATORY ACCREDITATION, INC.

Certificate of Accreditation

Perry Johnson Laboratory Accreditation, Inc. has assessed the Laboratory of:

Columbia Analytical Services

1565 Jefferson Road, Building 300, Suite 360, Rochester, NY 14623

(Hereinafter called the Organization) and hereby declares that Organization has met the requirements of ISO/IEC 17025:2005 “General Requirements for the competence of Testing and Calibration Laboratories” and the DoD Quality Systems Manual for Environmental Laboratories Version 4.1 4/22/2009 and is accredited in accordance with the:

United States Department of Defense Environmental Laboratory Accreditation Program (DoD-ELAP)

***This accreditation demonstrates technical competence for the defined scope:
Environmental Testing
(As detailed in the supplement)***

Accreditation claims for such testing and/or calibration services shall only be made from addresses referenced within this certificate. This Accreditation is granted subject to the system rules governing the Accreditation referred to above, and the Organization hereby covenants with the Accreditation body’s duty to observe and comply with the said rules.

For PJLA:

Tracy Szerszen
President/Operations Manager

Perry Johnson Laboratory
Accreditation, Inc. (PJLA)
755 W. Big Beaver, Suite 1325
Troy, Michigan 48084

<i>Initial Accreditation Date:</i>	<i>Issue Date:</i>	<i>Accreditation No.:</i>	<i>Certificate No.:</i>
January 22, 2010	April 7, 2012	65817	L12-48

The validity of this certificate is maintained through ongoing assessments based on a continuous accreditation cycle. The validity of this certificate should be confirmed through the PJLA website: www.pjlabs.com



Certificate of Accreditation: Supplement
ISO/IEC 17025:2005 and DoD-ELAP

Columbia Analytical Services

1565 Jefferson Road, Building 300, Suite 360, Rochester, NY 14609
Lisa Reyes Phone: 585-288-5380

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous	(CAS SOP) GEN-TICW	UV-VIS	Total inorganic carbon
Aqueous	EPA 1631	CVAFS	Mercury
Aqueous	EPA 1664A	Gravimetric	Oil and grease
Aqueous	EPA 1664A	Gravimetric	Total petroleum hydrocarbons
Aqueous	EPA 218.6	IC-UV	Chromium, Hexavalent
Aqueous	EPA 245.1	CVAA	Mercury
Aqueous	EPA 300.0	IC	Chloride
Aqueous	EPA 300.0	IC	Fluoride
Aqueous	EPA 300.0	IC	Nitrate
Aqueous	EPA 300.0	IC	Sulfate
Aqueous	EPA 351.2	UV-VIS	Nitrogen, total Kjeldahl
Aqueous	EPA 353.2	UV-VIS	Nitrite as N
Aqueous	EPA 410.4	UV-VIS	Chemical oxygen demand
Aqueous	EPA 7470A	CVAA	Mercury
Aqueous	EPA 8151A	GC-ECD	Dinoseb
Aqueous	EPA 8260C	GC-MS-SIM	1,1-Dichloroethene
Aqueous	EPA 8260C	GC-MS-SIM	1,2-Dichlorobenzene
Aqueous	EPA 8260C	GC-MS-SIM	1,2-Dichloroethane
Aqueous	EPA 8260C	GC-MS-SIM	1,4-Dioxane
Aqueous	EPA 8260C	GC-MS-SIM	Carbon tetrachloride
Aqueous	EPA 8260C	GC-MS-SIM	Dichloromethane
Aqueous	EPA 8260C	GC-MS-SIM	Ethylbenzene
Aqueous	EPA 8260C	GC-MS-SIM	m- + p-Xylene
Aqueous	EPA 8260C	GC-MS-SIM	o-Xylene
Aqueous	EPA 8260C	GC-MS-SIM	Tetrachloroethene
Aqueous	EPA 8260C	GC-MS-SIM	Trichloroethene
Aqueous	EPA 8260C	GC-MS-SIM	Vinyl chloride
Aqueous	EPA 8260C	GC-MS-SIM	Xylenes, total
Aqueous	EPA 8310	HPLC-UV/FLUOR	Acenaphthene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Acenaphthylene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Anthracene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Benzo(a)anthracene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Benzo(a)pyrene



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Aqueous	EPA 8310	HPLC-UV/FLUOR	Benzo(b)fluoranthene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Benzo(g,h,i)perylene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Benzo(k)fluoranthene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Chrysene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Dibenzo(a,h)anthracene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Fluoranthene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Fluorene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Indeno(1,2,3-cd)pyrene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Naphthalene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Phenanthrene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Pyrene
Aqueous	EPA 9040B, C	POT	pH
Aqueous	EPA 9060, A	UV-VIS	Total organic carbon
Aqueous	EPA 9066	UV-VIS	Phenolics, total
Aqueous	RSK-175	GC-FID	Ethane
Aqueous	RSK-175	GC-FID	Ethylene
Aqueous	RSK-175	GC-FID	Methane
Aqueous	RSK-175	GC-FID	Propane
Aqueous	RSK-175	GC-FID	Acetylene
Aqueous	SM 2320B	Titration	Alkalinity, total, carbonate, and bicarbonate
Aqueous	SM 2340C	Titration	Hardness, total
Solids	(CAS SOP) GEN-351.2	UV-VIS	Nitrogen, total Kjeldahl
Solids	(CAS SOP) GEN-420.4/9066	UV-VIS	Phenolics, total
Solids	EPA Lloyd Kahn	UV-VIS	Total organic carbon
Solids	EPA 300.0	IC	Chloride
Solids	EPA 300.0	IC	Fluoride
Solids	EPA 300.0	IC	Nitrate
Solids	EPA 300.0	IC	Sulfate
Solids	EPA 7471B	CVAA	Mercury
Solids	EPA 8330A	HPLC-UV	1,3,5-Trinitrobenzene
Solids	EPA 8330A	HPLC-UV	1,3-Dinitrobenzene
Solids	EPA 8330A	HPLC-UV	2,4,6-Trinitrotoluene
Solids	EPA 8330A	HPLC-UV	2,4-Dinitrotoluene



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Solids	EPA 8330A	HPLC-UV	2,6-Dinitrotoluene
Solids	EPA 8330A	HPLC-UV	2-Amino-4,6-dinitrotoluene
Solids	EPA 8330A	HPLC-UV	2-Nitrotoluene
Solids	EPA 8330A	HPLC-UV	3-Nitrotoluene
Solids	EPA 8330A	HPLC-UV	4-Amino-2,6-dinitrotoluene
Solids	EPA 8330A	HPLC-UV	4-Nitrotoluene
Solids	EPA 8330A	HPLC-UV	HMX
Solids	EPA 8330A	HPLC-UV	Nitrobenzene
Solids	EPA 8330A	HPLC-UV	RDX
Solids	EPA 8330A	HPLC-UV	Tetryl
Solids	EPA 9045C, D	POT	pH
Solids	SM 5220B	Titration	Chemical oxygen demand
Aqueous/Solids	EPA 1010A	Pensky Martin	Ignitability
Aqueous/Solids	EPA 353.2	UV-VIS	Nitrate/nitrite as N
Aqueous/Solids	EPA 6010C	ICP-AES	Aluminum
Aqueous/Solids	EPA 6010C	ICP-AES	Antimony
Aqueous/Solids	EPA 6010C	ICP-AES	Arsenic
Aqueous/Solids	EPA 6010C	ICP-AES	Barium
Aqueous/Solids	EPA 6010C	ICP-AES	Beryllium
Aqueous/Solids	EPA 6010C	ICP-AES	Boron
Aqueous/Solids	EPA 6010C	ICP-AES	Cadmium
Aqueous/Solids	EPA 6010C	ICP-AES	Calcium
Aqueous/Solids	EPA 6010C	ICP-AES	Chromium
Aqueous/Solids	EPA 6010C	ICP-AES	Cobalt
Aqueous/Solids	EPA 6010C	ICP-AES	Copper
Aqueous/Solids	EPA 6010C	ICP-AES	Iron
Aqueous/Solids	EPA 6010C	ICP-AES	Lead
Aqueous/Solids	EPA 6010C	ICP-AES	Magnesium
Aqueous/Solids	EPA 6010C	ICP-AES	Manganese
Aqueous/Solids	EPA 6010C	ICP-AES	Nickel
Aqueous/Solids	EPA 6010C	ICP-AES	Potassium
Aqueous/Solids	EPA 6010C	ICP-AES	Selenium
Aqueous/Solids	EPA 6010C	ICP-AES	Silver



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Aqueous/Solids	EPA 6010C	ICP-AES	Sodium
Aqueous/Solids	EPA 6010C	ICP-AES	Thallium
Aqueous/Solids	EPA 6010C	ICP-AES	Tin
Aqueous/Solids	EPA 6010C	ICP-AES	Vanadium
Aqueous/Solids	EPA 6010C	ICP-AES	Zinc
Aqueous/Solids	EPA 6020A	ICP-MS	Arsenic
Aqueous/Solids	EPA 6020A	ICP-MS	Antimony
Aqueous/Solids	EPA 6020A	ICP-MS	Barium
Aqueous/Solids	EPA 6020A	ICP-MS	Beryllium
Aqueous/Solids	EPA 6020A	ICP-MS	Cadmium
Aqueous/Solids	EPA 6020A	ICP-MS	Chromium
Aqueous/Solids	EPA 6020A	ICP-MS	Cobalt
Aqueous/Solids	EPA 6020A	ICP-MS	Copper
Aqueous/Solids	EPA 6020A	ICP-MS	Lead
Aqueous/Solids	EPA 6020A	ICP-MS	Manganese
Aqueous/Solids	EPA 6020A	ICP-MS	Nickel
Aqueous/Solids	EPA 6020A	ICP-MS	Selenium
Aqueous/Solids	EPA 6020A	ICP-MS	Silver
Aqueous/Solids	EPA 6020A	ICP-MS	Thallium
Aqueous/Solids	EPA 6020A	ICP-MS	Vanadium
Aqueous/Solids	EPA 6020A	ICP-MS	Zinc
Aqueous/Solids	EPA 680	GC-MS	Monochlorobiphenyls, Total
Aqueous/Solids	EPA 680	GC-MS	Dichlorobiphenyls, Total
Aqueous/Solids	EPA 680	GC-MS	Trichlorobiphenyls, Total
Aqueous/Solids	EPA 680	GC-MS	Tetrachlorobiphenyls, Total
Aqueous/Solids	EPA 680	GC-MS	Pentachlorobiphenyls, Total
Aqueous/Solids	EPA 680	GC-MS	Hexachlorobiphenyls, Total
Aqueous/Solids	EPA 680	GC-MS	Heptachlorobiphenyls, Total
Aqueous/Solids	EPA 680	GC-MS	Octachlorobiphenyls, Total
Aqueous/Solids	EPA 680	GC-MS	Nonachlorobiphenyls, Total
Aqueous/Solids	EPA 680	GC-MS	Decachlorobiphenyls, Total
Aqueous/Solids	EPA 6850	HPLC-MS	Perchlorate



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Aqueous/Solids	EPA 7196A	UV-VIS	Chromium, hexavalent
Aqueous/Solids	EPA 7199	IC-UV	Chromium, hexavalent
Aqueous/Solids	EPA 8015C	GC-FID	Gasoline range organics
Aqueous/Solids	EPA 8015C	GC-FID	Diesel range organics
Aqueous/Solids	EPA 8081B	GC-ECD	4,4'-DDD
Aqueous/Solids	EPA 8081B	GC-ECD	4,4'-DDE
Aqueous/Solids	EPA 8081B	GC-ECD	4,4'-DDT
Aqueous/Solids	EPA 8081B	GC-ECD	Aldrin
Aqueous/Solids	EPA 8081B	GC-ECD	α -BHC
Aqueous/Solids	EPA 8081B	GC-ECD	Alpha-chlordane
Aqueous/Solids	EPA 8081B	GC-ECD	β -BHC
Aqueous/Solids	EPA 8081B	GC-ECD	Chlordane, technical
Aqueous/Solids	EPA 8081B	GC-ECD	δ -BHC
Aqueous/Solids	EPA 8081B	GC-ECD	Dieldrin
Aqueous/Solids	EPA 8081B	GC-ECD	Endosulfan I
Aqueous/Solids	EPA 8081B	GC-ECD	Endosulfan II
Aqueous/Solids	EPA 8081B	GC-ECD	Endosulfan sulfate
Aqueous/Solids	EPA 8081B	GC-ECD	Endrin
Aqueous/Solids	EPA 8081B	GC-ECD	Endrin aldehyde
Aqueous/Solids	EPA 8081B	GC-ECD	Endrin ketone
Aqueous/Solids	EPA 8081B	GC-ECD	γ -BHC (Lindane)
Aqueous/Solids	EPA 8081B	GC-ECD	γ -Chlordane
Aqueous/Solids	EPA 8081B	GC-ECD	Heptachlor
Aqueous/Solids	EPA 8081B	GC-ECD	Heptachlor epoxide
Aqueous/Solids	EPA 8081B	GC-ECD	Hexachlorobenzene
Aqueous/Solids	EPA 8081B	GC-ECD	Methoxychlor
Aqueous/Solids	EPA 8081B	GC-ECD	Toxaphene
Aqueous/Solids	EPA 8082A	GC-ECD	PCB 1016
Aqueous/Solids	EPA 8082A	GC-ECD	PCB 1221
Aqueous/Solids	EPA 8082A	GC-ECD	PCB 1232
Aqueous/Solids	EPA 8082A	GC-ECD	PCB 1242
Aqueous/Solids	EPA 8082A	GC-ECD	PCB 1248
Aqueous/Solids	EPA 8082A	GC-ECD	PCB 1254



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Aqueous/Solids	EPA 8082A	GC-ECD	PCB 1260
Aqueous/Solids	EPA 8082A	GC-ECD	PCB 1268
Aqueous/Solids	EPA 8151A	GC-ECD	2,4-D
Aqueous/Solids	EPA 8151A	GC-ECD	Dicamba
Aqueous/Solids	EPA 8151A	GC-ECD	2,4,5-T
Aqueous/Solids	EPA 8151A	GC-ECD	2,4,5-TP
Aqueous/Solids	EPA 8151A	GC-ECD	Pentachlorophenol (PCP)
Aqueous/Solids	EPA 8260C	GC-MS	1,1,1,2-Tetrachloroethane
Aqueous/Solids	EPA 8260C	GC-MS	1,1,1-Trichloroethane
Aqueous/Solids	EPA 8260C	GC-MS	1,1,2,2-Tetrachloroethane
Aqueous/Solids	EPA 8260C	GC-MS	1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)
Aqueous/Solids	EPA 8260C	GC-MS	1,1,2-Trichloroethane
Aqueous/Solids	EPA 8260C	GC-MS	1,1-Dichloroethane
Aqueous/Solids	EPA 8260C	GC-MS	1,1-Dichloroethene
Aqueous/Solids	EPA 8260C	GC-MS	1,1-Dichloropropene
Aqueous/Solids	EPA 8260C	GC-MS	1,2,3-Trichlorobenzene
Aqueous/Solids	EPA 8260C	GC-MS	1,2,3-Trichloropropane
Aqueous/Solids	EPA 8260C	GC-MS	1,2,4-Trichlorobenzene
Aqueous/Solids	EPA 8260C	GC-MS	1,2,4-Trimethylbenzene
Aqueous/Solids	EPA 8260C	GC-MS	1,2-Dibromo-3-chloropropane
Aqueous/Solids	EPA 8260C	GC-MS	1,2-Dibromoethane
Aqueous/Solids	EPA 8260C	GC-MS	1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon-114)
Aqueous/Solids	EPA 8260C	GC-MS	1,2-Dichloro-1,1,2-trifluoroethane (Freon 123a)
Aqueous/Solids	EPA 8260C	GC-MS	1,2-Dichlorobenzene
Aqueous/Solids	EPA 8260C	GC-MS	1,2-Dichloroethane
Aqueous/Solids	EPA 8260C	GC-MS	1,2-Dichloroethene, total
Aqueous/Solids	EPA 8260C	GC-MS	1,2-Dichloropropane
Aqueous/Solids	EPA 8260C	GC-MS	1,3,5-Trimethylbenzene
Aqueous/Solids	EPA 8260C	GC-MS	1,3-Dichlorobenzene
Aqueous/Solids	EPA 8260C	GC-MS	1,3-Dichloropropane
Aqueous/Solids	EPA 8260C	GC-MS	1,4-Dichlorobenzene
Aqueous/Solids	EPA 8260C	GC-MS	1,4-Dioxane



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Aqueous/Solids	EPA 8260C	GC-MS	2,2-Dichloro-1,1,1-trifluoroethane (Freon 123)
Aqueous/Solids	EPA 8260C	GC-MS	2,2-Dichloropropane
Aqueous/Solids	EPA 8260C	GC-MS	2-Butanone (MEK)
Aqueous/Solids	EPA 8260C	GC-MS	2-Chloro-1,3-butadiene
Aqueous/Solids	EPA 8260C	GC-MS	2-Chloroethylvinyl ether
Aqueous/Solids	EPA 8260C	GC-MS	2-Chlorotoluene
Aqueous/Solids	EPA 8260C	GC-MS	2-Hexanone
Aqueous/Solids	EPA 8260C	GC-MS	2-Methyl-1-propanol (Isobutyl alcohol)
Aqueous/Solids	EPA 8260C	GC-MS	2-Methyl-2-propanol (Tertbutyl alcohol)
Aqueous/Solids	EPA 8260C	GC-MS	2-Nitropropane
Aqueous/Solids	EPA 8260C	GC-MS	2-Propanol
Aqueous/Solids	EPA 8260C	GC-MS	3-Chloro-1-propene (Allyl chloride)
Aqueous/Solids	EPA 8260C	GC-MS	4-Chlorotoluene
Aqueous/Solids	EPA 8260C	GC-MS	4-Ethyltoluene
Aqueous/Solids	EPA 8260C	GC-MS	4-Isopropyltoluene
Aqueous/Solids	EPA 8260C	GC-MS	4-Methyl-2-pentanone (MIBK)
Aqueous/Solids	EPA 8260C	GC-MS	Acetone
Aqueous/Solids	EPA 8260C	GC-MS	Acetonitrile
Aqueous/Solids	EPA 8260C	GC-MS	Acrolein
Aqueous/Solids	EPA 8260C	GC-MS	Acrylonitrile
Aqueous/Solids	EPA 8260C	GC-MS	Benzene
Aqueous/Solids	EPA 8260C	GC-MS	Benzyl chloride
Aqueous/Solids	EPA 8260C	GC-MS	Bromobenzene
Aqueous/Solids	EPA 8260C	GC-MS	Bromochloromethane
Aqueous/Solids	EPA 8260C	GC-MS	Bromodichloromethane
Aqueous/Solids	EPA 8260C	GC-MS	Bromoform
Aqueous/Solids	EPA 8260C	GC-MS	Bromomethane
Aqueous/Solids	EPA 8260C	GC-MS	Carbon disulfide
Aqueous/Solids	EPA 8260C	GC-MS	Carbon tetrachloride
Aqueous/Solids	EPA 8260C	GC-MS	Chlorobenzene
Aqueous/Solids	EPA 8260C	GC-MS	Chloroethane
Aqueous/Solids	EPA 8260C	GC-MS	Chloroform
Aqueous/Solids	EPA 8260C	GC-MS	Chloromethane



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Aqueous/Solids	EPA 8260C	GC-MS	cis-1,2-Dichloroethene
Aqueous/Solids	EPA 8260C	GC-MS	cis-1,3-Dichloropropene
Aqueous/Solids	EPA 8260C	GC-MS	Cyclohexane
Aqueous/Solids	EPA 8260C	GC-MS	Cyclohexanone
Aqueous/Solids	EPA 8260C	GC-MS	Dibromochloromethane
Aqueous/Solids	EPA 8260C	GC-MS	Dibromomethane
Aqueous/Solids	EPA 8260C	GC-MS	Dichlorodifluoromethane (Freon 12)
Aqueous/Solids	EPA 8260C	GC-MS	Dichlorofluoromethane (Freon 21)
Aqueous/Solids	EPA 8260C	GC-MS	Dichloromethane
Aqueous/Solids	EPA 8260C	GC-MS	Diethyl ether
Aqueous/Solids	EPA 8260C	GC-MS	Diisopropyl ether
Aqueous/Solids	EPA 8260C	GC-MS	Ethyl methacrylate
Aqueous/Solids	EPA 8260C	GC-MS	Ethyl tert-butyl ether
Aqueous/Solids	EPA 8260C	GC-MS	Ethylbenzene
Aqueous/Solids	EPA 8260C	GC-MS	Hexachlorobutadiene
Aqueous/Solids	EPA 8260C	GC-MS	Iodomethane
Aqueous/Solids	EPA 8260C	GC-MS	Isopropylbenzene
Aqueous/Solids	EPA 8260C	GC-MS	m- + p-Xylene
Aqueous/Solids	EPA 8260C	GC-MS	Methacrylonitrile
Aqueous/Solids	EPA 8260C	GC-MS	Methyl acetate
Aqueous/Solids	EPA 8260C	GC-MS	Methyl methacrylate
Aqueous/Solids	EPA 8260C	GC-MS	Methylcyclohexane
Aqueous/Solids	EPA 8260C	GC-MS	Methyl-tert-butyl ether (MTBE)
Aqueous/Solids	EPA 8260C	GC-MS	Napthalene
Aqueous/Solids	EPA 8260C	GC-MS	N-butylacetate
Aqueous/Solids	EPA 8260C	GC-MS	N-butylbenzene
Aqueous/Solids	EPA 8260C	GC-MS	N-heptane
Aqueous/Solids	EPA 8260C	GC-MS	N-propylbenzene
Aqueous/Solids	EPA 8260C	GC-MS	o-Xylene
Aqueous/Solids	EPA 8260C	GC-MS	Propionitrile
Aqueous/Solids	EPA 8260C	GC-MS	sec-butylbenzene
Aqueous/Solids	EPA 8260C	GC-MS	Styrene
Aqueous/Solids	EPA 8260C	GC-MS	tert-amyl methyl ether



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Aqueous/Solids	EPA 8260C	GC-MS	tert-butylbenzene
Aqueous/Solids	EPA 8260C	GC-MS	Tetra hydrofuran
Aqueous/Solids	EPA 8260C	GC-MS	Tetrachloroethene
Aqueous/Solids	EPA 8260C	GC-MS	Toluene
Aqueous/Solids	EPA 8260C	GC-MS	trans-1,2-Dichloroethene
Aqueous/Solids	EPA 8260C	GC-MS	trans-1,3-Dichloropropene
Aqueous/Solids	EPA 8260C	GC-MS	trans-1,4-Dichloro-2-butene
Aqueous/Solids	EPA 8260C	GC-MS	Trichloroethene
Aqueous/Solids	EPA 8260C	GC-MS	Trichlorofluoromethane (Freon 11)
Aqueous/Solids	EPA 8260C	GC-MS	Vinyl acetate
Aqueous/Solids	EPA 8260C	GC-MS	Vinyl chloride
Aqueous/Solids	EPA 8260C	GC-MS	Xylenes, total
Aqueous/Solids	EPA 8270D	GC-MS	1,2,4,5-Tetrachlorobenzene
Aqueous/Solids	EPA 8270D	GC-MS	1,2,4-Trichlorobenzene
Aqueous/Solids	EPA 8270D	GC-MS	1,2-Dichlorobenzene
Aqueous/Solids	EPA 8270D	GC-MS	1,2-Diphenylhydrazine
Aqueous/Solids	EPA 8270D	GC-MS	1,3,5-Trinitrobenzene
Aqueous/Solids	EPA 8270D	GC-MS	1,3-Dichlorobenzene
Aqueous/Solids	EPA 8270D	GC-MS	1,3-Dinitrobenzene
Aqueous/Solids	EPA 8270D	GC-MS	1,4-Dichlorobenzene
Aqueous/Solids	EPA 8270D	GC-MS	1,4-Dioxane
Aqueous/Solids	EPA 8270D	GC-MS	1,4-Naphthoquinone
Aqueous/Solids	EPA 8270D	GC-MS	1-Methyl-2-pyrrolidinone
Aqueous/Solids	EPA 8270D	GC-MS	1-Methylnaphthalene
Aqueous/Solids	EPA 8270D	GC-MS	1-Naphthylamine
Aqueous/Solids	EPA 8270D	GC-MS	2,3,4,6-Tetrachlorophenol
Aqueous/Solids	EPA 8270D	GC-MS	2,4,5-Trichlorophenol
Aqueous/Solids	EPA 8270D	GC-MS	2,4,6-Trichlorophenol
Aqueous/Solids	EPA 8270D	GC-MS	2,4-Dichlorophenol
Aqueous/Solids	EPA 8270D	GC-MS	2,4-Dimethylphenol
Aqueous/Solids	EPA 8270D	GC-MS	2,4-Dinitrophenol
Aqueous/Solids	EPA 8270D	GC-MS	2,4-Dinitrotoluene
Aqueous/Solids	EPA 8270D	GC-MS	2,6-Dichlorophenol



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Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solids	EPA 8270D	GC-MS	2,6-Dinitrotoluene
Aqueous/Solids	EPA 8270D	GC-MS	2-Acetylaminofluorene
Aqueous/Solids	EPA 8270D	GC-MS	2-Chloronaphthalene
Aqueous/Solids	EPA 8270D	GC-MS	2-Chlorophenol
Aqueous/Solids	EPA 8270D	GC-MS	2-Methyl-5-nitroaniline (5-Nitro-o-toluidine)
Aqueous/Solids	EPA 8270D	GC-MS	2-Methylnaphthalene
Aqueous/Solids	EPA 8270D	GC-MS	2-Methylphenol
Aqueous/Solids	EPA 8270D	GC-MS	2-Naphthylamine
Aqueous/Solids	EPA 8270D	GC-MS	2-Nitroaniline
Aqueous/Solids	EPA 8270D	GC-MS	2-Nitrophenol
Aqueous/Solids	EPA 8270D	GC-MS	2-Picoline
Aqueous/Solids	EPA 8270D	GC-MS	3,3'-Dichlorobenzidine
Aqueous/Solids	EPA 8270D	GC-MS	3,3'-Dimethylbenzidine
Aqueous/Solids	EPA 8270D	GC-MS	3+4-Methylphenol
Aqueous/Solids	EPA 8270D	GC-MS	3-Methylcholanthrene
Aqueous/Solids	EPA 8270D	GC-MS	3-Nitroaniline
Aqueous/Solids	EPA 8270D	GC-MS	4,6-Dinitro-2-methylphenol
Aqueous/Solids	EPA 8270D	GC-MS	4-Aminobiphenyl
Aqueous/Solids	EPA 8270D	GC-MS	4-Bromophenyl-phenylether
Aqueous/Solids	EPA 8270D	GC-MS	4-Chloro-3-methylphenol
Aqueous/Solids	EPA 8270D	GC-MS	4-Chloroaniline
Aqueous/Solids	EPA 8270D	GC-MS	4-Chlorophenyl-phenylether
Aqueous/Solids	EPA 8270D	GC-MS	4-Nitroaniline
Aqueous/Solids	EPA 8270D	GC-MS	4-Nitrophenol
Aqueous/Solids	EPA 8270D	GC-MS	4-Nitroquinoline-1-oxide
Aqueous/Solids	EPA 8270D	GC-MS	7,12-Dimethylbenz(a)anthracene
Aqueous/Solids	EPA 8270D	GC-MS	α,α -Dimethylphenethylamine
Aqueous/Solids	EPA 8270D	GC-MS	Acenaphthene
Aqueous/Solids	EPA 8270D	GC-MS	Acenaphthylene
Aqueous/Solids	EPA 8270D	GC-MS	Acetophenone
Aqueous/Solids	EPA 8270D	GC-MS	Aniline
Aqueous/Solids	EPA 8270D	GC-MS	Anthracene
Aqueous/Solids	EPA 8270D	GC-MS	Aramite



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Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solids	EPA 8270D	GC-MS	Atrazine
Aqueous/Solids	EPA 8270D	GC-MS	Benzaldehyde
Aqueous/Solids	EPA 8270D	GC-MS	Benzidine
Aqueous/Solids	EPA 8270D	GC-MS	Benzo(a)anthracene
Aqueous/Solids	EPA 8270D	GC-MS	Benzo(a)pyrene
Aqueous/Solids	EPA 8270D	GC-MS	Benzo(b)fluoranthene
Aqueous/Solids	EPA 8270D	GC-MS	Benzo(g,h,i)perylene
Aqueous/Solids	EPA 8270D	GC-MS	Benzo(k)fluoranthene
Aqueous/Solids	EPA 8270D	GC-MS	Benzoic acid
Aqueous/Solids	EPA 8270D	GC-MS	Benzyl alcohol
Aqueous/Solids	EPA 8270D	GC-MS	Biphenyl
Aqueous/Solids	EPA 8270D	GC-MS	Bis(1-chloroisopropyl)ether
Aqueous/Solids	EPA 8270D	GC-MS	Bis(-2-chloroethoxy)methane
Aqueous/Solids	EPA 8270D	GC-MS	Bis(2-chloroethyl)ether
Aqueous/Solids	EPA 8270D	GC-MS	Bis(2-ethylhexyl)phthalate
Aqueous/Solids	EPA 8270D	GC-MS	Butyl benzyl phthalate
Aqueous/Solids	EPA 8270D	GC-MS	Caprolactam
Aqueous/Solids	EPA 8270D	GC-MS	Carbazole
Aqueous/Solids	EPA 8270D	GC-MS	Chlorobenzilate
Aqueous/Solids	EPA 8270D	GC-MS	Chrysene
Aqueous/Solids	EPA 8270D	GC-MS	Cyclohexane, isothiocyanato-
Aqueous/Solids	EPA 8270D	GC-MS	Diallate
Aqueous/Solids	EPA 8270D	GC-MS	Dibenzo(a,h)anthracene
Aqueous/Solids	EPA 8270D	GC-MS	Dibenzofuran
Aqueous/Solids	EPA 8270D	GC-MS	Diethylphthalate
Aqueous/Solids	EPA 8270D	GC-MS	Dimethoate
Aqueous/Solids	EPA 8270D	GC-MS	Dimethyl phthalate
Aqueous/Solids	EPA 8270D	GC-MS	Di-n-butylphthalate
Aqueous/Solids	EPA 8270D	GC-MS	Di-n-octyl phthalate
Aqueous/Solids	EPA 8270D	GC-MS	Dinoseb
Aqueous/Solids	EPA 8270D	GC-MS	Diphenylamine
Aqueous/Solids	EPA 8270D	GC-MS	Disulfoton
Aqueous/Solids	EPA 8270D	GC-MS	Ethyl methanesulfonate



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Matrix	Standard/Method	Technology	Analyte
Aqueous/Solids	EPA 8270D	GC-MS	Fluoranthene
Aqueous/Solids	EPA 8270D	GC-MS	Fluorene
Aqueous/Solids	EPA 8270D	GC-MS	Hexachlorobenzene
Aqueous/Solids	EPA 8270D	GC-MS	Hexachlorobutadiene
Aqueous/Solids	EPA 8270D	GC-MS	Hexachlorocyclopentadiene
Aqueous/Solids	EPA 8270D	GC-MS	Hexachloroethane
Aqueous/Solids	EPA 8270D	GC-MS	Hexachlorophene
Aqueous/Solids	EPA 8270D	GC-MS	Hexachloropropene
Aqueous/Solids	EPA 8270D	GC-MS	Indeno(1,2,3-cd)pyrene
Aqueous/Solids	EPA 8270D	GC-MS	Isodrin
Aqueous/Solids	EPA 8270D	GC-MS	Isophorone
Aqueous/Solids	EPA 8270D	GC-MS	Isosafrole
Aqueous/Solids	EPA 8270D	GC-MS	Methapyrilene
Aqueous/Solids	EPA 8270D	GC-MS	Methyl methanesulfonate
Aqueous/Solids	EPA 8270D	GC-MS	Methyl parathion
Aqueous/Solids	EPA 8270D	GC-MS	Naphthalene
Aqueous/Solids	EPA 8270D	GC-MS	Nitrobenzene
Aqueous/Solids	EPA 8270D	GC-MS	N-nitrosodiethylamine
Aqueous/Solids	EPA 8270D	GC-MS	N-nitrosodimethylamine
Aqueous/Solids	EPA 8270D	GC-MS	N-nitrosodi-n-butylamine
Aqueous/Solids	EPA 8270D	GC-MS	N-nitroso-di-n-propylamine
Aqueous/Solids	EPA 8270D	GC-MS	N-nitrosodiphenylamine
Aqueous/Solids	EPA 8270D	GC-MS	N-nitrosomethylethylamine
Aqueous/Solids	EPA 8270D	GC-MS	N-nitrosomorpholine
Aqueous/Solids	EPA 8270D	GC-MS	N-nitrosopiperidine
Aqueous/Solids	EPA 8270D	GC-MS	N-nitrosopyrrolidine
Aqueous/Solids	EPA 8270D	GC-MS	Octachlorostyrene
Aqueous/Solids	EPA 8270D	GC-MS	o,o,o-triethyl phosphorothioate
Aqueous/Solids	EPA 8270D	GC-MS	o-toluidine
Aqueous/Solids	EPA 8270D	GC-MS	Parathion (ethyl)
Aqueous/Solids	EPA 8270D	GC-MS	p-dimethylaminoazobenzene
Aqueous/Solids	EPA 8270D	GC-MS	Pentachlorobenzene
Aqueous/Solids	EPA 8270D	GC-MS	Pentachloroethane



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Matrix	Standard/Method	Technology	Analyte
Aqueous/Solids	EPA 8270D	GC-MS	Pentachloronitrobenzene
Aqueous/Solids	EPA 8270D	GC-MS	Pentachlorophenol
Aqueous/Solids	EPA 8270D	GC-MS	Phenacetin
Aqueous/Solids	EPA 8270D	GC-MS	Phenanthrene
Aqueous/Solids	EPA 8270D	GC-MS	Phenol
Aqueous/Solids	EPA 8270D	GC-MS	Phorate
Aqueous/Solids	EPA 8270D	GC-MS	Phthalimide
Aqueous/Solids	EPA 8270D	GC-MS	Pyrene
Aqueous/Solids	EPA 8270D	GC-MS	Pyridine
Aqueous/Solids	EPA 8270D	GC-MS	Safrole
Aqueous/Solids	EPA 8270D	GC-MS	Sulfotepp
Aqueous/Solids	EPA 8270D	GC-MS	Thionazin
Aqueous/Solids	EPA 8270D	GC-MS-LL	1,4-Dioxane
Aqueous/Solids	EPA 8270D	GC-MS-LL	1-Methylnaphthalene
Aqueous/Solids	EPA 8270D	GC-MS-LL	2-Methylnaphthalene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Acenaphthene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Acenaphthylene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Anthracene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Benzo(a)anthracene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Benzo(a)pyrene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Benzo(b)fluoranthene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Benzo(g,h,i)perylene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Benzo(k)fluoranthene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Bis(2-ethylhexyl)phthalate
Aqueous/Solids	EPA 8270D	GC-MS-LL	Butyl benzyl phthalate
Aqueous/Solids	EPA 8270D	GC-MS-LL	Carbazole
Aqueous/Solids	EPA 8270D	GC-MS-LL	Chrysene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Dibenzo(a,h)anthracene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Dibenzofuran
Aqueous/Solids	EPA 8270D	GC-MS-LL	Diethyl phthalate
Aqueous/Solids	EPA 8270D	GC-MS-LL	Dimethyl phthalate
Aqueous/Solids	EPA 8270D	GC-MS-LL	Di-n-butyl phthalate
Aqueous/Solids	EPA 8270D	GC-MS-LL	Di-n-octyl phthalate



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Matrix	Standard/Method	Technology	Analyte
Aqueous/Solids	EPA 8270D	GC-MS-LL	Fluoranthene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Fluorene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Hexachlorobenzene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Indeno(1,2,3-cd)pyrene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Naphthalene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Nitrobenzene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Octachlorostyrene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Phenanthrene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Pyrene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Pyridine
Aqueous/Solids	EPA 9012A, B	UV-VIS	Cyanide, total
Aqueous/Solids	EPA 9034	Titration	Sulfide, acid soluble
Aqueous/Solids	EPA 9056A	IC	Bromide
Aqueous/Solids	EPA 9056A	IC	Chloride
Aqueous/Solids	EPA 9056A	IC	Fluoride
Aqueous/Solids	EPA 9056A	IC	Nitrate as Nitrogen
Aqueous/Solids	EPA 9056A	IC	Nitrite as Nitrogen
Aqueous/Solids	EPA 9056A	IC	Sulfate
Aqueous/Solids	GEN-AVS	Titrimetric	Acid Volatile Sulfide
Aqueous/Solids	EPA 8330B	HPLC	1,3,5-Trinitrobenzene
Aqueous/Solids	EPA 8330B	HPLC	1,3-Dinitrobenzene
Aqueous/Solids	EPA 8330B	HPLC	2,4,6-Trinitrotoluene (TNT)
Aqueous/Solids	EPA 8330B	HPLC	2,4-Dinitrotoluene
Aqueous/Solids	EPA 8330B	HPLC	2,6-Dinitrotoluene
Aqueous/Solids	EPA 8330B	HPLC	2-Amino 4,6-Dinitrotoluene
Aqueous/Solids	EPA 8330B	HPLC	2-Nitrotoluene
Aqueous/Solids	EPA 8330B	HPLC	3,5-Dinitroaniline
Aqueous/Solids	EPA 8330B	HPLC	3-Nitrotoluene
Aqueous/Solids	EPA 8330B	HPLC	4-Amino 2,6-Dinitrotoluene
Aqueous/Solids	EPA 8330B	HPLC	4-Nitrotoluene
Aqueous/Solids	EPA 8330B	HPLC	Hexahydro 1,3,5-Trinitro 1,3,5-Triazine
Aqueous/Solids	EPA 8330B	HPLC	Methyl 2,4,6 Trinitrophenylnitramine
Aqueous/Solids	EPA 8330B	HPLC	Nitrobenzene
Aqueous/Solids	EPA 8330B	HPLC	Nitroglycerin



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Matrix	Standard/Method	Technology	Analyte
Aqueous/Solids	EPA 8330B	HPLC	Octahydro 1.3.5.7 Tetranitro 1,3,5,7 Tetraz
Aqueous/Solids	EPA 8330B	HPLC	Pentaerythritol Tetranitrate (PETN)
Aqueous/Solids	HPLC-METACID	HPLC	Acetic Acid
Aqueous/Solids	HPLC-METACID	HPLC	Butanoic Acid (Butyric Acid)
Aqueous/Solids	HPLC-METACID	HPLC	Lactic Acid
Aqueous/Solids	HPLC-METACID	HPLC	Propionic Acid
Aqueous/Solids	HPLC-METACID	HPLC	Pyruvic Acid

Matrix	Standard/Method	Technology	Analyte
Aqueous	EPA 3010A	Acid Digestion	Metals prep
Aqueous	EPA 3510C	SF Extraction	Semivolatiles, pesticides, PCBs, DRO
Aqueous	EPA 5030B	P&T	Volatiles
Solids	EPA 3050B	Acid Digestion	Metals prep
Solids	EPA 3060A	Digestion	Hexavalent chromium digestion
Solids	EPA 3541	SOX Extraction	Semivolatiles, pesticides, PCBs, DRO
Solids	EPA 5035	P&T closed	Volatiles
Aqueous/Solids	EPA 1311	TCLP	Physical Extraction
Aqueous/Solids	EPA 1312	SPLP	Physical Extraction
Aqueous/Solids	EPA 3620B	Florisil Cleanup	Semivolatiles, pesticides, PCBs
Aqueous/Solids	EPA 3660B	Sulfur Cleanup	Semivolatiles, pesticides, PCBs
Aqueous/Solids	EPA 3665A	Sulfuric Acid Cleanup	PCBs
Aqueous/Solids	EPA 9012A, B	Distillation	Cyanide
Aqueous/Solids	EPA 9030B	Distillation	Sulfide, acid soluble



SCOPE OF ACCREDITATION TO ISO/IEC 17025-2005

ENVIRONMENTAL CONSERVATION LABORATORIES – JACKSONVILLE

4810 Executive Park Court, Suite 111

Jacksonville, FL 32216

Denise K. Stern Phone: 904 296 3007

Email address: dstern@encolabs.com

ENVIRONMENTAL

Valid To: April 30, 2014

Certificate Number: 3000.02

In recognition of the successful completion of the A2LA evaluation process, (including an assessment of the laboratory's compliance with ISO IEC 17025:2005, the 2003 NELAC Chapter 5 Standard, and the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 4.2 of the DoD Quality Systems Manual for Environmental Laboratories) accreditation is granted to this laboratory to perform recognized EPA methods using the following testing technologies and in the analyte categories identified below:

<u>Parameter/Analyte</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste</u>	<u>Air</u>
Isopropyl alcohol (2-Propanol)	EPA 8015C	NA	ENCO VGCMS-07
4-Ethyltoluene	NA	NA	ENCO VGCMS-07
Cyclohexane	EPA 8260B	EPA 8260B	ENCO VGCMS-07
1,1,1-Trichloroethane	EPA 624, 8260B	EPA 8260B	EPA TO-14A, EPA TO-15
1,1,2,2-Tetrachloroethane	EPA 624, 8260B	EPA 8260B	EPA TO-14A, EPA TO-15
1,1,2-Trichloro-1,2,2-trifluoroethane	EPA 8260B	EPA 8260B	EPA TO-14A
1,1,2-Trichloroethane	EPA 624, 8260B	EPA 8260B	EPA TO-14A, EPA TO-15
1,1-Dichloroethane	EPA 624, 8260B	EPA 8260B	EPA TO-14A, EPA TO-15
1,1-Dichloroethylene	EPA 624, 8260B	EPA 8260B	EPA TO-14A, EPA TO-15
1,2-Dichloro-1,1,2,2-tetrafluoroethane	NA	NA	EPA TO-14A
1,3-Butadiene	NA	NA	EPA TO-15
1,4-Dioxane	EPA 8260B	EPA 8260B	EPA TO-15
2,2,4-Trimethylpentane	NA	NA	EPA TO-15
Benzyl chloride	NA	NA	EPA TO-15
n-Hexane	NA	NA	EPA TO-15
2-Hydroxy isobutyric acid	ENCO VGC-13	NA	NA
Acetic acid	ENCO VGC-13	NA	NA
Butyric acid (Butanoic acid)	ENCO VGC-13	NA	NA
Hexanoic acid	ENCO VGC-13	NA	NA
Isohexanoic acid (4-methyl-pentanoic acid)	ENCO VGC-13	NA	NA
Isopentanoic acid (3-methyl-butanoic acid)	ENCO VGC-13	NA	NA
Lactic acid	ENCO VGC-13	NA	NA
Pentanoic acid	ENCO VGC-13	NA	NA

<u>Parameter/Analyte</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste</u>	<u>Air</u>
Propionic acid (Propanoic acid)	ENCO VGC-13	NA	NA
Pyruvic acid	ENCO VGC-13	NA	NA
Propylene glycol	ENCO VGC-18	NA	NA
Ethyl acetate	EPA 8015C	NA	ENCO VGCMS-07
Ethylene glycol	EPA 8015C	NA	NA
Diesel range organics (DRO)	EPA 8015C	EPA 8015C	NA
Gasoline range organics (GRO)	EPA 8015C	EPA 8015C	NA
Isobutyl alcohol (2-Methyl-1-propanol)	EPA 8015C, 8260B	EPA 8260B	NA
Methanol	EPA 8015C	EPA 8015C	NA
n-Butyl alcohol	EPA 8015C	NA	NA
n-Propanol	EPA 8015C	NA	NA
1,2-Dibromo-3-chloropropane (DBCP)	EPA 504, 504.1, 8011, 8260B	EPA 8260B	NA
1,2-Dibromoethane (EDB, Ethylene dibromide)	EPA 504, 504.1, 8011, 8260B	EPA 8260B	EPA TO-14A, EPA TO-15
1,2-Dichlorobenzene	EPA 624, 8260B, 8270D	EPA 8260B, 8270D	EPA TO-14A, EPA TO-15
1,2-Dichloroethane	EPA 624, 8260B	EPA 8260B	EPA TO-14A, EPA TO-15
1,2-Dichloropropane	EPA 624, 8260B	EPA 8260B	EPA TO-14A, EPA TO-15
1,3-Dichlorobenzene	EPA 624, 8260B, 8270D	EPA 8260B, 8270D	EPA TO-14A, EPA TO-15
1,4-Dichlorobenzene	EPA 624, 8260B, 8270D	EPA 8260B, 8270D	EPA TO-14A, EPA TO-15
2-Chloroethyl vinyl ether	EPA 624, 8260B	EPA 8260B	NA
Acrolein (Propenal)	EPA 624, 8260B	EPA 8260B	NA
Acrylonitrile	EPA 624, 8260B	EPA 8260B	NA
Benzene	EPA 624, 8260B	EPA 8260B	EPA TO-14A, EPA TO-15
Bromodichloromethane	EPA 624, 8260B	EPA 8260B	ENCO VGCMS-07
Bromoform	EPA 624, 8260B	EPA 8260B	EPA TO-15
Carbon tetrachloride	EPA 624, 8260B	EPA 8260B	EPA TO-14A, EPA TO-15
Chlorobenzene	EPA 624, 8260B	EPA 8260B	EPA TO-14A, EPA TO-15
Chloroethane	EPA 624, 8260B	EPA 8260B	EPA TO-14A, EPA TO-15
Chloroform	EPA 624, 8260B	EPA 8260B	EPA TO-14A, EPA TO-15
cis-1,3-Dichloropropene	EPA 624, 8260B	EPA 8260B	EPA TO-14A, EPA TO-15
Dibromochloromethane	EPA 624, 8260B	EPA 8260B	ENCO VGCMS-07
Ethylbenzene	EPA 624, 8260B	EPA 8260B	EPA TO-14A, EPA TO-15
Methyl bromide (Bromomethane)	EPA 624, 8260B	EPA 8260B	EPA TO-14A, EPA TO-15
Methyl chloride (Chloromethane)	EPA 624, 8260B	EPA 8260B	EPA TO-14A, EPA TO-15
Methylene chloride	EPA 624, 8260B	EPA 8260B	EPA TO-14A, EPA TO-15
Tetrachloroethylene	EPA 624, 8260B	EPA 8260B	EPA TO-14A, EPA TO-15
Toluene	EPA 624, 8260B	EPA 8260B	EPA TO-14A, EPA TO-15
trans-1,2-Dichloroethylene	EPA 624, 8260B	EPA 8260B	EPA TO-15
trans-1,3-Dichloropropylene	EPA 624, 8260B	EPA 8260B	EPA TO-14A, EPA TO-15
Trichloroethene	EPA 624, 8260B	EPA 8260B	EPA TO-14A, EPA TO-15
Trichlorofluoromethane	EPA 624, 8260B	EPA 8260B	EPA-TO-14A
Vinyl chloride	EPA 624, 8260B	EPA 8260B	EPA TO-14A, EPA TO-15
Xylene (total)	EPA 624, 8260B	EPA 8260B	EPA TO-14A, EPA TO-15
1,1,1,2-Tetrachloroethane	EPA 8260B	EPA 8260B	NA
1,1-Dichloropropene	EPA 8260B	EPA 8260B	NA
1,2,3-Trichlorobenzene	EPA 8260B	EPA 8260B	NA

<u>Parameter/Analyte</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste</u>	<u>Air</u>
1,2,3-Trichloropropane	EPA 8260B	EPA 8260B	NA
1,2,4-Trichlorobenzene	EPA 8260B, 625, 8270D	EPA 8260B, 8270D	EPA TO-14A, EPA TO-15
1,2,4-Trimethylbenzene	EPA 8260B	EPA 8260B	EPA TO-14A
1,3,5-Trimethylbenzene	EPA 8260B	EPA 8260B	EPA TO-14A
1,3-Dichloropropane	EPA 8260B	EPA 8260B	NA
2,2-Dichloropropane	EPA 8260B	EPA 8260B	NA
2-Butanone (Methyl ethyl ketone, MEK)	EPA 8260B, 8015C	EPA 8260B	EPA TO-15
2-Chlorotoluene	EPA 8260B	EPA 8260B	NA
2-Hexanone	EPA 8260B	EPA 8260B	ENCO VGCMS-07
4-Chlorotoluene	EPA 8260B	EPA 8260B	NA
4-Methyl-2-pentanone (MIBK)	EPA 8260B, 8015C	EPA 8260B	EPA TO-15
Acetone	EPA 8260B	EPA 8260B	ENCO VGCMS-07
Acetonitrile	EPA 8260B	EPA 8260B	NA
Allyl chloride (3-Chloropropene)	EPA 8260B	EPA 8260B	EPA TO-15
Bromobenzene	EPA 8260B	EPA 8260B	NA
Bromochloromethane	EPA 8260B	EPA 8260B	NA
Carbon disulfide	EPA 8260B	EPA 8260B	EPA TO-15
Chloroprene	EPA 8260B	EPA 8260B	NA
cis-1,2-Dichloroethylene	EPA 8260B	EPA 8260B	EPA TO-14A, EPA TO-15
Dibromomethane	EPA 8260B	EPA 8260B	NA
Dichlorodifluoromethane	EPA 8260B	EPA 8260B	EPA TO-14A
Diethyl ether	EPA 8260B	EPA 8260B	NA
Ethanol	EPA 8260B, 8015C	EPA 8260B	NA
Ethyl methacrylate	EPA 8260B	EPA 8260B	NA
Hexachlorobutadiene	EPA 8260B, 625, 8270D	EPA 8260B, 8270D	EPA TO-14A, EPA TO-15
Iodomethane (Methyl iodine)	EPA 8260B	EPA 8260B	NA
Isopropylbenzene	EPA 8260B	EPA 8260B	NA
Isopropyl ether	EPA 8260B	EPA 8260B	NA
Methacrylonitrile	EPA 8260B	EPA 8260B	NA
Methyl Acetate	EPA 8260B	EPA 8260B	NA
Methyl Cyclohexane	EPA 8260B	EPA 8260B	NA
Methyl methacrylate	EPA 8260B	EPA 8260B	NA
Methyl tert-butyl ether (MTBE)	EPA 8260B	EPA 8260B	EPA TO-15
m.p-Xylene	EPA 8260B	EPA 8260B	EPA TO-14A, EPA TO-15
Naphthalene	EPA 8260B, 625 Scan-Sim, 8270D Scan-Sim	EPA 8260B, 8270D Scan-Sim	NA
n-Butyl benzene	EPA 8260B	EPA 8260B	NA
n-Propyl benzene	EPA 8260B	EPA 8260B	NA
o-Xylene	EPA 8260B	EPA 8260B	EPA TO-14A, EPA TO-15
p-Isopropyltoluene	EPA 8260B	EPA 8260B	NA
Propionitrile (Ethyl cyanide)	EPA 8260B	EPA 8260B	NA
sec-Butylbenzene	EPA 8260B	EPA 8260B	NA
Styrene	EPA 8260B	EPA 8260B	EPA TO-14A, EPA TO-15
tert-Butylbenzene	EPA 8260B	EPA 8260B	NA
trans-1,4-Dichloro-2-butene	EPA 8260B	EPA 8260B	NA
Vinyl acetate	EPA 8260B	EPA 8260B	EPA TO-15
4,4'-DDD	EPA 608, 8081B	EPA 8081B	NA
4,4'-DDE	EPA 608, 8081B	EPA 8081B	NA

<u>Parameter/Analyte</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste</u>	<u>Air</u>
4,4'-DDT	EPA 608, 8081B	EPA 8081B	NA
Aldrin	EPA 608, 8081B	EPA 8081B	NA
alpha-BHC (alpha-Hexachlorocyclohexane)	EPA 608, 8081B	EPA 8081B	NA
Aroclor-1016(PCB-1016)	EPA 608, 8082A	EPA 8082A	NA
Aroclor-1221(PCB-1221)	EPA 608, 8082A	EPA 8082A	NA
Aroclor-1232(PCB-1232)	EPA 608, 8082A	EPA 8082A	NA
Aroclor-1242(PCB-1242)	EPA 608, 8082A	EPA 8082A	NA
Aroclor-1248(PCB-1248)	EPA 608, 8082A	EPA 8082A	NA
Aroclor-1254(PCB-1254)	EPA 608, 8082A	EPA 8082A	NA
Aroclor-1260(PCB-1260)	EPA 608, 8082A	EPA 8082A	NA
Aroclor-1262(PCB-1260)	EPA 608, 8082A	EPA 8082A	NA
Aroclor-1268(PCB-1260)	EPA 608, 8082A	EPA 8082A	NA
beta-BHC (beta-Hexachlorocyclohexane)	EPA 608, 8081B	EPA 8081B	NA
Chlordane(tech.)	EPA 608, 8081B	EPA 8081B	NA
delta-BHC	EPA 608, 8081B	EPA 8081B	NA
Dieldrin	EPA 608, 8081B	EPA 8081B	NA
Endosulfan I	EPA 608, 8081B	EPA 8081B	NA
Endosulfan II	EPA 608, 8081B	EPA 8081B	NA
Endosulfan sulfate	EPA 608, 8081B	EPA 8081B	NA
Endrin	EPA 608, 8081B	EPA 8081B	NA
Endrin aldehyde	EPA 608, 8081B	EPA 8081B	NA
gamma-BHC (Lindane,gamma-Hexachlorocyclohexane)	EPA 608, 8081B	EPA 8081B	NA
Heptachlor	EPA 608, 8081B	EPA 8081B	NA
Heptachlor epoxide	EPA 608, 8081B	EPA 8081B	NA
Toxaphene (Chlorinated camphene)	EPA 608, 8081B	EPA 8081B	NA
alpha-Chlordane	EPA 8081B	EPA 8081B	NA
Endrin ketone	EPA 8081B	EPA 8081B	NA
gamma-Chlordane	EPA 8081B	EPA 8081B	NA
Isodrin	EPA 8081B, 8270D	EPA 8081B, 8270D	NA
Methoxychlor	EPA 8081B	EPA 8081B	NA
Mirex	EPA 8081B	EPA 8081B	NA
Kepone	EPA 8270D	EPA 8270D	NA
o,o,o-Triethylphosphorothioate	EPA 8270D	EPA 8270D	NA
Parathion,ethyl	EPA 8270D	EPA 8270D	NA
Phorate	EPA 8270D	EPA 8270D	NA
Sulfotepp	EPA 8270D	EPA 8270D	NA
Thionazin (Zinophos)	EPA 8270D	EPA 8270D	NA
Dalapon	EPA 615, 8151A	EPA 8151A	NA
3,5-DCBA	EPA 615, 8151A	EPA 8151A	NA
4-Nitrophenol	EPA 615, 8151A, 625, 8270D	EPA 8270D, 8151A	NA
Dicamba	EPA 615, 8151A	EPA 8151A	NA
MCPP	EPA 615, 8151A	EPA 8151A	NA
MCPA	EPA 615, 8151A	EPA 8151A	NA
Dichlorprop	EPA 615, 8151A	EPA 8151A	NA
2,4-D	EPA 615, 8151A	EPA 8151A	NA

<u>Parameter/Analyte</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste</u>	<u>Air</u>
Pentachlorophenol	EPA 615, 8151A, 625, 8270D	EPA 8151A, 8270D	NA
2,4,5-TP (Silvex)	EPA 615, 8151A	EPA 8151A	NA
Chloramben	EPA 615, 8151A	EPA 8151A	NA
2,4,5-T	EPA 615, 8151A	EPA 8151A	NA
2,4-DB	EPA 615, 8151A	EPA 8151A	NA
Bentazon	EPA 615, 8151A	EPA 8151A	NA
Picloram	EPA 615, 8151A	EPA 8151A	NA
Dinoseb	EPA 615, 8151A, 625, 8270D	EPA 8151A, 8270D	NA
Dacthal	EPA 615, EPA 8151A	EPA 8151A	NA
Acifluorfen	EPA 615, EPA 8151A	EPA 8151A	NA
2,4-DCAA	EPA 615, EPA 8151A	EPA 8151A	NA
Total coliforms	SM9222B	NA	NA
Fecal coliforms	SM9222D	NA	NA
Aluminum	EPA 200.7, 6010C	EPA 6010C	NA
Antimony	EPA 200.7, 6010C	EPA 6010C	NA
Arsenic	EPA 200.7, 6010C	EPA 6010C	NA
Barium	EPA 200.7, 6010C	EPA 6010C	NA
Beryllium	EPA 200.7, 6010C	EPA 6010C	NA
Boron	EPA 200.7, 6010C	EPA 6010C	NA
Cadmium	EPA 200.7, 6010C	EPA 6010C	NA
Calcium	EPA 200.7, 6010C	EPA 6010C	NA
Chromium	EPA 200.7, 6010C	EPA 6010C	NA
Cobalt	EPA 200.7, 6010C	EPA 6010C	NA
Copper	EPA 200.7, 6010C	EPA 6010C	NA
Hardness (calc.)	SM2340B	NA	NA
Iron	EPA 200.7, 6010C, SM18 3500-Fe D	EPA 6010C	NA
Lead	EPA 200.7, 6010C	EPA 6010C	NA
Lithium	EPA 200.7, 6010C	EPA 6010C	NA
Magnesium	EPA 200.7, 6010C	EPA 6010C	NA
Manganese	EPA 200.7, 6010C	EPA 6010C	NA
Molybdenum	EPA 200.7, 6010C	EPA 6010C	NA
Nickel	EPA 200.7, 6010C	EPA 6010C	NA
Potassium	EPA 200.7, 6010C	EPA 6010C	NA
Selenium	EPA 200.7, 6010C	EPA 6010C	NA
Silver	EPA 200.7, 6010C	EPA 6010C	NA
Sodium	EPA 200.7, 6010C	EPA 6010C	NA
Strontium	EPA 200.7, 6010C	EPA 6010C	NA
Thallium	EPA 200.7, 6010C	EPA 6010C	NA
Tin	EPA 200.7, 6010C	EPA 6010C	NA
Titanium	EPA 200.7, 6010C	EPA 6010C	NA
Vanadium	EPA 200.7, 6010C	EPA 6010C	NA
Zinc	EPA 200.7, 6010C	EPA 6010C	NA
Mercury	EPA 245.1, 7470A	EPA 7471B	NA
Sulfate	ASTM D516-90	NA	NA
Ignitability	EPA 1010A	EPA 1010A, EPA 1030	NA
Conductivity	EPA 120.1, SM18 2510B	NA	NA
Turbidity	EPA 180.1, SM18 2130B	NA	NA
Orthophosphate as P	EPA 365.3	NA	NA

<u>Parameter/Analyte</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste</u>	<u>Air</u>
Color	SM2120B	NA	NA
Alkalinity as CaCO3	SM2320B	NA	NA
Hardness	SM2340C	NA	NA
Residue-nonfilterable (TSS)	SM2540D	NA	NA
Residue-total	SM2540B	NA	NA
Residue-filterable (TDS)	SM2540C	NA	NA
Chromium VI	SM3500-CrD(18th/19th Ed.)/UV-VIS	NA	NA
Chloride	SM4500-CI-C	NA	NA
Total residual chlorine	SM4500-CI-G	NA	NA
pH	SM18 4500-H+-B, EPA 9040C	EPA 9040C, 9045D	NA
Corrosivity (pH)	NA	EPA 9040C	NA
Paint Filter Liquids Test	NA	EPA 9095B	NA
Nitrite	SM4500-NO2 B	NA	NA
Biochemical oxygen demand	SM5210B	NA	NA
Carbonaceous BOD(CBOD)	SM5210B	NA	NA
Chemical oxygen demand	SM5220D, EPA 410.4	NA	NA
Total Organic Carbon	SM18 5310B, EPA 9060A	NA	NA
Total Petroleum Hydrocarbons (TPH)	FL-PRO	FL-PRO	NA
Oil & Grease (HEM)	EPA 1664A	EPA 9071B	NA
Total Petroleum Hydrocarbons (TPH) (HEM-SGT)	EPA 1664A	NA	NA
Carbon dioxide	RSK-175	NA	NA
Ethane	RSK-175	NA	NA
Ethylene	RSK-175	NA	NA
Methane	RSK-175	NA	NA
2,4,6-Trichlorophenol	EPA 625, 8270D	EPA 8270D	NA
2,4-Dichlorophenol	EPA 625, 8270D	EPA 8270D	NA
2,4-Dimethylphenol	EPA 625, 8270D	EPA 8270D	NA
2,4-Dinitrophenol	EPA 625, 8270D	EPA 8270D	NA
2,4-Dinitrotoluene (2,4-DNT)	EPA 625, 8270D	EPA 8270D	NA
2,6-Dinitrotoluene (2,6-DNT)	EPA 625, 8270D	EPA 8270D	NA
2-Chloronaphthalene	EPA 625, 8270D	EPA 8270D	NA
2-Chlorophenol	EPA 625, 8270D	EPA 8270D	NA
2-Methyl-4,6-dinitrophenol	EPA 625, 8270D	EPA 8270D	NA
2-Nitrophenol	EPA 625, 8270D	EPA 8270D	NA
3,3'-Dichlorobenzidine	EPA 625, 8270D	EPA 8270D	NA
4-Bromophenyl phenylether	EPA 625, 8270D	EPA 8270D	NA
4-Chloro-3-methylphenol	EPA 625, 8270D	EPA 8270D	NA
4-Chlorophenyl phenylether	EPA 625, 8270D	EPA 8270D	NA
Acenaphthene	EPA 625 Scan-Sim , 8270D Scan-Sim	EPA 8270D Scan-Sim	NA
Acenaphthylene	EPA 625 Scan-Sim , 8270D Scan-Sim	EPA 8270D Scan-Sim	NA
Aniline	EPA 625, 8270D	EPA 8270D	NA
Anthracene	EPA 625 Scan-Sim, 8270D Scan-Sim	EPA 8270D Scan-Sim	NA

<u>Parameter/Analyte</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste</u>	<u>Air</u>
Benzidine	EPA 625, 8270D	EPA 8270D	NA
Benzo(a)anthracene	EPA 625 Scan-Sim , 8270D Scan-Sim	EPA 8270D Scan-Sim	NA
Benzo(a)pyrene	EPA 625 Scan-Sim , 8270D Scan-Sim	EPA 8270D Scan-Sim	NA
Benzo(b)fluoranthene	EPA 625 Scan-Sim , 8270D Scan-Sim	EPA 8270D Scan-Sim	NA
Benzo(g,h,i)perylene	EPA 625 Scan-Sim , 8270D Scan-Sim	EPA 8270D Scan-Sim	NA
Benzo(k)fluoranthene	EPA 625 Scan-Sim , 8270D Scan-Sim	EPA 8270D Scan-Sim	NA
bis(2-Chloroethoxy)methane	EPA 625, 8270D	EPA 8270D	NA
bis(2-Chloroethyl) ether	EPA 625, 8270D	EPA 8270D	NA
bis(2-Chloroisopropyl) ether (2,2'-Oxybis(1-chloropropane)	EPA 625, 8270D	EPA 8270D	NA
bis(2-Ethylhexyl) phthalate(DEHP)	EPA 625, 8270D	EPA 8270D	NA
Butylbenzylphthalate	EPA 625, 8270D	EPA 8270D	NA
Chrysene	EPA 625 Scan-Sim , 8270D Scan-Sim	EPA 8270D Scan-Sim	NA
Dibenzo(a,h)anthracene	EPA 625 Scan-Sim, 8270D Scan-Sim	EPA 8270D Scan-Sim	NA
Diethyl phthalate	EPA 625, 8270D	EPA 8270D	NA
Dimethyl phthalate	EPA 625, 8270D	EPA 8270D	NA
Di-n-butyl phthalate	EPA 625, 8270D	EPA 8270D	NA
Di-n-octyl phthalate	EPA 625, 8270D	EPA 8270D	NA
Fluoranthene	EPA 625 Scan-Sim , 8270D Scan-Sim	EPA 8270D Scan-Sim	NA
Fluorene	EPA 625 Scan-Sim, 8270D Scan-Sim	EPA 8270D Scan-Sim	NA
Hexachlorobenzene	EPA 625, 8270D	EPA 8270D	NA
Hexachlorocyclopentadiene	EPA 625, 8270D	EPA 8270D	NA
Hexachloroethane	EPA 625, 8270D	EPA 8270D	NA
Indeno(1,2,3-cd)pyrene	EPA 625 Scan-Sim, 8270D Scan-Sim	EPA 8270D Scan-Sim	NA
Isophorone	EPA 625, 8270D	EPA 8270D	NA
Nitrobenzene	EPA 625, 8270D	EPA 8270D	NA
n-Nitrosodimethylamine	EPA 625, 8270D	EPA 8270D	NA
n-Nitrosodi-n-propylamine	EPA 625, 8270D	EPA 8270D	NA
n-Nitrosodiphenylamine	EPA 625, 8270D	EPA 8270D	NA
Phenanthrene	EPA 625 Scan-Sim , 8270D Scan-Sim	EPA 8270D Scan-Sim	NA
Phenol	EPA 625, 8270D	EPA 8270D	NA
Pyrene	EPA 625 Scan-Sim, 8270D Scan-Sim	EPA 8270D Scan-Sim	NA
Pyridine	EPA 625, 8270D	EPA 8270D	NA
1,1-Biphenyl	EPA 8270D	EPA 8270D	
1,2,4,5-Tetrachlorobenzene	EPA 8270D	EPA 8270D	NA
1,2-Diphenylhydrazine	EPA 8270D	EPA 8270D	NA
1,3,5-Trinitrobenzene (1,3,5-TNB)	EPA 8270D	EPA 8270D	NA

<u>Parameter/Analyte</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste</u>	<u>Air</u>
1,3-Dinitrobenzene (1,3-DNB)	EPA 8270D	EPA 8270D	NA
1,4-Naphthoquinone	EPA 8270D	EPA 8270D	NA
1,4-Phenylenediamine	EPA 8270D	EPA 8270D	NA
1-Methylnaphthalene	EPA 625 Scan-Sim, 8270D Scan-Sim	EPA 8270D Scan-Sim	NA
1-Naphthylamine	EPA 8270D	EPA 8270D	NA
2,3,4,6-Tetrachlorophenol	EPA 8270D	EPA 8270D	NA
2,4,5-Trichlorophenol	EPA 8270D	EPA 8270D	NA
2,6-Dichlorophenol	EPA 8270D	EPA 8270D	NA
2-Acetylaminofluorene	EPA 8270D	EPA 8270D	NA
2-Methylnaphthalene	EPA 625 Scan-Sim, 8270D Scan-Sim	EPA 8270D Scan-Sim	NA
2-Methylphenol (o-Cresol)	EPA 8270D	EPA 8270D	NA
2-Naphthylamine	EPA 8270D	EPA 8270D	NA
2-Nitroaniline	EPA 8270D	EPA 8270D	NA
2-Picoline (2-Methylpyridine)	EPA 8270D	EPA 8270D	NA
3,3'-Dimethylbenzidine	EPA 8270D	EPA 8270D	NA
3-Methylcholanthrene	EPA 8270D	EPA 8270D	NA
3-Methylphenol (m-Cresol)	EPA 8270D	EPA 8270D	NA
3-Nitroaniline	EPA 8270D	EPA 8270D	NA
4-Aminobiphenyl	EPA 8270D	EPA 8270D	NA
4-Chloroaniline	EPA 8270D	EPA 8270D	NA
4-Dimethyl aminoazobenzene	EPA 8270D	EPA 8270D	NA
4-Methylphenol (p-Cresol)	EPA 8270D	EPA 8270D	NA
4-Nitroaniline	EPA 8270D	EPA 8270D	NA
4-Nitroquinoline-n-oxide	EPA 8270D	EPA 8270D	NA
5-Nitro-o-toluidine	EPA 8270D	EPA 8270D	NA
7,12-Dimethylbenz(a)anthracene	EPA 8270D	EPA 8270D	NA
a-a-Dimethylphenethylamine	EPA 8270D	EPA 8270D	NA
Acetophenone	EPA 8270D	EPA 8270D	NA
Aramite	EPA 8270D	EPA 8270D	NA
Atrazine	EPA 8270D	EPA 8270D	NA
Benzaldehyde	EPA 8270D	EPA 8270D	NA
Benzoic acid	EPA 8270D	EPA 8270D	NA
Benzyl alcohol	EPA 8270D	EPA 8270D	NA
Caprolactam	EPA 8270D	EPA 8270D	NA
Carbazole	EPA 8270D	EPA 8270D	NA
Chlorobenzilate	EPA 8270D	EPA 8270D	NA
Cresol, Total	EPA 8270D	EPA 8270D	NA
Diallate	EPA 8270D	EPA 8270D	NA
Dibenzo(a,h)pyrene	EPA 8270D	EPA 8270D	NA
Dibenzofuran	EPA 8270D	EPA 8270D	NA
Dimethoate	EPA 8270D	EPA 8270D	NA
Diphenylamine	EPA 8270D	EPA 8270D	NA
Disulfoton	EPA 8270D	EPA 8270D	NA
DPH (as Azobenzene)	EPA 8270D	EPA 8270D	NA
Ethyl methanesulfonate	EPA 8270D	EPA 8270D	NA
Famphur	EPA 8270D	EPA 8270D	NA

<u>Parameter/Analyte</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste</u>	<u>Air</u>
Hexachlorophene	EPA 8270D	EPA 8270D	NA
Hexachloropropene	EPA 8270D	EPA 8270D	NA
Isosafrole	EPA 8270D	EPA 8270D	NA
Methapyrilene	EPA 8270D	EPA 8270D	NA
Methyl methane sulfonate	EPA 8270D	EPA 8270D	NA
Methyl parathion (Parathion,methyl)	EPA 8270D	EPA 8270D	NA
Nitroquinoline-1-oxide	EPA 8270D	EPA 8270D	NA
n-Nitrosodiethylamine	EPA 8270D	EPA 8270D	NA
n-Nitroso-di-n-butylamine	EPA 8270D	EPA 8270D	NA
n-Nitrosomethylethylamine	EPA 8270D	EPA 8270D	NA
n-Nitrosomorpholine	EPA 8270D	EPA 8270D	NA
n-Nitrosopiperidine	EPA 8270D	EPA 8270D	NA
n-Nitrosopyrrolidine	EPA 8270D	EPA 8270D	NA
o-Toluidine	EPA 8270D	EPA 8270D	NA
Pentachlorobenzene	EPA 8270D	EPA 8270D	NA
Pentachloroethane	EPA 8270D	EPA 8270D	NA
Pentachloronitrobenzene	EPA 8270D	EPA 8270D	NA
Phenacetin	EPA 8270D	EPA 8270D	NA
Pronamide (Kerb)	EPA 8270D	EPA 8270D	NA
Safrole	EPA 8270D	EPA 8270D	NA
C9-C18 Aliphatic Hydrocarbons	MAEPH	MAEPH	NA
C19-C36 Aliphatic Hydrocarbons	MAEPH	MAEPH	NA
C11-C22 Aromatic Hydrocarbons	MAEPH	MAEPH	NA
C5-C8 Aliphatic Hydrocarbons	MAVPH	MAVPH	NA
C9-C12 Aliphatic Hydrocarbons	MAVPH	MAVPH	NA
C9-C10 Aromatic Hydrocarbons	MAVPH	MAVPH	NA
Toxicity Characteristic Leaching Procedure (TCLP)	EPA 1311	EPA 1311	NA
Synthetic Precipitation Leaching Procedure (SPLP)	EPA 1312	EPA 1312	NA

<u>Analytical method</u>	<u>Prep Method</u>			
	<u>Soil</u>	<u>Water</u>	<u>Air</u>	<u>Waste</u>
EPA 8260B	EPA 5035	EPA 5030B	NA	EPA 5035
EPA 624	NA	EPA 5030B	NA	NA
EPA 625	NA	EPA 3510C	NA	NA
EPA 8270D	EPA 3545A	EPA 3510C	NA	EPA 3580A
EPA 200.7	NA	EPA 200.7	NA	NA
EPA 6010C	EPA 3050B	EPA 3005A	NA	EPA 3050B
EPA 608	NA	EPA 3510C	NA	NA
EPA 8081B	EPA 3545A	EPA 3510C	NA	EPA 3580A
EPA 8082A	EPA 3545A, EPA 3540C	EPA 3510C	NA	EPA 3580A
EPA 615	NA	EPA 615	NA	NA

Peter Meyer

<u>Analytical method</u>	<u>Prep Method</u>			
EPA 8151A	EPA 8151A	EPA 8151A	NA	EPA 8151A
MA VPH, May 2004 Revision 1.1	EPA 5035	EPA 5030B	NA	NA
MA EPH, May 2004 Revision 1.1	EPA 3545A	EPA 3510C	NA	NA
FLPRO	EPA 3545A	EPA 3510C	NA	NA
8015C – GRO	EPA 5035	EPA 5030B	NA	NA
8015C – DRO	EPA 3545A	EPA 3510C	NA	NA
TO14A	NA	NA	TO14A	NA
TO15	NA	NA	TO15	NA
SPLP	EPA 1312	EPA 1312	NA	EPA 1312
TCLP	EPA 1311	EPA 1311	NA	EPA 1311



The American Association for Laboratory Accreditation

World Class Accreditation

Accredited DoD ELAP Laboratory

A2LA has accredited

ENVIRONMENTAL CONSERVATION LABORATORIES - JACKSONVILLE

Jacksonville, FL

for technical competence in the field of

Environmental Testing

In recognition of the successful completion of the A2LA evaluation process that includes an assessment of the laboratory's compliance with ISO/IEC 17025:2005, the 2003 NELAC Chapter 5 Standard, and the requirements of the Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 4.2 of the DoD Quality System Manual for Environmental Laboratories (QSM); accreditation is granted to this laboratory to perform recognized EPA methods as defined on the associated A2LA Environmental Scope of Accreditation. This accreditation demonstrates technical competence for this defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).



Presented this 1st day of May 2012.

President & CEO
For the Accreditation Council
Certificate Number 3000.02
Valid to April 30, 2014
Revised June 1, 2012

For the tests or types of tests to which this accreditation applies, please refer to the laboratory's Environmental Scope of Accreditation.



SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

ENVIRONMENTAL CONSERVATION LABORATORIES – ORLANDO

10775 Central Port Drive

Orlando, FL 32824

Lori Mangrum Phone: 407 826 5314

lmangrum@encolabs.com

ENVIRONMENTAL

Valid To: March 31, 2014

Certificate Number: 3000.01

In recognition of the successful completion of the A2LA evaluation process, (including an assessment of the laboratory's compliance with ISO IEC 17025:2005, the 2003 NELAC Chapter 5 Standard, and the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 4.2 of the DoD Quality Systems Manual for Environmental Laboratories) accreditation is granted to this laboratory to perform recognized EPA methods using the following testing technologies and in the analyte categories identified below:

Testing Technologies

<u>Analyte / Parameter</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste</u>
<u>Metals</u>	EPA 6020A/200.8	EPA 6020A
Aluminum	EPA 6020A/200.8	EPA 6020A
Antimony	EPA 6020A/200.8	EPA 6020A
Arsenic	EPA 6020A/200.8	EPA 6020A
Barium	EPA 6020A/200.8	EPA 6020A
Beryllium	EPA 6020A/200.8	EPA 6020A
Cadmium	EPA 6020A/200.8	EPA 6020A
Calcium	EPA 6020A/200.8	EPA 6020A
Chromium	EPA 6020A/200.8	EPA 6020A
Cobalt	EPA 6020A/200.8	EPA 6020A
Copper	EPA 6020A/200.8	EPA 6020A
Hardness	SM 2340 B	-----
Iron	EPA 6020A/200.8	EPA 6020A
Lead	EPA 6020A/200.8	EPA 6020A
Magnesium	EPA 6020A/200.8	EPA 6020A
Manganese	EPA 6020A/200.8	EPA 6020A
Mercury	EPA 245.1/7470A	EPA 7471B
Molybdenum	EPA 6020A/200.8	EPA 6020A
Nickel	EPA 6020A/200.8	EPA 6020A
Potassium	EPA 6020A/200.8	EPA 6020A
Selenium	EPA 6020A/200.8	EPA 6020A
Silver	EPA 6020A/200.8	EPA 6020A
Sodium	EPA 6020A/200.8	EPA 6020A
Thallium	EPA 6020A/200.8	EPA 6020A
Tin	EPA 6020A/200.8	EPA 6020A
Titanium	EPA 6020A/200.8	EPA 6020A
Vanadium	EPA 6020A/200.8	EPA 6020A

Analyte / Parameter	Non-Potable Water	Solid Hazardous Waste
<u>Metals</u>	EPA 6020A/200.8	EPA 6020A
Zinc	EPA 6020A/200.8	EPA 6020A
<u>Microbiology</u>		
Total Coliforms	SM 9222B	-----
Fecal Coliforms	SM 9222D	-----
<u>General Chemistry</u>		
Acidity, as CaCO ₃	EPA 305.1/SM 2310 B (4A)	-----
Alkalinity as CaCO ₃	EPA 310.1/SM 2320 B	EPA 310.1/SM 2320 B
Alkalinity as CaCO ₃	EPA 310.2	EPA 310.2
Biochemical oxygen demand	EPA 405.1/SM 5210 B	-----
Bromide	EPA 300.0/9056A	EPA 9056A
Carbonaceous BOD (CBOD)	SM 5210 B	-----
Chemical oxygen demand	EPA 410.4	-----
Chloride	EPA 300.0/9056A	EPA 9056A
Chromium VI	EPA 7196/ SM 3500-Cr D	EPA 7196
Conductivity	EPA 120.1	-----
Cyanide	EPA 335.2/SM 4500-CN E	EPA 9014
Cyanide, Reactive	-----	SW-846 7.3.3
Ferric iron (calculated)	SM 3500-Fe D	-----
Ferrous iron	SM 3500-Fe D	-----
Fluoride	EPA 300.0/9056A	EPA 9056A
Hardness	EPA 130.2/SM 2340 C	-----
Kjeldahl nitrogen -total	EPA 351.2	EPA351.2
Nitrate as N	EPA 300.0/353.1/9056A	EPA 353.1/9056A
Nitrate-nitrite	EPA 300.0/353.1/9056A	EPA 353.1/9056A
Nitrite as N	EPA 300.0/354.1/9056A/SM 4500-NO ₂ B	EPA 9056A/ SM 4500-NO ₂ B
Organic nitrogen	EPA 351.2/350.1	EPA 351.2/350.1
Orthophosphate as P	EPA 365.1	-----
Orthophosphate as P	EPA 365.3	-----
pH	EPA 150.1/9040C/SM 4500-H ⁺ -B	EPA 9045D
Phosphorus, total	EPA 365.4	EPA 365.4
Residue-filterable (TDS)	SM 2540 C	-----
Residue-nonfilterable (TSS)	SM 2540 D	-----
Residue-total	SM 2540 B/SM 2540 G/EPA 160.3	SM 2540G/EPA 160.3
Residue-volatile	EPA 160.4	EPA 160.4
Sulfate	EPA 300.0/9056A	EPA 9056A
Sulfide	EPA 376.1/SM 4500-S E	EPA 9030B/9034
Sulfide, Reactive	-----	SW-846 7.3.4
Surfactants -MBAS	SM 5540 C	-----
Total nitrate-nitrite	EPA 9056 A/SM 4500-NO ₃ H	EPA 9056 A/SM 4500-NO ₃ H
Total cyanide	EPA 9014	EPA 9014
Total nitrogen	TKN + Total nitrate-nitrite	TKN + Total nitrate-nitrite
Total Organic Carbon	EPA 9060A/SM 5310B	TOC Walkley Black
Total phenolics	EPA 420.1	EPA 420.1
Total, fixed, and volatile residue	SM 2540 G	SM 2540 G
Turbidity	EPA 180.1	-----
Un-ionized ammonia	DEP SOP 10/03/83	DEP SOP 10/03/83
<u>Extractable Organics</u>		
1,2,4-Trichlorobenzene	EPA 8270D/625	EPA 8270D

Analyte / Parameter	Non-Potable Water	Solid Hazardous Waste
<u>Extractable Organics</u>		
1,2,4,5-Tetrachlorobenzene	EPA 8270D/625	EPA 8270D
1,2-Dichlorobenzene	EPA 8270D/625	EPA 8270D
1,2-Diphenylhydrazine	EPA 8270D/625	EPA 8270D
1,3-Dichlorobenzene	EPA 8270D/625	EPA 8270D
1,4-Dichlorobenzene	EPA 8270D/625	EPA 8270D
1-Methylnaphthalene	EPA 8270D/625/ Scan-Sim	EPA 8270D/ Scan-Sim
2,3,4,6-Tetrachlorophenol	EPA 8270D/625	EPA 8270D
2,4,5-Trichlorophenol	EPA 8270D/625	EPA 8270D
2,4,6-Trichlorophenol	EPA 8270D/625	EPA 8270D
2,4-Dichlorophenol	EPA 8270D/625	EPA 8270D
2,4-Dimethylphenol	EPA 8270D/625	EPA 8270D
2,4-Dinitrophenol	EPA 8270D/625	EPA 8270D
2,4-Dinitrotoluene (2,4-DNT)	EPA 8270D/625/ Scan-Sim	EPA 8270D
2,6-Dichlorophenol	EPA 8270D/625	EPA 8270D
2,6-Dinitrotoluene (2,6-DNT)	EPA 8270D/625	EPA 8270D
2-Chloronaphthalene	EPA 8270D/625	EPA 8270D
2-Chlorophenol	EPA 8270D/625	EPA 8270D
2-Methyl-4,6-dinitrophenol	EPA 8270D/625	EPA 8270D
2-Methylnaphthalene	EPA 8270D/625 Scan-Sim	EPA 8270D Scan-Sim
2-Methylphenol (o-Cresol)	EPA 8270D/625	EPA 8270D
2-Nitroaniline	EPA 8270D/625	EPA 8270D
2-Nitrophenol	EPA 8270D/625	EPA 8270D
3,3'-Dichlorobenzidine	EPA 8270D/625	EPA 8270D
3/4-Methylphenols (m/p-Cresols)	EPA 8270D/625	EPA 8270D
3-Nitroaniline	EPA 8270D/625	EPA 8270D
4-Bromophenyl phenyl ether	EPA 8270D/625	EPA 8270D
4-Chloro-3-methylphenol	EPA 8270D/625	EPA 8270D
4-Chloroaniline	EPA 8270D/625	EPA 8270D
4-Chlorophenyl phenyl ether	EPA 8270D/625	EPA 8270D
4-Nitrophenol	EPA 8270D/625	EPA 8270D
Acenaphthene	EPA 8270D/625 Scan-Sim	EPA 8270D Scan-Sim
Acenaphthylene	EPA 8270D/625 Scan-Sim	EPA 8270D Scan-Sim
4-Methylphenol (p-Cresol)	EPA 8270D/625	EPA 8270D
4-Nitroaniline	EPA 8270D/625	EPA 8270D
Acetophenone	EPA 8270D/625	EPA 8270D
Anthracene	EPA 8270D/625/ Scan-Sim	EPA 8270D
Atrazine	EPA 8270D/625	EPA 8270D
Benzaldehyde	EPA 8270D/625	EPA 8270D
Benzidine	EPA 8270D/625/ Scan-Sim	EPA 8270D
Benzo(a)anthracene	EPA 8270D/625/ Scan-Sim	EPA 8270D Scan-Sim
Benzo(a)pyrene	EPA 8270D/625/ Scan-Sim	EPA 8270D Scan-Sim
Benzo(b)fluoranthene	EPA 8270D/625/ Scan-Sim	EPA 8270D Scan-Sim
Benzo(g,h,i)perylene	EPA 8270D/625/ Scan-Sim	EPA 8270D Scan-Sim
Benzo(k)fluoranthene	EPA 8270D/625/ Scan-Sim	EPA 8270D Scan-Sim
Benzyl alcohol	EPA 8270D/625	EPA 8270D
1,1-Biphenyl	EPA 8270D/625	EPA 8270D
bis(2-Chloroethoxy) methane	EPA 8270D/625	EPA 8270D
bis(2-Chloroethyl) ether	EPA 8270D/625	EPA 8270D
bis(2-Chloroisopropyl) ether (2,2'-Oxybis(1-chloropropane))	EPA 8270D/625	EPA 8270D
bis(2-Ethylhexyl) phthalate (DEHP)	EPA 8270D/625	EPA 8270D

Analyte / Parameter	Non-Potable Water	Solid Hazardous Waste
<u>Extractable Organics</u>		
Butyl benzyl phthalate	EPA 8270D/625	EPA 8270D
Caprolactam	EPA 8270D/625	EPA 8270D
Carbazole	EPA 8270D/625	EPA 8270D
Chrysene	EPA 8270D/625/ Scan-Sim	EPA 8270D Scan-Sim
Dibenz(a,h)anthracene	EPA 8270D/625/ Scan-Sim	EPA 8270D Scan-Sim
Dibenzofuran	EPA 8270D/625	EPA 8270D
Diethyl phthalate	EPA 8270D/625	EPA 8270D
Dimethyl phthalate	EPA 8270D/625/ Scan-Sim	EPA 8270D
Di-n-butyl phthalate	EPA 8270D/625	EPA 8270D
Di-n-octyl phthalate	EPA 8270D/625	EPA 8270D
Fluoranthene	EPA 8270D/625/ Scan-Sim	EPA 8270D Scan-Sim
Fluorene	EPA 8270D/625 Scan-Sim	EPA 8270D Scan-Sim
Hexachlorobenzene	EPA 8270D/625/ Scan-Sim	EPA 8270D
Hexachlorobutadiene	EPA 8270D/625/ Scan-Sim	EPA 8270D
Hexachlorocyclopentadiene	EPA 8270D/625	EPA 8270D
Hexachloroethane	EPA 8270D/625	EPA 8270D
Indeno(1,2,3-cd)pyrene	EPA 8270D/625/ Scan-Sim	EPA 8270D Scan-Sim
Isodrin	EPA 8270D/625	EPA 8270D
Isophorone	EPA 8270D/625	EPA 8270D
Naphthalene	EPA 8270D/625 Scan-Sim	EPA 8270D Scan-Sim
Nitrobenzene	EPA 8270D/625	EPA 8270D
n-Nitrosodimethylamine	EPA 8270D/625	EPA 8270D
n-Nitrosodi-n-propylamine	EPA 8270D/625	EPA 8270D
n-Nitrosodiphenylamine	EPA 8270D/625	EPA 8270D
n-Nitrosopyrrolidine	EPA 8270D/625	EPA 8270D
Pentachlorophenol	EPA 8270D/625/ Scan-Sim	EPA 8270D
Phenanthrene	EPA 8270D/625 Scan-Sim	EPA 8270D Scan-Sim
Phenol	EPA 8270D/625	EPA 8270D
Pyrene	EPA 8270D/625 Scan-Sim	EPA 8270D Scan-Sim
Pyridine	EPA 8270D/625	EPA 8270D
Total Petroleum Hydrocarbons (TPH)	FL·PRO	FL·PRO
<u>Volatile Organics</u>		
1,1,1,2-Tetrachloroethane	EPA 8260B/624	EPA 8260B
1,1,1-Trichloroethane	EPA 8260B/624	EPA 8260B
1,1,2,2-Tetrachloroethane	EPA 8260B/624	EPA 8260B
1,1,2-Trichloro-1,2,2-trifluoroethane	EPA 8260B/624	EPA 8260B
1,1,2-Trichloroethane	EPA 8260B/624	EPA 8260B
1,1-Dichloroethane	EPA 8260B/624	EPA 8260B
1,1-Dichloroethene	EPA 8260B/624	EPA 8260B
1,1-Dichloropropene	EPA 8260B/624	EPA 8260B
1,2,3-Trichlorobenzene	8260B/624	EPA 8260B
1,2,3-Trichloropropane	EPA 8260B/624	EPA 8260B
1,2,4-Trichlorobenzene	EPA 8260B/624	EPA 8260B
1,2,4-Trimethylbenzene	EPA 8260B/624	EPA 8260B
1,2-Dibromo-3-chloropropane (DBCP)	EPA 504/8011/8260B	EPA 8260B
1,2-Dibromoethane (EDB, Ethylene dibromide)	EPA 504/8011/8260B	EPA 8260B
1,2-Dichlorobenzene	EPA 8260B/624	EPA 8260B
1,2-Dichloroethane	EPA 8260B/624	EPA 8260B

Analyte / Parameter	Non-Potable Water	Solid Hazardous Waste
<u>Volatile Organics</u>		
1,2-Dichloropropane	EPA 8260B/624	EPA 8260B
1,3,5-Trimethylbenzene	EPA 8260B/624	EPA 8260B
1,3-Dichlorobenzene	EPA 8260B/624	EPA 8260B
1,3-Dichloropropane	EPA 8260B/624	EPA 8260B
1,4-Dichlorobenzene	EPA 8260B/624	EPA 8260B
1,4-Dioxane (1,4-Diethylenoxide)	EPA 8260B/8260C SIM/624	EPA 8260B/8260C SIM
2,2-Dichloropropane	EPA 8260B/624	EPA 8260B
2-Butanone (Methyl ethyl ketone, MEK)	EPA 8260B/624	EPA 8260B
2-Chloroethyl vinyl ether	EPA 8260B/624	EPA 8260B
2-Chlorotoluene	EPA 8260B/624	EPA 8260B
2-Hexanone	EPA 8260B/624	EPA 8260B
4-Chlorotoluene	EPA 8260B/624	EPA 8260B
4-Methyl-2-pentanone (MIBK)	EPA 8260B/624	EPA 8260B
Acetone	EPA 8260B/624	EPA 8260B
Acetonitrile	EPA 8260B/624	EPA 8260B
Acrolein (Propenal)	EPA 8260B/624	EPA 8260B
Acrylonitrile	EPA 8260B/624	EPA 8260B
Allyl chloride (3-Chloropropene)	EPA 8260B/624	EPA 8260B
Benzene	EPA 8260B/624	EPA 8260B
Bromobenzene	EPA 8260B/624	EPA 8260B
Bromochloromethane	EPA 8260B/624	EPA 8260B
Bromodichloromethane	EPA 8260B/624	EPA 8260B
Bromoform	EPA 8260B/624	EPA 8260B
Carbon tetrachloride	EPA 8260B/624	EPA 8260B
Carbon disulfide	EPA 8260B/624	EPA 8260B
Chlorobenzene	EPA 8260B/624	EPA 8260B
Chloroethane	EPA 8260B/624	EPA 8260B
Chloroform	EPA 8260B/624	EPA 8260B
Chloroprene	EPA 8260B/624	EPA 8260B
cis-1,2-Dichloroethene	EPA 8260B/624	EPA 8260B
cis-1,3-Dichloropropene	EPA 8260B/624	EPA 8260B
Cyclohexane	EPA 8260B/624	EPA 8260B
Dibromochloromethane	EPA 8260B/624	EPA 8260B
Dibromomethane	EPA 8260B/624	EPA 8260B
Dichlorodifluoromethane	EPA 8260B/624	EPA 8260B
Ethyl methacrylate	EPA 8260B/624	EPA 8260B
Hexachlorobutadiene	EPA 8260B/624	EPA 8260B
Ethylbenzene	EPA 8260B/624	EPA 8260B
Iodomethane (Methyl iodide)	EPA 8260B/624	EPA 8260B
Isobutyl alcohol (2-Methyl-1-propanol)	EPA 8260B/624	EPA 8260B
Isopropylbenzene	EPA 8260B/624	EPA 8260B
m+p-Xylenes	EPA 8260B/624	EPA 8260B
Methacrylonitrile	EPA 8260B/624	EPA 8260B
Methyl acetate	EPA 8260B/624	EPA 8260B
Methyl bromide (Bromomethane)	EPA 8260B/624	EPA 8260B
Methyl chloride (Chloromethane)	EPA 8260B/624	EPA 8260B
Methyl methacrylate	EPA 8260B/624	EPA 8260B
Methyl tert-butyl ether (MTBE)	EPA 8260B/624	EPA 8260B
Methylcyclohexane	EPA 8260B/624	EPA 8260B

Analyte / Parameter	Non-Potable Water	Solid Hazardous Waste
<u>Volatile Organics</u>		
Methylene chloride	EPA 8260B/624	EPA 8260B
Naphthalene	EPA 8260B/624	EPA 8260B
n-Butylbenzene	EPA 8260B/624	EPA 8260B
n-Propylbenzene	EPA 8260B/624	EPA 8260B
o-Xylene	EPA 8260B/624	EPA 8260B
Pentachloroethane	EPA 8260B/624	EPA 8260B
p-Isopropyltoluene	EPA 8260B/624	EPA 8260B
Propionitrile (Ethyl cyanide)	EPA 8260B/624	EPA 8260B
sec-Butylbenzene	EPA 8260B/624	EPA 8260B
Styrene	EPA 8260B/624	EPA 8260B
tert-Butylbenzene	EPA 8260B/624	EPA 8260B
Tetrachloroethene (Perchloroethylene)	EPA 8260B/624	EPA 8260B
Toluene	EPA 8260B/624	EPA 8260B
trans-1,2-Dichloroethene	EPA 8260B/624	EPA 8260B
trans-1,3-Dichloropropene	EPA 8260B/624	EPA 8260B
trans-1,4-Dichloro-2-butene	EPA 8260B/624	EPA 8260B
Trichloroethene (Trichloroethylene)	EPA 8260B/624	EPA 8260B
Trichlorofluoromethane	EPA 8260B/624	EPA 8260B
Vinyl acetate	EPA 8260B/624	EPA 8260B
Vinyl chloride	EPA 8260B/624	EPA 8260B
Xylene (total)	EPA 8260B/624	EPA 8260B
<u>Pesticides-Herbicides-PCBs</u>		
2,4,5-T	EPA 8151A /615	EPA 8151A
2,4-D	EPA 8151A /615	EPA 8151A
2,4-DB	EPA 8151A /615	EPA 8151A
3,5-Dichlorobenzoic acid	EPA 8151A /615	EPA 8151A
4,4'-DDD	EPA 8081B/608	EPA 8081B
4,4'-DDE	EPA 8081B/608	EPA 8081B
4,4'-DDT	EPA 8081B/608	EPA 8081B
4-Nitrophenol	EPA 8151A/615	EPA 8151A
Acifluorfen	EPA 8151A/615	EPA 8151A
Aldrin	EPA 8081B/608	EPA 8081B
alpha-BHC (alpha- Hexachlorocyclohexane)	EPA 8081B/608	EPA 8081B
alpha-Chlordane	EPA 8081B/608	EPA 8081B
Aroclor-1016(PCB-1016)	EPA 8082A/608	EPA 8082A
Aroclor-1221 (PCB-1221)	EPA 8082A/608	EPA 8082A
Aroclor-1232 (PCB-1232)	EPA 8082A/608	EPA 8082A
Aroclor-1242 (PCB-1242)	EPA 8082A/608	EPA 8082A
Aroclor-1248 (PCB-1248)	EPA 8082A/608	EPA 8082A
Aroclor-1254 (PCB-1254)	EPA 8082A/608	EPA 8082A
Aroclor-1260 (PCB-1260)	EPA 8082A/608	EPA 8082A
Aroclor-1262 (PCB-1262)	EPA 8082A/608	EPA 8082A
Aroclor-1268 (PCB-1268)	EPA 8082A/608	EPA 8082A
Azinphos-methyl (Guthion)	EPA 8141B	EPA 8141B
Bentazon	EPA 8151A/615	EPA 8151A
beta-BHC (beta- Hexachlorocyclohexane)	EPA 8081B/608	EPA 8081B
Bolstar (Sulprofos)	EPA 8141B	EPA 8141B
Chloramben	EPA 8151A/615	EPA 8151A

Analyte / Parameter	Non-Potable Water	Solid Hazardous Waste
<u>Pesticides-Herbicides-PCBs</u>		
Chlordane (tech.)	EPA 8081B/608	EPA 8081B
Chlorpyrifos	EPA 8141B	EPA 8141B
Coumaphos	EPA 8141B	EPA 8141B
Dacthal (DCPA)	EPA 8151A/615	EPA 8151A
Dalapon	EPA 8151A/615	EPA 8151A
delta-BHC	EPA 8081B/608	EPA 8081B
Demeton, Total	EPA 8141B	EPA 8141B
Diazinon	EPA 8141B	EPA 8141B
Dicamba	EPA 8151A/615	EPA 8151A
Dichlorofenthion	EPA 8141B	EPA 8141B
Dichloroprop (Dichlorprop)	EPA 8151A/615	EPA 8151A
Dlchlorovos (DDVP, Dichtovos)	EPA 8141B	EPA 8141B
Dieldrin	EPA 8081B/608	EPA 8081B
Dimethoate	EPA 8141B	EPA 8141B
Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNB P)	EPA 8151A/615	EPA 8151A
Disulfoton	EPA 8141B	EPA 8141B
Endosulfan I	EPA 8081B/608	EPA 8081B
Endosulfan II	EPA 8081B/608	EPA 8081B
Endosulfan sulfate	EPA 8081B/608	EPA 8081B
Endrin	EPA 8081B/608	EPA 8081B
Endrin aldehyde	EPA 8081B/608	EPA 8081B
Endrin ketone	EPA 8081B/608	EPA 8081B
EPN	EPA 8141B	EPA 8141B
Ethion	EPA 8141B	EPA 8141B
Ethoprop	EPA 8141B	EPA 8141B
fensulfothion	EPA 8141B	EPA 8141B
fenthion	EPA 8141B	EPA 8141B
gamma-BHC (Lindane, gamma-Hexachlorocyclohexane)	EPA 8081B/608	EPA 8081B
gamma-Chlordane	EPA 8081B/608	EPA 8081B
Heptachlor	EPA 8081B/608	EPA 8081B
Heptachlor epoxide	EPA 8081B/608	EPA 8081B
Isodrin	EPA 8081B/608	EPA 8081B
Malathion	EPA 8141B	EPA 8141B
MCPA	EPA 8151A/615	EPA 8151A
MCPP	EPA 8151A/615	EPA 8151A
Merphos	EPA 8141B	EPA 8141B
Methoxychlor	EPA 8081B/608	EPA 8081B
Methyl parathion (Parathion, methyl)	EPA 8141B	EPA 8141B
Mevinphos	EPA 8141B	EPA 8141B
Mirex	EPA 8081B/608	EPA 8081B
Monocrotophos	EPA 8141B	EPA 8141B
Naled	EPA 8141B	EPA 8141B
Parathion, ethyl	EPA 8141B	EPA 8141B
Pentachlorophenol	EPA 8151A/615	EPA 8151A
Phorate	EPA 8141B	EPA 8141B
Picloram	EPA 8151A/615	EPA 8151A
Ronnel	EPA 8141B	EPA 8141B
Silvex (2A.5-TP)	EPA 8151B/615	EPA 8151B
Stirofos	EPA 8141B	EPA 8141B

<u>Analyte / Parameter</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste</u>
<u>Pesticides-Herbicides-PCBs</u>		
Sulfotepp	EPA 8141B	EPA 8141B
Tetraethyl pyrophosphate (TEPP)	EPA 8141B	EPA 8141B
Tokuthion (Prothiophos)	EPA 8141B	EPA 8141B
Toxaphene (Chlorinated camphene)	EPA 8081B/608	EPA 8081B
Trichloronate	EPA 8141B	EPA 8141B

Preparation Methods

<u>Fraction</u>	<u>Analytical Method</u>	<u>Preparation Method</u>
Cyanide	EPA 9014 EPA 335.2 /SM 4500-CN E	EPA 9010C
TX	EPA 9056A	EPA 5050
Metal water prep	EPA 6020A/200.8	EPA 3005A
Metals soil prep	EPA 6020A	EPA 3050B
Metals TCLP prep	EPA 6020A/200.8	EPA 3010A
Extractable organics and Pesticides water prep	EPA 8270D/625/8081B/8082A/ 608/ 8141B	EPA 3510C
Extractable organics and Pesticides waste prep	EPA 8270D/625/8081B/8082A/ 608/ 8141B	EPA 3580A
Extractable organics and Pesticides soil prep	EPA 8270D/625/8081B/8082A/ 608/ 8141B	EPA 3550C
Organics water and mid-level soil prep	EPA 8260B/624	EPA 5030B
Organics low-level soil prep	EPA 8260B/624	EPA 5035
Soil/water leachate	Wets	ENCO WETS-88
SPLP	Wets, Organics, and Metals	EPA 1312
TCLP	Wets, Organics, and Metals	EPA 1311



The American Association for Laboratory Accreditation

World Class Accreditation

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A2LA has accredited

ENVIRONMENTAL CONSERVATION LABORATORIES - ORLANDO

Orlando, FL

for technical competence in the field of

Environmental Testing

In recognition of the successful completion of the A2LA evaluation process that includes an assessment of the laboratory's compliance with ISO/IEC 17025:2005, the 2003 NELAC Chapter 5 Standard, and the requirements of the Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 4.2 of the DoD Quality Systems Manual for Environmental Laboratories (QSM v4.2); accreditation is granted to this laboratory to perform recognized EPA methods as defined on the associated A2LA Environmental Scope of Accreditation. This accreditation demonstrates technical competence for this defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009*).



Presented this 29th day of May 2012.

A handwritten signature in black ink, appearing to read "Peter Meyer".

President & CEO
For the Accreditation Council
Certificate Number 3000.01
Valid to March 31, 2014

For the tests or types of tests to which this accreditation applies, please refer to the laboratory's Environmental Scope of Accreditation.

Appendix C
Navy CLEAN Data Management Plan

Final

**Data Management Process Overview
for the
Navy CLEAN and Joint Venture Programs**

Prepared 15 April 2008

Prepared by



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Introduction

This Data Management Plan (DMP) was developed to provide operating guidelines to satisfy the data management requirements for large quantities of data in support of the Navy CLEAN and Joint Venture (JV) Programs. The DMP is broadly applicable to the management and dissemination of data generated during environmental investigations. It is intended to be a living document and will be amended or revised to accommodate changes in the scope of environmental investigation or data management requirements.

During field investigations, CH2M HILL will collect a variety of environmental information that will support data analysis, reporting, and presentation. To ensure quality assurance/quality control (QA/QC) and meet current regulatory requirements, a complete audit trail of the information flow must be established. Each step in the data management process (data collection, storage, and analysis) must be adequately planned, executed, and documented. The DMP provides the processes and guidelines for sample tracking, storage, access, delivery, and reporting of new chemical analytical, geologic, biologic and spatial data generated by investigation operations. Additionally, this plan addresses the management of historical data. Key data management objectives are identified and listed below.

- Provide data users with tools that allow simple and rapid access to stored data of various types
- Provide methods of data entry and data loading with known accuracy and efficiency
- Apply well-documented data validation modifications to the electronic database
- Manage sample data using a unique sample identification number
- Establish a sample inventory of new data collected, and provide methods of sample inventory reconciliation
- Store and provide sample-specific attributes, including location identifier, sample type, sample media, depth, date, and target study area
- Provide reporting and delivery formats from a single database source to support data analysis, site characterization, risk assessment, modeling, and spatial analysis
- Provide the ability to electronically compare results to project-specific reference or screening criteria
- Identify needs for incorporating historical data and establish a database of this information when possible; otherwise, establish a data inventory plan that identifies and catalogues historical data not suited for database entry

To facilitate information utilization and decision-making, a set of guidelines and specifications is presented for personnel qualifications, elements of the data management system (DMS), and activities related to data management. The following specifications are provided to ensure

compatibility with the Navy CLEAN and JV Programs' goals and requirements. These specifications include the routines, processes, and guidelines for sample tracking, storage, access, delivery, and reporting of chemical analytical, geologic, biologic and spatial data generated during site characterization, remedial investigation, and remedial action activities at the sites.

Data Management Activities

This section describes data management activities for new data and historical data. It also discusses the responsibilities of the data team members, coordination and administration of the database, integration with the geographic information system (GIS), and reporting of data from the database.

2.1 New Data Management

For new data being generated as part of field and laboratory operations, the DMP revolves around nine overlapping phases of activity.

- 1. Project Planning and Setup:** A Kick-off Meeting is held to review project instructions, assign sample nomenclature, and detail the EIS level of effort and budget required for the project. Initial communication with the laboratory, data validator, and field crew is established to ensure that all project materials, deliverables, and specifications will be met.
- 2. Sample Collection and Tracking:** Field efforts are carried out according to information detailed in the Project Instructions and Sampling and Analysis Plan (SAP). Sample information and field measurements are collected and catalogued for loading into the project database. Lab login reports are received from labs, entered into the Sample Tracking Sheet (STS) and compared to information from the Project Instructions in order to track the completeness and timeliness of sample handling and processing.
- 3. Lab Analysis and Reporting:** Analyses are performed in accordance with the Laboratory Scope of Work (SOW) and the Uniform Federal Policy Sampling and Analysis Plan (UFP SAP). Hard copy and electronic data deliverables (EDDs) are delivered to the data management team in the agreed-upon format. Lab electronic data are checked for completeness and consistency with hard copy data reports.
- 4. Data Validation and Reporting:** Validation or review is performed in accordance with the Data Validation SOW and the Uniform Federal Policy Sampling and Analysis Plan (UFP SAP). Hard copy and electronic data deliverables (EDDs) are delivered to the data management team in the agreed-upon format. Validated electronic data are checked for completeness and consistency with hard copy data reports.
- 5. Project Data Loading and Storage:** Data from all phases of the data collection and analysis process are stored in a relational project repository database. Post Load reports are reviewed to verify that data was loaded correctly. Following data loading, reports are generated and reviewed to verify that data was loaded correctly. Updates and/or corrections are made to the data as necessary. All hard copy and electronic data are catalogued and sent for archiving as appropriate. Hardcopy and electronic data are sent for archiving. All documentation generated during the projects is filed into the appropriate project notebooks.

6. **Reporting and Delivery of Results:** Data are exported to one or more exterior applications for generating geographic data maps, summary statistics, data tables, and other reports.

2.2 Historical Data Management

There have been a substantial number of previous studies and investigations conducted at Naval Bases. Managing historical data from these studies is complicated by the fact that the agencies and contractors performing these studies have used various data sampling, analysis, and management procedures. The variety of historical data sources and formats – including ecological reports, field data, and analytical data – must be addressed.

To manage historical data in a manner that addresses the variety of sources and formats, along with concerns regarding data validation, the following procedures will be implemented:

1. All source data received will be logged and saved to CH2M HILL servers. Electronic data received to support data from approved documents on original data collection forms, logs, or laboratory reporting sheets will undergo a limited check against accompanying written reports to ensure their accuracy.
2. If only hard copy files exist for desired results, these files will be used to perform manual entry of all data into electronic database files, following a “double blind” protocol for data entry. Any discrepancies found between the two versions of each entered record will be reviewed and corrected by the Data Management Coordinator (DMC).
3. When electronic data gaps occur, the DMC will make the data set as complete as possible by consulting the appropriate approved documents or completed laboratory reporting sheets, through direct communication with the appropriate environmental contractor or laboratory staff, or communication with the Program Chemist. To the greatest possible extent, data will not be entered without a reliable source.
4. After data clean up by the DMC has been completed, the data will be reviewed by a Project Chemist (PC) using all available information. If this process finds no errors, the data will be loaded into the data repository. Any assumptions or corrections made during the cleanup and review process will be noted and tracked in an Error Resolution file

2.3 Data Management Team Members

The CH2M HILL data management team will work together to properly execute the data management process. The team model presented here is based on a Project Manager supported directly by key technology staff. The functional responsibilities of the team are described below. The responsibilities are identified by titles but not necessarily individual staff positions. The workflow among the members of the data management team is shown in Figure 1.

The Activity Manager (AM) and the Project Manager (PM) are responsible for preparing the work plan, schedule, milestones, and coordinating efforts with the client. The AM/PM may or may not have adequate skills to guide the data management driven aspects of their project. While the AM/PM must be willing to accept guidance from the technology leaders, they do not need to possess the technology skills as a background. The PM is also responsible for ensuring

data quality and is brought into the team to perform data QA/QC at various times during the data management process.

The Environmental Information Specialist (EIS) assigned to the project team is responsible for the coordination of new or existing data generated by field activities or provided by laboratory analyses. The EIS oversees contracted analytical and data validation services, ensures that analytical data are complete and consistent, enters field data results into the **Field Data Entry Tool (FDETool)**, and assists the Database Specialist in resolving any data ambiguities. The EIS will conduct verification activities following receipt of electronic data and participate in QA/QC activities to resolve inconsistencies as necessary. The EIS acts as a liaison between the Database Specialist, the PM, and the PC.

The Database Specialist has overall responsibility for the design, operation, and maintenance of the Environmental Database. The DBC is responsible for the implementation, and evaluation of standard operating procedures to ensure integrity of the enterprise-wide database system. The Database Specialist coordinates the different activity data and enhances the database tools, and structure as required to increase performance and efficiency for the entire program. Additional duties include loading data into the Environmental database. This includes analytical results from laboratory electronic data deliverables and field data results that have been entered by the EIS into the **FDETool**. The Database Specialists work with the EIS and Program Data Management Coordinator to ensure that the data are loaded successfully and following established program standards and procedures.

The Field Team Leaders (FTLs) help prepare the work plan and implement the plan in the field. FTLs assign staff members to sampling teams; assign responsibilities to team members; prepare for and coordinate sampling activities; oversee the collection, recording, and documentation of the field data; and ensure that the chain-of-custody form is completed correctly.

The Project Chemist (PC) prepares the laboratory and data validation subcontracts, ensures that the electronic data deliverable was provided in accordance with the contract, assists the EIS in communicating with laboratories and data validators as needed, assists the EIS in interpreting analytical results, assists in designating CAS Numbers to new analytes, and maintains the regulatory criteria in the database.

The Program Data Management Coordinator (DMC) is responsible for the CH2M HILL data management process at all Navy bases. The DMC manages and tracks data management personnel schedules and deliverables for the Navy program; interacts with the EIS on all aspects of data management activities; provides guidance and coordination to the EIS during resolution of data inconsistencies; coordinates completion of data queries for reports; coordinates database modification efforts with the DBC; is responsible for designing, developing, and implementing standard data entry and data retrieval tools; and leads the data management continuous process improvement investigation.

The IS Operations Lead monitors workload across all IS activities (GIS, Web, and Database) for resource and schedule conflicts, and works with IS resources to make recommendations for process change and improvement.

The IS Program Lead serves as the primary point of contact for the Navy regarding IS issues, coordinates resource requirements with the regional IS Staffing Lead, and provides direction and management to the DBC, DMC, and IS Operations Lead.

2.4 Database Management and Administration

Database management and administration will be coordinated and conducted by the Database Specialist. Activities will be conducted using a suite of previously developed tools and products: Field Data Entry Tool (FDETool) for field data loading; EDD and Supplemental Naval Installation Restoration Information Solution (NIRIS) Electronic Data Deliverable (SNEDD) formats for analytical data loading; formatting macros for data table creation, Archive and Load Prep Tool (ALPTool) for electronic file QC and generation, EnDat and/or NIRIS for long-term storage; and EnStat for rendering, reporting, and presentation of results. The data management team will focus their efforts on providing rapid data loading, entry, and retrieval, while promoting data integrity through various standardized procedures. Database administration, at the minimum, will consist of:

- Allocating system storage for the database
- Adding, altering, and deleting users, roles, and privileges
- Periodically defragmenting the database for more efficient operation
- Upgrading database software as necessary
- Providing routine backup of the database
- Maintaining an approved list of valid values for data consistency
- Maintaining redundancy control to ensure that each data record is unique and consistent with conventions

In addition to electronic tools, all required paper documentation, including hard copy of laboratory results, field notebooks, and COC sheets, will be matched to EDD files, logged, and filed in project paper files.

2.5 GIS Integration

To the greatest degree possible, spatial coordinate data will be captured and associated with all field sampling events. This will be done to facilitate the creation of spatial data maps of the sampling activities and results, which will be rendered using GIS software tools. Various data management tools used in the DMS process will provide a means of storing geospatial coordinate data.

GIS integration will allow the project team to couple results information with geospatially correct images of water bodies, topography, building and transportation infrastructure, and other types of analytical maps. More detailed information on the requirements and specifications for GIS can be found in the project documentation for that activity.

2.6 Reporting and Submittals

The project repository database will be the analytical data source for all reports presented to the Navy CLEAN and JV Programs by CH2M HILL. Data for the reports will be extracted and aggregated using standard software tools.

As mentioned above, the EnStat application will be provided to project EISs. EnStat will allow users to electively query results from the project repository database. Internally developed table formatting macros will present the results in a variety of pre-formatted tabular reports.

Database Management System

The following sections identify the required project database tools and their relationships to each other. In addition, they discuss the procedures that maintain data integrity and security through standardized tasks, data verification through valid values and redundancy control, security and controlled access to the stored data, and file backup.

3.1 Project Database Requirements

The project repository database will be a relational database system that stores information in a series of data tables. Relational database systems are designed so that each piece of information is stored only once. Data tables can then be linked so that duplication of fields in multiple tables is avoided and consistent nomenclature is enforced between related sets of data. This architecture ensures relatively high data quality and information integrity, saves storage space on the data server, and speeds up data manipulation for large data files.

It is essential that the DMS provide features to enhance data management, including the following:

- Tools preloaded with drop down menus and valid values to limit data entry errors
- Built-in QA/QC routines to protect against data redundancy and errors
- Routines that electronically compare results to project-specific reference or screening criteria
- A project repository database that securely stores all historical and present project data
- Standard but flexible reporting and delivery formats from a single database source

3.2 Tools for Data Management System Requirements

This section describes the required data management tools to be utilized. The software tools described are internally developed applications that will provide a fully integrated solution for meeting the requirements listed above.

TABLE 3-1
DMS Tools

Tools	Description
Checklist - Data Management Process	Standardized checklist to ensure that all phases data management are completed.
Checklist - EDD Prep for Load and Archive Files	Standardized checklist to ensure that Load and Archive Files are generated correctly.
Checklist - EDD Prep for Raw and Detects Tables for Unvalidated or Validated Data	Standardized checklist to ensure that reporting tables are generated and formatted appropriately.
Checklist - EIS QC Checklist for Unvalidated and Validated EDDs and Hard Copy Data	Standardized checklist detailing QC checks to be performed on data

TABLE 3-1
DMS Tools

Tools	Description
Form - Data Request/Needs	Form detailing data loading into the database repository
Form - EIS DM Budget Tracking	Form to track EIS budget allotted on project
Form - EIS Questions to Ask at Start of Project	Standardized list of questions that EISs should posed at project startup to ensure appropriate data management related project planning and implementation
Macro - EcoRisk Tables from EnStat Output	Macro to format EcoRisk data tables
Macro - HHRA Tables from EnStat Output	Macro to format HHRA data tables
Macro - Raw & Detects Tables from Unvalidated or Validated EDD	Macro to generate and format Unvalidated or Validated data tables
Macro - Raw, Detects, & Exceedance Tables from EnStat Output	Macro to format final Raw, Detects, and Exceedances data tables pulled from EnStat
Template - Corrections to File Letter	General template for the generation of Corrections to File Letters
Template - Data Archiving (List of Contents) Form	Template to generate Data Archiving forms to affix to laboratory and data validation reports
Template - EnDat Post Load Reports	Used to assess and QC data loaded into EnDat to ensure data load accuracy and completeness
Template - IS Costing LOE	Template to generate the level of effort and overall data management budget for projects
Template - QC Association Table	General template for the generation of QC Association tables used in data validation
Template - Sample Tracking Sheet	General template for the set up of project Sample Tracking Sheets
Template - Station and Sample Nomenclature	Program template outlining the Station and Sample Nomenclature rules to be used on environmental projects
Tool - ALPTool	Internally developed tool for performing an Analyte ID QC on SNEDD files, and generating EnDat Archive, EnDat Load, and NIRIS Analytical NEDD files.
Tool - EnDat	Internally developed relational database repository
Tool - EnStat	Internally developed tool for querying and reporting data from EnDat
Tool - FDETool	Internally developed tool for the input and loading of sample and field data.

TABLE 3-1
DMS Tools

Tools	Description
Tool - NIRIS	Navy developed relational database repository
Tool - Projects Currently in DM Tracking Table	Internal tool for tracking the status of all current data management projects
Tool - EDD	Standardized internal CH2M HILL electronic deliverable format for loading data into only EnDat
Tool - SNEDD	Standardized internal CH2M HILL electronic deliverable format for loading data into EnDat and NIRIS
Tool - Valid Value Reference Tables	Reference tables detailing all valid values utilized in the DMS

3.3 Data Integrity

3.3.1 Valid Values and Referential Integrity

Applications and tools throughout the DMS will use the same reference tables when applying reference attributes to project data. Such reference data include the names of site objects and sampling locations, sampling matrix and method categories, detection limits, analyte names, etc. The use of these reference tables is critical for maintaining the completeness and accuracy of data sets and how they are grouped and categorized.

All data must be loaded and stored in such a manner that relationships between categories of data are enforced. For instance, all sampling records must be associated with a valid site object such as a planned sediment sampling location. The project repository database and all collection, analysis, and reporting tools used in the DMS are designed to enforce, for any project data record entered, entries in fields that refer to other types of data as required by the overall data model.

Note that the DMS has numerous features that reduce or eliminate manual data entry and manipulation. Automation generally promotes the integrity of data by eliminating the need for manual keystrokes and, hence, key stroke errors. These features include look-up lists on data entry forms to ensure the values of key reference information, and standardized QA/QC routines on lab and validated data.

3.3.2 Electronic Data Deliverable Requirements

Tables 3-2 and 3-3 provide the format standards for laboratory electronic data. The SNEDD format depicted in Table 3-2 is intended for use by all laboratories supplying electronic data deliverables for newly acquired Contract Task Orders (CTOs). The format depicted in Table 3-3 is an auxiliary file intended for use on previous CTOs that were established before the SNEDD process was implemented.

Laboratories and Data Validators will be provided with comprehensive Reference and Lookup tables detailing the most current valid values to be entered into all EDDs submitted to CH2M HILL. Laboratories and Validators may submit requests for the addition of new valid values if values had not been previously established.

3.4 Security and Access

The EnDat project repository database implements controlled access to data through password-protected user accounts. These accounts, with Read, Write, and Modify access, are maintained by the Database Specialist. EISs can access the project repository database, with Read Only access, using established querying tools.

The NIRIS database is hosted and maintained by NITC. Access is strictly controlled and granted on a case by case basis. An ORC ECA Digital Certificate must be obtained before requesting access. Once access is granted, the database can only be accessed through querying tools, unless the user is a Regional Data Manager.

3.5 File Backup

All internal CH2M HILL electronic files (including data management project files) that reside on servers are automatically backed up nightly. An export file is created for the EnDat database nightly and that file is also automatically backed up. This allows for the ability to recover all data and the database structure in event of media failure.

TABLE 3-2
SNEDD Format

CH2M HILL SNEDD Format			
Field Name	Field Format	REQ	Field Description
Contract_ID	A13	R	Contract ID assigned by Division Contracting Office: format is UIC (6 char.) + FY (2 char.) + FAR code (1 char.) + Number (4 char.). (e.g. D459559365800)
DO_CTO_Number	A4	R	CTO or TO # assigned by Navy. (e.g. CTO-12 = 0012)
Phase	A8	RA	Task Phase, SubTask Number or Annual Quarter. (e.g. QTR1)
Installation_ID	A20**	R	Unique identifier for installation. (e.g. WHIDBEY)
Sample_Name	A50	R	CH2M HILL Sample ID (from Chain Of Custody).
CH2M_Code	A4*	R	CH2M HILL Preparation Method Code (e.g. NONS)
Analysis_Group	A9*	R	The CH2M HILL code for the analysis performed on the sample.
Analytical_Method	A20**	R	Analytical Method used to analyze sample fraction. (e.g. 6010)
PRC_Code	A15**	R	NIRIS code for the analytical method category (e.g. LEACH)
Lab_Code	A10**	R	CH2M HILL Code assigned to the laboratory (e.g. SHEA)
Lab_Name	A50**	R	The name of the laboratory that conducted the analysis.
Leachate_Method	A16**	RA	Code for the leachate method used on sample. (e.g. SW1310)
Sample_Basis	A16*	RA	Sample basis of analysis; wet weight, dry weight etc. (e.g. DRY)
Extraction_Method	A16**	RA	Code for the extraction method used on sample. (e.g. FLTRES)
Result_Type	A16*	RA	Type of results; dilution, reanalysis etc. (e.g. 000)
Lab_QC_Type	A15*	RA	Code for Laboratory Sample (MS, MSD, LBLK, LCS)
Sample_Medium	A16*	R	Sample medium reported by the laboratory. (e.g. L)
QC_Level	A16*	R	QC Level of data package : EPA levels I to IV. (e.g. 3)
DateTime_Collected	MM/DD/YYYY 00:00	R	Date and time sample was collected. Use 24 hour clock. (e.g. 02/13/07 15:34)
Date_Received	MM/DD/YYYY	R	The date the sample was received in the lab. (e.g. 03/24/07)
Leachate_Date	YYYYMMDD	RA	Date the sample was leached. (e.g. March 12, 2007 = 20070312)
Leachate_Time	HH:MM:SS	RA	Time the sample was leached. Use 24 hour clock. (e.g. 14:30:05)
Extraction_Date	YYYYMMDD	RA	Date that the lab extracted the sample.
Extraction_Time	HH:MM:SS	RA	Time of day that the lab extracted the sample. Use 24 hour clock.
Analysis_Date	YYYYMMDD	R	Date that the lab performed the analysis.
Analysis_Time	HH:MM:SS	R	Time of day that the lab extracted the sample. Use 24 hour clock.
Lab_Sample_ID	A20	R	Unique ID assigned to the sample by the laboratory.
Dilution	N10,2	R	Dilution factor used. (e.g. 10)
Run_Number	N4	RA	Number distinguishing multiple or repeat analyses by the same method, on the same day. Must be equal to or greater than 1.
Percent_Moisture	N6,3	RA	Percent moisture of the sample. (e.g. 20)
Percent_Lipid	N6,3	RA	Percent lipid of the sample.
Chem_Name	A45*	R	The compound being analyzed.
Analyte_ID	A20*	R	Analyte ID (CAS Number) assigned to the analyte. (e.g. 7440-47-3)
Analyte_Value	N18,7	R	Leave Blank for Validator to enter the final analyte concentration.
Original_Analyte_Value	N18,7	R	Analyte concentration value originally generated by the Laboratory.
Result_Units	A16*	R	Unit of measure for the analyte value. (e.g. UG_L)
Lab_Qualifier	A16*	RA	Lab data qualifier. Values will not be rejected if not in domain table.
Validator_Qualifier	A16*	RA	Leave blank for Validator. Values will not be rejected if not in domain table.
GC_Column_Type	A16*	RA	Data code for the type of GC column used in an analysis.
Analysis_Result_Type	A3*	R	Type of analysis performed (allowed: TIC or TRG).
Result_Narrative	A120	RA	Additional information or comments associated with the result.
QC_Control_Limit_Code	A16*	RA	Type of quality control limit. Req'd if QC criteria included. (eg. CLPA)
QC_Accuracy_Upper	N6,3	RA	Accuracy Upper Limit. Upper QC limit of % recovery as measured for a known target analyte spiked into a QC sample. (e.g. 25.45)
QC_Accuracy_Lower	N6,3	RA	Accuracy Lower Limit. Lower QC limit of % recovery as measured for a known target analyte spiked into a QC sample. (e.g. 10.15)
Control_Limit_Date	YYYYMMDD	RA	Date a control limit is established.
QC_Narrative	A120	RA	Leave blank for Validator. Enter EnDat EDD's DV_Qual_Code.
MDL	N18,7	RA	Method Detection Limit
Detection_Limit	N18,7	RA	Reported Detection Limit
SDG	A50	R	Lab code for a group of samples in a data deliverable package.
Analysis_Batch	A20	R	Laboratory code for a batch of analyses analyzed together.
Validator_Name	A50**	R	Leave Blank. Name of Validator. (e.g. CONTRACTOR INC.)
Val_Date	YYYYMMDD	RA	Populated by Validator/Reviewer. Validation/Review QC date.

TABLE 3-3
Auxiliary EDD Format

CH2M HILL EDD Format			
Field Name	Field Format	Req'd	Description
Sample_ID	A25	R	CH2M HILL sample ID (taken from the chain of custody).
Analysis_Group *	A9	R	The CH2M HILL code for the analysis performed on the sample.
DateTime_Collected	00/00/0000 00:00:00	R	The date the sample was collected (from the chain of custody). Use 24-hour clock
Date_Received	00/00/0000	R	The date the sample was received in the lab.
Date_Extracted	00/00/0000	RA	Extraction or preparation date.
Date_Analyzed	00/00/0000	R	The date the sample was analyzed.
Lab_Sample_ID	A15	R	The laboratory sample ID.
Dilution_Factor	N5	R	The dilution factor used. Use 1 if not diluted.
SDG_Number	A15	R	Laboratory code for the group of samples in a data deliverable package.
Chem_Code	A12	R	The ERPIMS parameter code.
Chem_Name *	A45	R	The compound being analyzed.
CAS_Number *	A6-A2-A1	R	CAS Number (Note dashes).
Ana_Value	N11	R	The analytical result. It should match the number of significant digits on the hard copy. Use detection limit when not detected.
Lab_Qual *	A5	RA	The lab qualifiers, if any (e.g., U, UJ, B); there may be a qualifier not on the valid value table in special cases.
DV_Qual	A5		Left blank for data validation qualifiers.
DV_Qual_Code*	A5		Left blank for data validation qualifier codes. Use valid values.
Units *	A15	R	The unit of the result (e.g., mg/L).
Detect_Limit	N5	R	The minimum available sample-specific detection limit for the compound, the laboratory reporting limit.
MDL	N10,3	R	Method detection limit.
Preparation	A15	R	ERPIMS code used for the preparation method of the sample fraction.
Analysis_Method	A15	R	Analytical method used to analyze the sample fraction. Use ERPIMS codes.
Result_Type *	A15	RA	The laboratory QC type for single compounds (e.g., SURR, IS) All surrogates and internal standard results are to be reported in % recovery units.
Lab_QC_Type *	A15	RA	Laboratory samples (lab blanks, dups., LCS, etc.).
PCT_Moisture	N3,3	RA	Percent moisture for soil samples; not applicable for aqueous samples.
Basis	A3	RA	Concentrations are reported on a wet or dry weight basis. Use ERPIMS codes.
Batch	A12	R	Laboratory code for the batch of samples analyzed together.
Lab_Code	A10	R	The ERPIMS code for the name of the laboratory.
ReRun*	A9	RA	To report dilutions, re-extractions, and/or re-analyses.
QC_Limits	AAA-AAA	RA	Laboratory QC limits in percent recovery for surrogates, internal standards, laboratory control spikes, calibration checks, interference check standards, serial dilutions, and MS/MSDs.
Comment	A 30	RA	For the laboratory to note exceptions.
<p><u>Notes:</u> * - See valid value list TICs are not reported on the EDD R - Required field NR - Not Required RA - Required as Appropriate EDD to be submitted in Excel</p>			

Phases of Data Management

As outlined in Section 2.1, the movement of data from the planning stage to the repository database follows six phases, as detailed in Figure 4-1. The following sections describe for each phase how data are managed and the responsibilities of team members.

4.1 Project Planning and Setup

An initial Kick-off meeting will be held to review project instructions, subcontractor information, sample logistics, nomenclature, and project level of effort and budgets. Activities will be supported by EIS Questions to Ask at Start of Project Form, Projects Currently in DM Tracking Table, IS Costing LOE Template, STS and the Station and Sample Nomenclature Template.

The EIS will be responsible for coordinating with the laboratory to discuss the sampling schedule, required turn around times, bottle orders, sample labels, etc. If requested, order bottle ware and create sample labels. If requested, once the bottles have arrived, the order will be reviewed to ensure the proper amount and type of equipment has arrived.

4.2 Sample Collection and Tracking

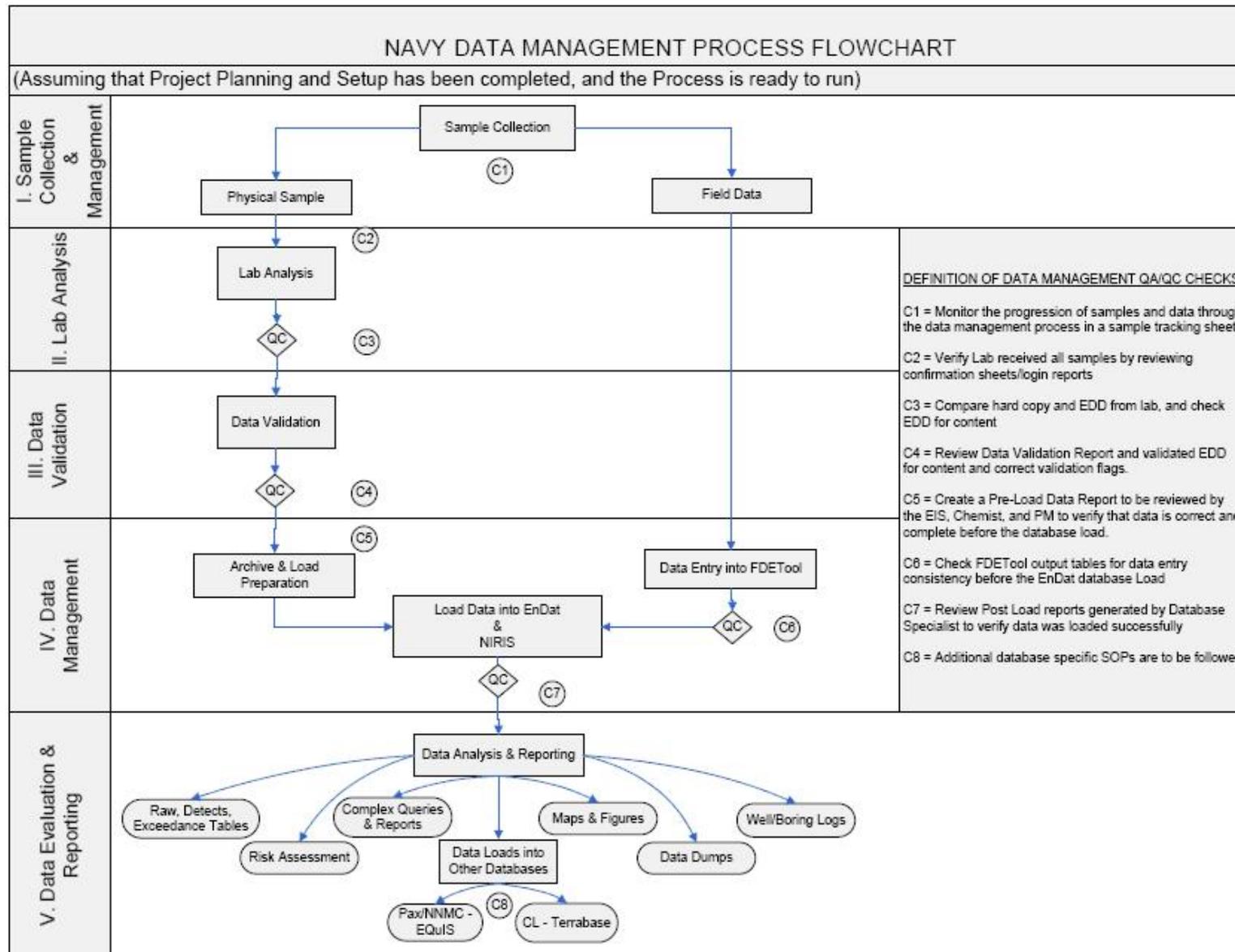
Sample control during the sampling phase is required to ensure the integrity of the associated analyte. Sample control must be maintained and documented from the point of collection through the point of disposal. Sample control will be managed both in the field and in the laboratory, and will be documented through the use of field log books and a Chain of Custody (COC). When custody of a sample is transferred from one party to another, the recipient of the sample assumes responsibility for maintaining control of the sample and documenting that control on the COC.

4.2.1 Sample Collection

A photocopy of each field logbook page completed during sampling, and of each COC, will be made by the FTL and forwarded to the DM at predefined intervals during sampling events. This information will serve as notification to the EIS of samples being shipped to an offsite lab and of the field crew's sampling progress.

Communication with field and laboratory staff will occur daily during the field event. The EIS will resolve issues that arise in the field (bottle ware shortage, equipment failure, etc). The lab will be informed of the shipment dates and the number of coolers or samples being sent. Laboratory login reports will be reviewed to ensure samples were received in good condition (no breakage, within holding time, within designated temperature). The field crew and PM will be notified if there were problems with shipment.

FIGURE 4-1



4.2.2 Field Data Collection

The FDETool can be completed at any time during the sampling event timeline, and will be turned in with the data load. After the lab has received the samples and submitted login reports, data will be entered into the FDETool using the STS, field log books and COCs. Once all field data has been entered, FDETool output reports will be generated and QC'd

In projects utilizing the SNEDD format deliverable, the NIRIS field-related NEDDs should be generated by the FDETool. These files will be reserved for use after the data has been loaded into EnDat and is ready for archiving.

4.2.3 Sample and Document Tracking

A STS will be generated and updated as samples are collected using Project Instruction Tables, Chains of Custody (COC), and Lab Login Reports. The Sample Tracking Sheet should be updated and kept current throughout the data management process. A 100% QC will be performed on COCs received from the field crew. The field crew and/or lab will be notified if corrections need to be made the COCs or lab login reports. Any corrections or modifications made will be noted in a Corrections-To-File Letter. All samples collected will be tracked throughout the data management process

All documentation acquired during the data management process, including Statements of Work (SOWs), Bids, COCs, Field Notes, Sample Tracking Sheets, Login Reports, Corrections-to-File Letters, FDETool QC tables, Post Load Reports, Invoices, and Communication Logs shall be compiled throughout the process to be stored in the appropriate Activity's Project Notebook.

4.3 Laboratory Analysis and Reporting

4.3.1 Sample Analysis

Upon receipt of samples from the field, the laboratory will check that the COC forms correctly cover all samples submitted. Each COC form must be signed with the date and time of receipt by the laboratory. Samples will be logged into the Laboratory Information Management System (LIMS) using information from the COC forms and the project instructions.

Samples will be analyzed as specified on the accompanying COC forms and in the Laboratory SOW. Generally, questions or noted inconsistencies identified by the laboratory should be addressed directly to the PC or EIS.

4.3.2 Laboratory Reporting

The laboratory will attach the signed COCs to their hard copy data deliverables to officially relinquish control of the data back to the Environmental Contractor within the specified turn around time.

4.3.3 Laboratory Data QC

Hard copy data and EDDs will be reviewed to ensure that they are complete and acceptable as outlined in the EIS QC Checklist for Unvalidated and Validated EDDs and Hard Copy Data

Form. A 10% QC check will be performed on the analysis results to ensure that the hard copy data matches the EDD. All detected errors should be resolved with the laboratory.

Preliminary raw and detects will be generated by running the EDD through the Raw & Detects Tables from Unvalidated or Validated EDD Macro to assist the PM with a preliminary data analysis. A separate table must be created for each matrix.

Data archiving forms will be generated and affixed to each laboratory report received, for cataloguing, tracking, and archiving purposes.

4.4 Data Validation and Reporting

The data validator will be notified in advance of when to expect data, and of any samples or analyses that should not be validated. (i.e. grain size should not be validated). The hard copy data, **EDDs**, and a **QC Association Table** will be mailed or emailed to the data validator. The EIS will coordinate the return of the data package to CH2M HILL for archiving with the data validator.

4.4.1 Data Validation

Upon receipt of data from CH2M HILL, data validation will be performed in accordance with the Data Validation SOW, UFP SAP, and any other documents required. Generally, questions or noted inconsistencies identified by the validator should be addressed directly to laboratory, with the EIS notified of issues and resolutions identified.

4.4.2 Validated Data Reporting

The Data Validator will provide a hardcopy and electronic version of the Data Validation Report, as well as a validated version of the EDD to the data management team in the agreed-upon format within the required turn around time.

4.4.3 Validated Data QC

The validated data will be reviewed to ensure that they are complete and acceptable as outlined in the EIS QC Checklist for Unvalidated and Validated EDDs and Hard Copy Data Form. A 100% QC check will be performed on the validated results to ensure that the hard copy data matches the EDD. All detected errors should be resolved with the data validator. .

Validated raw and detects tables will be generated by running the EDD through the Raw & Detects Tables from Unvalidated or Validated EDD Macro to assist the PM with a validated data analysis. A separate table must be created for each matrix.

Data archiving forms will be generated and affixed to each Data Validation Report received, for cataloguing, tracking, and archiving purposes.

4.4.4 Chemist PreLoad Check

All data must be submitted to the PC for a Chemist PreLoad check prior to data loading. All EDDs will be compiled into a single excel Archive file. If data were not validated, the hardcopy data, Archive or PreLoad EDDs, QC association table, and Unvalidated Raw and Detects tables will be provided to the PC for a PreLoad Check that will ensure the hard copy data and EDDs are complete and acceptable. If data

were validated, the hardcopy data validation report, validated EDDs, QC association table and Validated Raw and Detects tables will be provided to the PC for a PreLoad Check that will ensure the hard copy data and EDDs are complete and acceptable.

4.5 Project Data Loading and Storage

All fully evaluated data will be stored in the project repository database(s). This includes other field data acquired with the tools described in the previous sections.

4.5.1 Data Loading

EDDs will be formatted into Load and Archive files with or without the use of the ALPTool, as specified on the EDD Prep for Load and Archive Files Checklist. The Load EDD and FDETool will then be provided to the Database Specialist, who will load the data into the project repository database(s).

4.5.2 Quality Assurance/Quality Control (QA/QC)

Following data loading, the Database Specialist will generate Post Load reports and provide them to the EIS for review and QC. The EIS will review these reports to verify that all data was loaded into the project repository database(s) correctly. Updates or corrections to loaded data will be coordinated with the Database Specialist as necessary. Any changes made to the data by the Database Specialist prior to load, or that will be completed after the load should be tracked, and incorporated into the hard copy and EDD files that are to be archived after project completion.

4.5.3 Invoice Review

Laboratory invoices should be submitted once the laboratory has completed requested analyses, and submitted all results and requested corrections. Data validation invoices should be submitted shortly after the validation has been completed, and the report submitted to CH2M HILL. Invoices will be submitted to the PM through AP Workflow for approval. After all data has been loaded into the data repository and corrections made, the PM should submit all laboratory and data validator invoices to the EIS for review and approval. The EIS will compare costs billed to CH2M HILL to the STS, project instructions, and EDD to ensure that the company is billed correctly for the sample, analysis, and cost totals.

4.5.4 Storage of Deliverables and Documentation

After all corrections identified through the data management process have been completed (if any), the final report written, and the project determined complete, the PM can grant approval to archive the EDD and hard copy data.

Electronic files should be provided to the DMC for archiving on the project servers. The hardcopy reports for any data that was not validated should be sent to the Data Archiving Specialist. For validated data, efforts will be coordinated with the Data Validator to ensure that both the hardcopy Data Validation Report and Laboratory Report are sent to the Data Archiving Specialist. The data will be prepped for archiving and filed within the building until the Data Archiving Specialist has received authorization to send the data to storage.

All project-related documentation generated, such as the STS, Corrections to File Letters, Login Reports, COCs, etc, should be filed into the appropriate project binder for future reference.

4.6 Reporting and Delivery of Results

EnStat will be the primary tool for project staff to access project data. EnStat provides options for querying different types of data and reports, including: raw tables, detects tables, Exceedance tables, regulatory criteria, etc. Adhoc queries or special requests will need to be coordinated with the Database Specialist.

Data requests should be coordinated with the project EIS. The PM will specify the data needs, requirements and formatting (i.e. headers, footers, or other special needs) to be applied to their requests. Raw, detects, and exceedance tables must be queried with EnStat and formatted separately with the Raw, Detects, & Exceedance Tables from EnStat Output Macro for EACH matrix (solid/aqueous). Other macro templates that can be utilized to assist with the formatting of EnStat output files include the HHRA Tables from EnStat Output Macro and EcoRisk Tables from EnStat Output Macro.