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FINAL SAMPLING AND ANALYSIS PLAN BASEWIDE PERFLUORINATED COMPOUND SITE INVESTIGATION NALF FENTRESS NAS OCEANA VA

08/01/2016

CH2M HILL

SAP Worksheet #1—Title and Approval Page

Final

Sampling and Analysis Plan
Basewide Perfluorinated Compound Site Investigation

Naval Auxiliary Landing Field Fentress
Chesapeake, Virginia

Contract Task Order WE44

August 2016

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Mid-Atlantic

Under the

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

Prepared by

ch2m

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.

Review Signatures:

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Angela Jones/U.S. Navy Remedial Project Manager/ Date

Robert Thomson

Rob Thomson/USEPA Project Manager/ Date

Stephen Mihalko 7/19/16

Steve Mihalko/VDEQ Project Manager/ Date

Laura Cook 7/19/2016

Laura Cook/CH2M HILL Project Manager/ Date

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Executive Summary

This site-specific Sampling and Analysis Plan (SAP) is being submitted to provide a systematic data collection and analysis structure for the investigation of perfluorinated compounds (PFCs) at Naval Auxiliary Landing Field (NALF) Fentress, in Chesapeake, Virginia. In accordance with the Guidance for Uniform Federal Policy (UFP) for Quality Assurance Project Plans (USEPA, 2005), this 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.

NALF Fentress was initially investigated as part of the Initial Assessment Study (IAS) of Naval Air Station (NAS) Oceana, completed in 1984 (NEESA, 1984). The IAS identified Site 14, the NALF Fentress Landfill, as a site requiring additional investigation to determine environmental impacts. In response to the IAS, the Round 1 Verification Step Study, which included investigation of the NALF Fentress Landfill, was performed in 1986 (CH2M, 1986). Subsequently, the 1989 Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA) for NAS Oceana identified the NALF Fentress Landfill (referred to as Solid Waste Management Unit [SWMU] 10 in that report), Firefighter Burning Training Area (SWMU 64), and two waste fuel storage tanks (SWMUs 76 and 77) as requiring additional evaluation (Kearney, 1989). A 1990 United States Environmental Protection Agency (USEPA) 3008(h) Corrective Action Order identified 60 SWMUs at NAS Oceana for additional study, including the NALF Fentress sites identified in the RFA. In June 1992, the Work Plan for the RFA recommended no additional action under RCRA for the tank sites because they would be regulated under the Virginia Petroleum, Oil, and Lubricant Program (CH2M, 1992). A 1992 Environmental Investigation was completed to determine the nature and extent of contamination at the landfill and the Firefighter Burning Training Area. The results of the investigation at the landfill (named Site 14 in that report) indicated no unacceptable impacts to the environment from landfilling activities and the report recommended no further action. Soils and groundwater at Firefighter Burning Training Area (named Site 17 in that report), were contaminated with fuel-related compounds, and additional action was recommended to remove contaminated soils and monitor groundwater. Subsequent site inspections better defined the extent of contamination in soil and determined that impacts to groundwater did not require treatment (Baker, 1992). In 1994, more than 5,000 cubic yards of petroleum-contaminated soils were removed from Site 17 and treated onsite using bioremediation. The site was subsequently closed with no further action required (FWI, 1994).

PFCs are constituents historically found in aqueous film-forming foam (AFFF) which is used in firefighting operations and were not previously evaluated at Navy sites. PFCs are considered “emerging contaminants” and these chemicals do not adsorb readily to soils and consequently, are frequently found in groundwater. In 2013, the United States Environmental Protection Agency (USEPA) added new PFC sampling requirements to the Safe Drinking Water Act Unregulated Contaminant Monitoring Rule 3 (UCMR3), requiring all large and 800 small public water supply systems to test for these chemicals before 2015. As a result of a review of sites, former Sites 14 and 17 at NALF Fentress were identified for further evaluation of PFCs. Because of the firefighting activities and disposal of AFFF that took place at the site, and the proximity of AFFF releases to water supply wells within the site boundary and on residential properties offsite, additional sampling is necessary to ensure conditions protective of human health. Additionally, the base fire department identified additional possible sources of PFCs that will require evaluation. This SAP summarizes the proposed sampling approach (Phase I) to evaluate the possible presence of PFCs at these sources, base water supply wells, and downgradient, including along the perimeter of the installation. An additional Phase II investigation is also discussed as a contingency if PFCs are detected during Phase I. Phase II will follow the procedures described in this SAP, but locations will be agreed to based on the results of the Phase I sampling.

While all sites at NALF Fentress were previously closed with no further action determinations, the additional PFC investigations at NALF Fentress will be evaluated as part of the ongoing investigations at NAS Oceana, consistent with the original regulatory history of NAS Oceana and NALF Fentress. In July 1998, the Navy, Virginia Department of Environmental Quality (VDEQ), and USEPA agreed to conduct site remediation activities at NAS Oceana following the procedural and substantive requirements of the Comprehensive Environmental Response

Compensation, and Liability Act (CERCLA) program (42 United States Code §§9601 et seq., 10 U.S.C. §2701 et seq., and Executive Order 12580 [January 23, 1987]). CERCLA work is currently being conducted with USEPA Region 3 as the lead regulatory agency. VDEQ is the State regulatory agency. Together, these three agencies form the NAS Oceana/NALF Fentress Partnering Team. As such, the CERCLA process will be followed during this and subsequent investigations to evaluate PFCs at NALF Fentress.

This document will help ensure that environmental data collected or compiled are scientifically sound, of known and documented quality, and are suitable for intended uses. The laboratory information cited in this SAP is for the laboratory currently contracted to provide analytical services for this investigation. The analytical services for this investigation will be provided by TestAmerica Laboratory, Sacramento, California. Additionally, data validation services will be provided by CH2M. The field standard operating procedures (SOPs) for this work are included in **Appendix A,** and the laboratory Department of Defense Environmental Laboratory Accreditation Program (ELAP) documentation is included as **Appendix B**. This SAP was prepared under the Comprehensive Long-term Environmental Action – Navy (CLEAN) Contract N62470-11-D-8012, Contract Task Order (CTO) WE44, and developed in accordance with the following three guidance documents:

- *Guidance for Quality Assurance Project Plans* (USEPA, 2002)
- *Uniform Federal Policy for Quality Assurance Project Plans* (USEPA, 2005)
- *Guidance on Systematic Planning Using the Data Quality Objectives Process* (USEPA, 2006)

The investigation objectives for the NALF Fentress Phase I PFC investigation are as follows:

- Determine if PFCs are present in the base water supply.
- Determine the groundwater flow direction, gradient, and velocity, to better allow for better assessment of fate and transport at the site.
- Determine whether PFCs are present in groundwater in likely source areas for PFCs at the installation (former Sites 14 (Fentress Landfill) and 17 (Firefighter Burning Training Area), the current crash truck equipment test site, and a known aircraft crash site).
- Determine if PFCs are present downgradient of likely source areas (in Site 14 existing monitoring wells, existing monitoring wells downgradient of Site 14, and newly installed wells on the perimeter of the facility).
- Determine the potential for offsite migration of PFCs at NALF Fentress.

Activities to be completed to accomplish these goals include the following:

- Install and sample eight shallow (Columbia aquifer) and six deep (Yorktown aquifer) monitoring wells.
- Sample four existing monitoring wells (two shallow and two deep) at Site 14, which lies northeast and downgradient of Site 17.
- Sample two Columbia aquifer monitoring wells, which lie northeast and downgradient of Site 17.
- Conduct groundwater level survey of new and existing wells and slug-testing at three shallow and three deep wells.

All samples will be analyzed for PFCs and screened against the criteria listed in the UCMR3 for six PFCs. Quantitative risk assessment also will be completed if determined to be necessary.

If PFCs are detected in any of the samples collected in the Phase I event, Phase II sampling will be completed and may include the following:

- Additional monitoring well installation to define the vertical and lateral extent of contamination
- Potential sampling of water supply and irrigation wells within ½ mile downgradient of any Phase I Investigation PFC detections
- Soil sampling to determine if PFCs are still present in soil

SAP Worksheets

Appendixes

Figures

Abbreviations and Acronyms

µg/kg	microgram per kilogram
µg/L	microgram per liter
AFFF	aqueous film-forming foam
AM	Activity Manager
AQM	Activity Quality Manager
bgs	below ground surface
CA	corrective action
CAS	Chemical Abstracts Service
CCV	continuing calibration verification
CERCLA	Comprehensive Environmental Response Compensation, and Liability Act
CH2M	CH2M HILL, Inc.
CLEAN	Comprehensive Long-term Environmental Action—Navy
DL	detection limit
DO	dissolved oxygen
DoD	Department of Defense
DQI	data quality indicator
DQO	data quality objective
DV	Data Validator
EDD	electronic data deliverable
ELAP	Environmental Laboratory Accreditation Program
FB	field blank
FTL	Field Team Leader
H&S	health and safety
HDPE	high-density polyethylene
HHRA	Human Health Risk Assessment
HSA	hollow-stem auger
HSO	Health and Safety Officer
HSP	Health and Safety Plan
IAS	Initial Assessment Study
IDW	investigation-derived waste
LCS	laboratory control sample
LIMS	Laboratory Information Management System
LOD	limit of detection
LOQ	limit of quantitation
N/A	not applicable
NALF	Naval Auxiliary Landing Field
NAS	Naval Air Station
NAVFAC	Naval Facilities Engineering Command
Navy	Department of the Navy
NIRIS	Naval Installation Restoration Information System
ORP	oxidation-reduction potential
PC	Project Chemist

PFC	perfluorinated compound
PFBS	perfluorobutanesulfonic acid
PFHpA	perfluoroheptanoic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluoroctanoicacid
PFOS	perfluorooctanesulfonic acid
PM	Project Manager
POC	point of contact
PQL	project quantitation limit
PQO	project quality objective
PVC	polyvinyl chloride
QA	quality assurance
QAO	Quality Assurance Officer
QC	quality control
QL	quantitation limit
QSM	Quality Systems Manual
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RL	reporting limit
RPD	relative percent difference
RPM	Remedial Project Manager
RSL	regional screening level
SAP	Sampling and Analysis Plan
SME	Subject Matter Expert
SOP	standard operating procedure
SSC	Site Safety Coordinator
SNEDD	Supplemental NIRIS Electronic Data Deliverable
STC	Senior Technical Consultant
SWMU	solid waste management unit
TBD	to be determined
UCMR3	Unregulated Contaminant Monitoring Rule 3
UFP	United Federal Policy
USEPA	United States Environmental Protection Agency
VDEQ	Virginia Department of Environmental Quality

SAP Worksheet #2—SAP Identifying Information

Site Name/Number:	Firefighter Burning Training Area, Naval Auxiliary Landing Field (NALF) Fentress, Site 17 (and downgradient area)
Operable Unit:	Not applicable (N/A)
Contractor Name:	CH2M HILL, Inc. (CH2M)
Contract Number:	N62470-11-D-8012, Contract Task Order WE44
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 the following documents:
    - *Guidance for Quality Assurance Project Plans (USEPA, 2002)*
    - *Uniform Federal Policy for Quality Assurance Project Plans (USEPA, 2005)*
    - *Guidance on Systematic Planning Using the Data Quality Objectives Process (USEPA, 2006)*
2. Identify regulatory program:
    - Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)
3. This is a project-specific SAP.
4. List organizational partners (stakeholders) and connection with lead organization:

Organization Partners/Stakeholders	Connection
United States Environmental Protection Agency (USEPA)	Lead Regulatory Agency
Virginia Department of Environmental Quality (VDEQ)	State Regulatory Agency
Department of Defense (DoD)	Land Owner
Naval Facilities Engineering Command (NAVFAC), Mid-Atlantic Division	Lead Organization

5. 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 required United Federal Policy (UFP)-SAP elements are included in this SAP; therefore, the crosswalk table is not necessary for this project.
6. List dates and titles of any SAP documents written for previous site work that are relevant to the current investigation.
    - No previous SAPs have been completed that are relevant to the current investigation.

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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
Angela Jones	Remedial Project Manager (RPM)	NAVFAC Mid-Atlantic	(757) 341-0485	angela.jones1@navy.mil	EN1125151022VBO
Rob Thomson	RPM	USEPA Region 3	(215) 814-3357	rob.thomson@epa.gov	
Steve Mihalko	RPM	VDEQ	(804) 698-4202	stephen.mihalko@deq.virginia.gov	
Bonnie Capito	Librarian	NAVFAC Atlantic	(757) 322-4785	bonnie.capito@navy.mil	
Laura Cook	Activity Manager (AM)/Project Manager (PM)	CH2M	(757) 671-6214	laura.cook@ch2m.com	
Juliana Dean	Deputy AM	CH2M	(757) 671-6232	juliana.dean@ch2m.com	
Seng Camus	Project Chemist (PC)	CH2M	(808) 440-0231	seng.camus@ch2m.com	
Paul Landin	Activity Quality Manager (AQM)/Senior Technical Consultant (STC)	CH2M	(757) 671-6238	paul.landin@ch2m.com	
Bill Diguiseppi	Emerging Contaminants Subject Matter Expert (SME)	CH2M	(720) 409-9271	bill.diguiseppi@ch2m.com	
Dan Brown	Field Team Leader (FTL)	CH2M	(704) 544-5164	daniel.brown@ch2m.com	
Gwen Buckley	Alternate FTL	CH2M	(757) 671-6292	Gwendolyn.buckley@ch2m.com	
Laura Turpen	TestAmerica PM	TestAmerica	(916) 374-4414	Laura.Turpen@testamericainc.com	
Herb Kelly	Data Validator (DV)	CH2M	(352) 384-7100	Herb.kelly@ch2m.com	

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SAP Worksheet #4—Project Personnel Sign-Off Sheet

Name	Organization/Title/Role	Telephone Number (optional)	Signature/E-mail Receipt	SAP Section Reviewed	Date SAP Read
Laura Cook	CH2M/AM	(757) 671-6214			
Paul Landin	CH2M AQM/STC	(757) 671-6238			
Angela Jones	NAVFAC Mid-Atlantic RPM	(757) 341-0485			
Jim Tarr	NAVFAC Atlantic Technical Lead	(757) 322-4223			
Rob Thomson	USEPA Region III RPM	(215) 814-3357			
Steve Mihalko	VDEQ RPM	(804) 698-4202			
Laura Turpen	TestAmerica PM	(916) 374-4414			

Notes:

Each organization will read the SAP and provide an original copy of the sign-off sheet to the PM for maintenance in the central project file.

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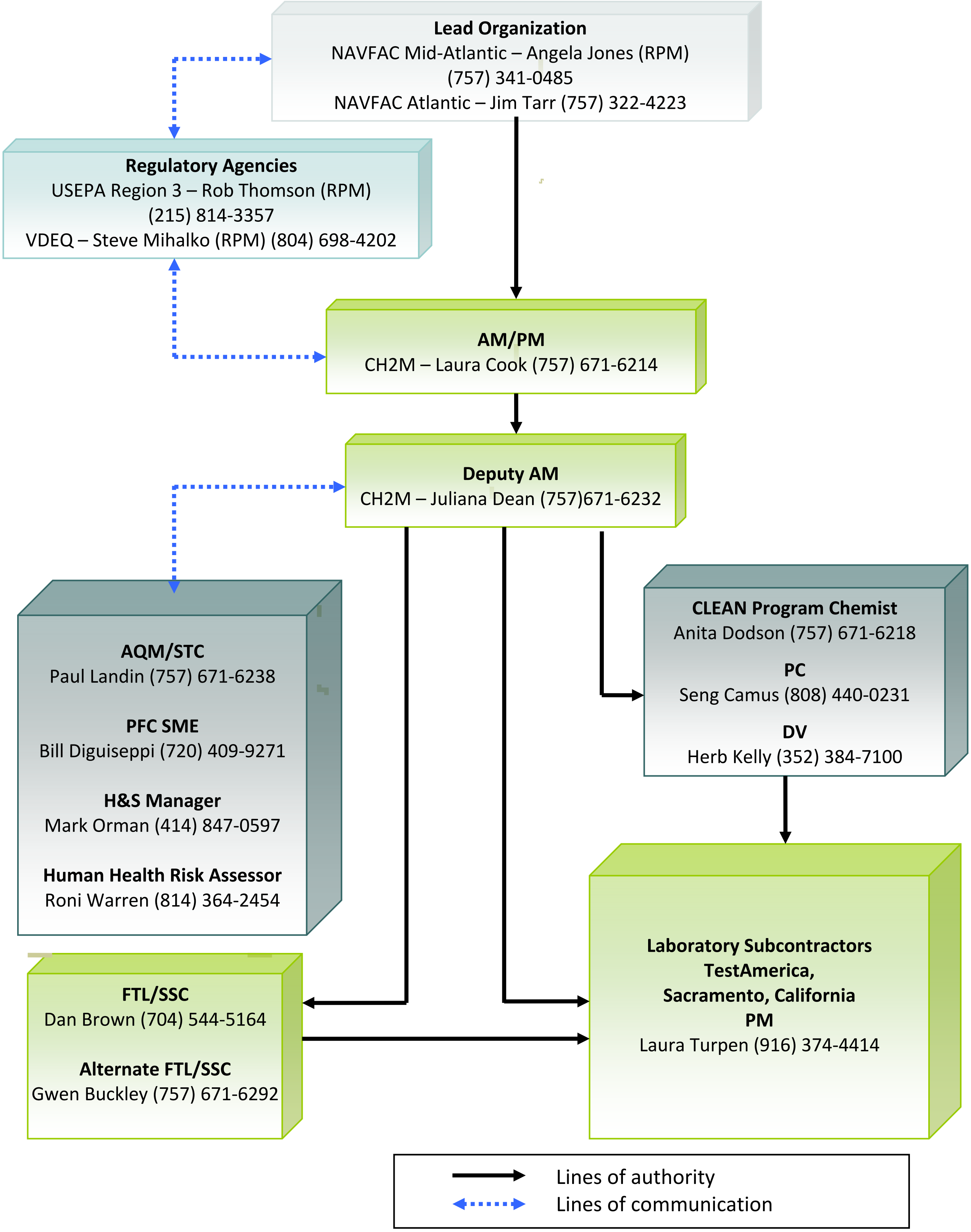
SAP Worksheet #5—Project Organizational Chart



Lead Organization
NAVFAC Mid-Atlantic – Angela Jones (RPM)
(757) 341-0485
NAVFAC Atlantic – Jim Tarr (757) 322-4223

Regulatory Agencies
USEPA Region 3 – Rob Thomson (RPM)
(215) 814-3357
VDEQ – Steve Mihalko (RPM) (804) 698-4202

AM/PM
CH2M – Laura Cook (757) 671-6214

Deputy AM
CH2M – Juliana Dean (757)671-6232

AQM/STC
Paul Landin (757) 671-6238

PFC SME
Bill Diguiseppi (720) 409-9271

H&S Manager
Mark Orman (414) 847-0597

Human Health Risk Assessor
Roni Warren (814) 364-2454

CLEAN Program Chemist
Anita Dodson (757) 671-6218

PC
Seng Camus (808) 440-0231

DV
Herb Kelly (352) 384-7100

FTL/SSC
Dan Brown (704) 544-5164

Alternate FTL/SSC
Gwen Buckley (757) 671-6292

Laboratory Subcontractors
TestAmerica,
Sacramento, California
PM
Laura Turpen (916) 374-4414

→ Lines of authority
↔ Lines of communication

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SAP Worksheet #6—Communication Pathways

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or E-mail	Procedure
Communication with NAVFAC (lead agency)	Navy RPM for WPNSTA Yorktown	Angela Jones	(757) 341-0485	Primary point of contact (POC) for Navy; communicates directly with VDEQ and USEPA as needed. Can delegate communication to other internal or external POCs.
Communication with VDEQ	VDEQ RPM	Steve Mihalko	(804) 698-4202	Primary POC for VDEQ; communicates directly with the Navy and USEPA as needed. Can delegate communication to other internal or external POCs. Upon notification of field changes, VDEQ will have 24 hours to approve or comment on the field changes. All data results will be presented and discussed during partnering meetings.
Communication with USEPA	USEPA RPM	Rob Thomson	(215) 814-3357	Primary POC for USEPA; communicates directly with the Navy and VDEQ as needed. Can delegate communication to other internal or external POCs. Upon notification of field changes, USEPA will have 24 hours to approve or comment on the field changes. All data results will be presented and discussed during partnering meetings.
Navy Quality Assurance (QA)/Quality Control (QC) input	NAVFAC Atlantic	Jim Tarr	(757) 322-4223	Provides review comments to Navy contractor on Pre-draft SAP via Navy Installation Restoration Information System (NIRIS) submittal. Provides overall Navy guidance via direct communication with Navy contractor chemist, as warranted.
Program QC and Oversight	CH2M AQM/STC	Paul Landin	(757) 671-6238	Provides technical and quality oversight to the project.
Communication to/from Navy contractor (e.g., submission of SAP for review; receipt of regulatory comments, updates on project progress, communication of stakeholder expectations)	CH2M Program SAP reviewer	Janna Staszak	(757) 671-6256	Provides senior technical oversight of the SAP.
Communication regarding overall project status and implementation and primary POC with Navy RPM, USEPA, and VDEQ	CH2M Naval Air Station (NAS) Oceana/NALF Fentress AM/PM	Laura Cook	(757) 671-6214	Primary POC for stakeholder agency managers; can delegate agency communication to other contract staff, as appropriated. All information and materials about the project will be forwarded to the Partnering Team by the AM. The AM oversees all NAS Oceana/NALF Fentress projects. If field changes occur during investigation activities, the AM/PM will work with the Navy RPM to communicate the field changes to the Partnering Team via e-mail and/or phone within 24 hours. All data will be communicated to the Partnering Team via e-mail and meetings.

SAP Worksheet #6—Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or E-mail	Procedure
Communication regarding perfluorinated compounds (PFCs)	CH2M PFC Technical Resource	Bill Diguiseppi	(720) 409-9271	Provide support on PFC aspects of project field work and data analysis and reporting.
Health and Safety (H&S) expectations and procedures	CH2M Health and Safety Officer (HSO)	Mark Orman	(414) 847-0597 (414) 712-4138 (cell)	Review of Health and Safety Plan (HSP). Direct communication (via e-mail, telephone, hardcopy, or in person, will be notified within 24 hours of incident) to/from Navy contractor project staff to ensure implementation of appropriate H&S procedures.
Implementation of sampling activities; SAP changes in the field; field corrective actions (CAs); daily field progress reports	CH2M FTL	Dan Brown Gwen Buckley	(704) 544-5164 (757) 671-6292	Documentation of deviations from SAP in field logbooks and rationale for deviations, made within 24 hours of deviation; assistance in material procurement and delivery; injection oversight and implementation; deviations made only with approval from contractor PM and/or environmental manager. See **Worksheet #32** Assessment Findings and CA Responses and **Worksheet #32-1** CA Form. The FTL will immediately notify the PM of any field issues that would negatively impact the ability to meet project data quality objectives (DQOs), or would negatively impact project schedule. The AM or PM may notify the Navy RPM. FTL will e-mail or fax daily field progress reports to contractor PMs weekly; telephone communication with PMs on as-needed basis.
Ensure staff H&S in the field	CH2M Site Safety Coordinator (SSC)	Dan Brown Gwen Buckley	(704) 544-5164 (757) 671-6292	Daily safety tailgates; daily observations; real-time discussions of observations and changes to be implemented with field staff.
Data tracking from collection through upload to database. Management of analytical lab and data validation sub contractors. Analytical CAs/release of analytical data	CH2M PC	Seng Camus	(808) 440-0231	Tracks data from sample collection through upload to the database, ensuring SAP requirements are met by laboratory and field staff. Will act as main POC for laboratory Quality Assurance Officer (QAO). The CH2M AM and PM are informed within 24 hours to pass on communications to Navy and regulators as required. Analytical laboratory CAs will be identified by, or brought to the attention of, the PC as soon as they are discovered. Facilitates resolution on a same-day basis after consulting with the PM and AQM and the Navy Chemist (if changes in the SAP are warranted) to ensure SAP requirements are met by the laboratory. Communicates with subs by phone, followed up with e-mail to document decisions and actions Should analytical laboratory issues affect data usability by rendering a significant amount of rejectable or unusable data such that the project completeness goal cannot be obtained, the PC will notify the project team including the Navy RPM and Navy QAO.

SAP Worksheet #6—Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or e-mail	Procedure
Reporting Laboratory Data Quality Issues	Laboratory PM	Laura Turpen	(916) 374-4414	All QA/QC issues with project filed samples will be reported by the laboratory to the PC within 1 business day. The second-tier subcontracted laboratory will report all data quality issues to the primary subcontracted laboratory PM as soon as the QA/QC issue is identified.
Field and Analytical CAs	CH2M Program Chemist CH2M FTL	Anita Dodson Dan Brown Gwen Buckley	(757) 671-6290 (704) 544-5164 (757) 671-6292	The need for CA for field and analytical issues will be determined by the FTL and or Contractor Chemist.
Stop Work Order	CH2M AM FTL/SSC Field Team Members	Laura Cook Dan Brown Gwen Buckley	(757) 671-6214 (704) 544-5164 (757) 671-6292	Any field member can immediately stop work if an unsafe condition which is immediately threatening to human health is observed. The field staff, FTL, or SSC, should notify the CH2M AM/PM immediately along with the Navy RPM. Ultimately, the FTL or AM/PM can stop work for a period of time. NAVFAC Mid-Atlantic can stop work at any time.
Reporting data quality issues	DV	Herb Kelly	(352) 384-7100	The DV reviews and qualifies analytical data as necessary. The data along with a validation narrative are returned to the PC within 14 calendar days.
Risk Assessment Support	CH2M Human Health Risk Assessment (HHRA) Lead	Roni Warren	(814) 364-2454	Risk assessment lead will oversee the preparation of the HHRA.

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SAP Worksheet #7—Personnel Responsibilities Table

Name	Title/Role	Organizational Affiliation	Responsibilities
Angela Jones	RPM	NAVFAC	Coordinates all environmental activities at NAS Oceana/NALF Fentress.
Jim Tarr	NAVFAC Chemist/QAO	NAVFAC	Navy Review of SAP and QA input.
Laura Cook	AM/PM	CH2M	Responsible for Environmental Restoration Program at NAS Oceana/NALF Fentress. Responsible for administration; coordinates staffing; monitors project performance; directs and oversees project staff.
Paul Landin	AQM/STC		Provides senior technical oversight, directs and oversees staff, and provides program level review of the SAP
Anita Dodson	Navy CLEAN Program Chemist		Provides guidance during preparation of SAP. Provides program level review of SAP.
Janna Staszak	Program Level SAP Reviewer		Provides guidance during preparation of SAP. Provides program level review of SAP.
Bill Diguiseppi	PFC Technical Resource		Provides support during PFC field work and data analysis and reporting.
Seng Camus	PC		Preparation of chemistry specific UFP-SAP worksheets. Ensure proper data tracking, reporting, and maintaining communication with contracted laboratory. Responsible for coordination of laboratory deliverables. Ensures that laboratory adheres to requirements in UFP-SAP.
Dan Brown/ Gwen Buckley	FTL		Supervises and coordinates all field activities and responsible for overseeing subcontractors.
Mark Orman	HSO		Oversees H&S for field activities.
Roni Warren	Senior Human Health Risk Assessor		Conducts HHRA to identify possible impacts to receptors.
Laura Turpen	Laboratory PM	TestAmerica	Manages analytical projects from initiation to completion.
Herb Kelly	DV	CH2M	Responsible for validation of environmental data.

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SAP Worksheet #8—Special Personnel Training Requirements Table

No specialized training beyond standard H&S training is required for this project.

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

Project Name: NALF Fentress PFC Investigation Projected Date(s) of Sampling: Winter 2015 - 2016 **PM:** Laura Cook	**Site Name:** NALF Fentress **Site Location:** NALF Fentress, Chesapeake, Virginia
Date of Session: **Scoping Sessions Purpose:** Agree on PFC Investigation Approach	

Name	Project Role	Affiliation	Scoping Session Participation Date	Phone #	E-mail Address
Angela Jones	Navy Technical Representative	NAVFAC Mid-Atlantic	11/23/2015	(757) 341-0485	angela.jones@navy.mil
Lance Laughmiller	Navy Supervisor	NAVFAC Mid-Atlantic	11/23/2015	(757) 341-0479	Lance.laughmiller@navy.mil
Jim Tarr	Technical Support	NAVFAC Atlantic	11/23/2015	(757) 322-4223	James.tarr@navy.mil
Steve Mihalko	VDEQ RPM	VDEQ	11/23/2015	(804) 698-4202	stephen.mihalko@deq.virginia.gov
Bruce Beach	USEPA RPM	USEPA	11/23/2015	(215) 814-3364	beach.bruce@epa.gov
Rob Thomson	Future USEPA RPM	USEPA	11/23/2015	(215) 814-3357	thomson.bob@epa.gov
Laura Cook	AM/PM	CH2M	11/23/2015	(757) 671-6214	laura.cook@ch2m.com
Juliana Dean	Deputy AM	CH2M	11/23/2015	(757) 671-6232	juliana.dean@ch2m.com

A brief scoping session was held to discuss the project background and objectives. Laura Cook described the regulatory history of NALF Fentress and outlined the potential PFC source at Site 17, as well as several other possible PFC sources identified during the interviews with fire department personnel. Locations of on-base and possible off-base water supply wells were also discussed. The proposed sampling strategy for evaluating the presence and extent of PFCs was discussed and agreed to. The team agreed to initially (as part of the Phase I field mobilization):

- Sample on-base drinking water (water treatment plant influent and effluent)
- Install six new deep and eight new shallow wells (in most likely PFC source areas and along the downgradient base perimeter)
- Evaluate groundwater flow direction, velocity, and gradient (both vertical and horizontal) using a water level survey and slug tests
- Sample all new wells
- Sample four existing wells at Site 14 (two shallow and two deep)
- Sample two leachfield monitoring wells

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

Analyses to be completed were agreed to, consistent with Unregulated Contaminant Monitoring Rule 3. These are:

- PFOS
- Perfluoroctanoicacid (PFOA)
- Perfluorononanoic acid (PFNA)
- Perfluorohexanesulfonic acid (PFHxS)
- Perfluoroheptanoic acid (PFHpA)
- Perfluorobutanesulfonic acid (PFBS)

The team agreed that if PFCs were detected in any of the samples, additional sampling would be completed, based on the nature and extent of the initial detections. At a minimum, any drinking water wells location within ½ mile downgradient of any PFC detections would be sampled. Any additional sampling approach will be agreed to by the Partnering Team prior to field mobilization. The team also agreed that wells for the Phase I investigation could be installed before this SAP is final to expedite the field effort.

SAP Worksheet #10—Conceptual Site Model

Installation Background

NALF Fentress (**Figure 1**) is located in Chesapeake, Virginia and is a noncontiguous property under the command of NAS Oceana. Established in 1940, the installation encompasses just over 2,500 acres and approximately 8,700 acres in restrictive easements. The facility is primarily used by squadrons stationed at NAS Oceana or Naval Station Norfolk Chambers Field for field carrier landing practice operations. Neither storage nor maintenance of aircraft is routinely performed at NALF Fentress.

Physical Characteristics

Topography at NALF Fentress is very flat, with relief varying by less than 5 feet across the entire installation (CH2M, 1992). Land surface elevations range between 10 and 15 feet above mean sea level. Surface runoff from the base is directed to a system of drainage ditches and surface canals, which direct water north and east of the facility toward the Pocaty River and the marshland surrounding it. The Pocaty River is part of the Intercoastal Waterway.

NALF Fentress is on the outer edge of the Atlantic Coastal Plain physiographic province. The Atlantic Coastal Plain is a broad wedge of unconsolidated sediments that dip and thicken to the east. The sediments consist of several thousand feet of unconsolidated sand, clay, silt, and gravels and are underlain by granite basement rock. The surficial hydrogeologic unit at NALF Fentress consists of the Columbia aquifer, which extends to a depth of approximately 17 to 30 feet below ground surface (bgs) at the installation. This unit is underlain by the Yorktown confining unit, which is approximately 15 feet thick and is underlain by the Yorktown-Eastover aquifer. No monitoring wells or water supply wells at the base have been installed to the total depth of the Yorktown-Eastover aquifer, but the approximate thickness of the unit is 100 feet based on *The Virginia Coastal Plain Hydrogeologic Framework* (USGS, 2006).

Basewide groundwater flow at NALF Fentress is unknown, but previous investigations of individual sites indicate a general flow direction to the north and northeast in both the Columbia and Yorktown Eastover aquifers, toward the intercoastal waterway. More regional groundwater flow is to the east toward the Atlantic Ocean (USGS, 2006). Additional data are required to determine the vertical and horizontal gradients across the base, flow direction, and velocity.

Previous Environmental Investigations

Results of previous environmental investigations at NALF Fentress are presented in **Table 1**.

Potential Contaminant Sources, Transport Pathways, and Receptors

Previous investigations indicated no further action was necessary at NALF Fentress. However, since that time certain PFCs have been identified as emerging contaminants that could have been released historically as a result of aqueous film forming foam (AFFF) use during firefighting activities. Because PFCs are environmentally persistent, they can be present in environmental media long after a release. This, combined with recent research regarding potential toxicity from exposure to these compounds, is why these compounds are currently included in this investigation at NALF Fentress. In October 2014, the Assistant Secretary of the Navy, Energy, Installations and Environment issued a statement requiring evaluation of sites with the potential for PFC contamination under the Defense Environmental Restoration Program and requiring sampling of PFCs in drinking water from finished water in Navy water supplies not included in the USEPA requirement, but where sources of PFCs upgradient are known or suspected. As a result of a review of sites, Site 14 and Site 17 at Fentress were identified for further evaluation of PFCs. Interviews of base fire department personnel were completed on November 2, 2015. Firefighting activities using AFFF were determined to have taken place at Site 17, and possibly other sites across the installation (**Figure 2**).

SAP Worksheet #10—Conceptual Site Model (continued)

TABLE 1

Previous Environmental Investigations at NALF Fentress

Previous Investigation/Document	Conclusions
Initial Assessment Study, Naval Air Station, Oceana, Virginia Beach, Virginia. (NEESA, 1984).	This document evaluated contaminant sources at NAS Oceana and NALF Fentress. Site 14, the Fentress Landfill was identified as a site requiring additional investigation to determine environmental impacts.
Progress Report, Round I Verification Step, Naval Air Station Oceana, Virginia Beach, Virginia. (CH2M, 1986)	Groundwater, surface water, and sediment were sampled at Site 14, and impacts were determined to be minor. However, a second round of monitoring was recommended to confirm initial results.
Resource Conservation and Recovery Act Facility Assessment Revised Phase II Report, Oceana Naval Air Station, Virginia Beach, Virginia (Earth Technology Corporation, 1989)	The Resource Conservation and Recovery Act (RCRA) Facility Assessment identified the Fentress Landfill (referred to as Solid Waste Management Unit [SWMU] 10 in that report), the Fentress Firefighter Burning Training Area (SWMU 64), and two waste fuel storage tanks at Fentress (SWMUs 76 and 77) as requiring additional evaluation.
RCRA Facility Investigation Work Plan, Naval Air Station Oceana, Virginia Beach, Virginia (CH2M, 1992)	The RCRA Facility Investigation Work Plan documented that no additional action was necessary for the waste fuel storage tanks (SWMUs 76 and 77) under RCRA because these were regulated under the Virginia Petroleum, Oil, and Lubricant Program.
Environmental Investigation of the Landfill and Firefighting Training Area, Naval Auxiliary Landing Field, Fentress, Chesapeake, Virginia (CH2M, 1991)	No unacceptable impacts to the environment from landfilling activities at Site 14 were noted and the report recommended no further action. Soils and groundwater at Firefighter Burning Training Area (named Site 17 in that report), were determined to be contaminated with petroleum-related compounds and additional action was recommended to remove contaminated soils and monitor groundwater.
Site Inspection Report, Site 14 - Fentress Landfill, Site 17 - Firefighting Training Area, Naval Auxiliary Landing Field, Fentress, Virginia (Baker, 1992) *and* *Supplemental Site Investigation Report, Site 14 - Fentress Landfill and Site 17 - Firefighting Training Area, Naval Auxiliary Landing Field, Fentress, Virginia* (Baker, 1993)	Results of previous investigations at the Site 14 Landfill were confirmed and no additional action was recommended. The nature and extent of the petroleum-related contamination at Site 17 was better defined to support a soil removal action and no groundwater remediation was determined required.
Engineering Evaluation/Cost Analysis, Site 17 - Firefighting Training Area, Naval Auxiliary Landing Field, Fentress, Virginia (FWI, 1994b)	Removal Action Alternatives for Site 17 were evaluated and excavation and onsite treatment using bioremediation was identified as the recommended treatment alternative.
Decision Document - Site 17 - Firefighting Training Area, Naval Auxiliary Landing Field, Fentress, Virginia (FWI, 1994a)	Site 14 was closed with no further action required following the removal action.

Two water supply wells that provide water to the installation (in one building, for approximately 40 people) are located approximately 1,000 feet from Site 17. More than 100 residential, commercial, and/or agricultural properties, some with private wells, lie within one mile of the base, to the north, potentially downgradient (based on minimal available groundwater flow data). While there are drinking water supply wells in the Yorktown aquifer, which is the confined aquifer at the site, the confining unit is thin (about 10 feet), and the potential for migration of contaminants through this unit exists. Additional investigation and sampling is necessary to evaluate transport pathways to drinking water wells on-base and migration off-base in order to evaluate corrective actions (CAs), if warranted. No ecological risks are to be assessed at this time, but risks may be considered following receipt of the Phase I data, if necessary, based on potential migration into adjacent surface water bodies.

SAP Worksheet #10—Conceptual Site Model (continued)

Data Gaps

The following key data gaps in the existing conceptual site model for NALF Fentress have been identified for further evaluation in the Phase I PFC Investigation:

- The presence or absence of PFCs in the base water supply
- The presence or absence of PFCs in groundwater in likely source areas for PFCs at the installation (particularly Site 17, the Firefighter Burning Training Area, the current crash truck equipment test site, and a nearby abandoned aircraft with unknown history)
- The presence or absence of PFCs in areas downgradient of the most likely source areas (Site 14 monitoring wells, irrigation wells downgradient of Site 14, and wells on the perimeter of the facility)
- The potential for offsite migration of PFCs at NALF Fentress
- The groundwater flow direction, gradient, and velocity

The Partnering Team will agree to any additional data gaps to be filled by a Phase II investigation before mobilizing for that investigation.

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

Problem Statement and Objectives

The investigation objectives for the NALF Fentress Phase I PFC investigation are to:

- Determine if PFCs are present in the base water supply
- Determine the groundwater flow direction, gradient, and velocity, to allow for better assessment of fate and transport at the site
- Determine whether PFCs are present in groundwater in likely source areas for PFCs at the installation (Site 17, the Firefighter Burning Training Area, the current crash truck equipment test site, and a nearby abandoned aircraft with unknown history)
- Determine if PFCs are present downgradient of likely sources areas (in Site 14 monitoring wells, irrigation wells downgradient of Site 14, and wells on the perimeter of the facility)
- Determine the potential for offsite migration of PFCs at NALF Fentress

What are the Environmental Questions that are being answered?

Table 2 lists the objectives for this field investigation, the environmental questions to be answered, the investigation approach, and the project quality objectives (PQOs).

What are the Project Action Limits? (Detailed in Worksheet #15)

See **Worksheet #15**.

For what will the data be used?

The data will be used to determine the nature and extent of contamination and potential risks attributable to PFCs and whether the site warrants further investigation, removal, or remediation.

What types of data are needed (matrix, target analytes, analytical groups, field screening, onsite analytical or offsite laboratory techniques, sampling techniques)?

This investigation will include a water-level survey, collection of slug test data, and sampling of groundwater, drinking water, and if necessary, soil (as part of a Phase II investigation). Additional sampling may be completed as a contingency, if necessary, based on project DQOs. Field measurements of water quality will be completed during groundwater sampling. Samples to be collected and analyses to be completed to meet each of the project objectives are described in **Table 2**. Sampling and well installation methodology is included in **Worksheet #14**. Justification for individual sample locations is provided in **Worksheets #17** and **#18**.

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

Field sampling methods are discussed in **Worksheet #14**. **Worksheet #15** presents analytical methodology and quantitation limits (QLs).

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

TABLE 2

Problem Definitions/Objectives, Environmental Questions, and Project Quality Objectives (PQOs)

Problem Definition/Objective	Environmental Question	General Investigation Approach	PQO
Determine if PFCs are present in base drinking water and/or groundwater, and if they are present, characterize the nature and extent of contamination, including in offsite water supply wells within ½ mile downgradient of measured impacts.	Are PFCs present in groundwater in the most likely sources areas at the site, downgradient of the sources areas, and in the base water supply (untreated and finished drinking water)? If PFCs are present on-base, are there impacts to water supply wells located outside and downgradient of the base boundary?	Sample the 14 new wells, four existing shallow wells at Site 14, two existing irrigation wells, and the base water supply (untreated and finished drinking water) for PFCs. Plan a Phase II if necessary.	If PFCs are detected in any wells, additional investigation will be considered as part of a Phase II investigation, and will include, at a minimum, sampling of all private wells within ½ mile downgradient of the wells in which PFCs were detected. Site-specific delineation of groundwater contamination may also be necessary. Additionally, determination of the possible presence of soil contamination remaining onsite may be necessary. Phase II sampling procedures are outlined in this SAP, but numbers of samples and locations will be determined based on team agreements after the Phase I results are received. Groundwater results will also be used to support a human health risk screening and/or quantitative risk assessment, as necessary. Results of both investigations may be used to determine if drinking water supplies are impacted. Decision logic is provided on **Figure 3**.
Better refine understanding of hydraulic characteristics of the site.	What is the groundwater flow direction, gradient, at the site?	Fourteen new wells will be installed in locations shown on **Figure 2**. Eight wells will be installed in the Columbia aquifer and six will be installed in the Yorktown aquifer. All new wells and existing site wells (four irrigation wells, and four wells at Site 14) will be gauged and groundwater contour maps for the Columbia and Yorktown aquifers will be generated to determine flow direction and gradient. Slug tests will be completed at six wells (three shallow and three deep) to determine hydraulic conductivity to allow for velocity calculations.	This information will be used to support planning for any additional sampling needed following the Phase I field event, and will be needed to design a remedy if one is determined to be needed for PFCs in NALF Fentress groundwater.

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

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

Detailed information on data collection is provided on **Worksheets #14** and **#17**. The quantities and types of QA/QC samples are detailed in **Worksheet #20**. When the data are validated, the PC will evaluate the effectiveness (i.e., blank qualifications) of field blanks (FBs) in a data quality evaluation report. The proposed sample locations at NALF Fentress are shown on **Figure 2;** if necessary following evaluation of the initial groundwater, a more comprehensive set of samples including possible source area soil and drinking water will be conducted per the decision logic on **Figure 3**. The CH2M Field Team will collect the NALF Fentress samples according to the procedures presented in **Worksheet #21** and included in **Appendix A** of this SAP.

- The samples will be shipped via overnight courier to an offsite DoD Environmental Laboratory Accreditation Program (ELAP)-approved laboratory (TestAmerica) under subcontract to CH2M for analysis.
- All chemical data generated will be submitted to CH2M and the Navy. Once received, reviewed, and validated by CH2M, all chemical data will be provided to the Navy RPM.
- The data report will include a CLP Level IV- equivalent package including all raw data. This will include a Supplemental NIRIS Electronic Data Deliverable (SNEDD) in Microsoft Excel format and a hard copy of the raw data.
- CH2M will receive the data and will upload it into a centralized database used for Navy projects (NIRIS) by the project team(s).
- Field notes collected by CH2M during the sampling activities will be scanned and included in the investigation report as an appendix. If electronic field forms are used, they will be downloaded and included in the investigation report. Information contained in the notes will be reviewed by the PM following the investigation and prior to report submission.
- CH2M will prepare an investigation report for the site that presents the data, a human health risk screening, and recommendations for no further action or further investigation/action.

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

Matrix: Groundwater, Effluent, Influent

Analytical Group: SVOCs (PFCs)

Analytical Method / Standard Operating Procedures (SOP) Reference: WS-LC-0025

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Field Duplicates	Semivolatile organic compounds (SVOCs) (PFCs)	One per 10 normal field samples	Precision	Relative percent difference (RPD) ≤ 25%
Matrix Spike/Matrix Spike Duplicate (MS/MSD)		One per 20 normal field samples	Accuracy/Precision	See below.
Equipment Rinseate Blank		One per day for decontaminated equipment. One per event for disposable equipment.	Contamination	No target analytes above the reporting limit (RL).
Ambient FB		One per week[1]	Contamination	No target analytes above the RL.
Temperature Blank		One per cooler	Representativeness	≤ 6°C but not frozen

Notes:

[1] Ambient FBs will be collected for each effluent (finished drinking water) sample, rather than one per week.

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

Matrix: Soil

Analytical Group: SVOCs (PFCs)

Analytical Method / SOP Reference: WS-LC-0025

QC Sample	Analytical Group	Frequency	Data Quality Indicators	Measurement Performance Criteria
Field Duplicates	SVOCs (PFC)	One per 10 normal field samples	Precision	RPD ≤ 35%
Matrix Spike/Matrix Spike Duplicate		One per 20 normal field samples	Accuracy/Precision	See below.
Equipment Rinseate Blank		One per day for decontaminated equipment. One per event for disposable equipment.	Contamination	No target analytes above the RL.
Ambient FB		One per week	Contamination	No target analytes above the RL.
Temperature Blank		One per cooler	Representativeness	≤ 6°C but not frozen

SAP Worksheet #13—Secondary Data Criteria and Limitations Table

No secondary data will be used in support of this SI fieldwork

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SAP Worksheet #14—Summary of Project Tasks

The technical approach for the proposed field activities at NALF Fentress is detailed below. The SOPs tabulated on **Worksheet #21** and provided in **Appendix A** address the protocols to be used for the NALF Fentress PFC Investigation.

Mobilization

Prior to mobilization, NAVFAC Mid-Atlantic, USEPA, and VDEQ will be notified to allow for appropriate oversight and coordination.

As part of the field mobilization, CH2M will procure the following subcontractors to support investigation activities:

- Utility Locator
- Surveyor
- Driller
- Investigation-derived waste (IDW) subcontractor

TestAmerica has been procured to provide laboratory analytical services. Mobilization for the field effort includes procuring necessary field equipment and initial transport to the site. Equipment and supplies will be brought to the site when the CH2M field team mobilizes for field activities.

Before beginning any phase of work, CH2M and its subcontractors will have field meetings to discuss the work items and worker responsibilities, and to familiarize workers with the HSP.

Before beginning any intrusive activities, CH2M will coordinate utility clearance with Miss Utility of Virginia and the base's approving authority. Additionally, a separate utilities subcontractor will be procured to ensure the accuracy of the utility markings.

Monitoring Well Installation

Fourteen permanent monitoring wells (eight shallow and six deep) will be installed at NALF Fentress in locations described in **Worksheets #11, #17** and **#18**. Wells will be installed in accordance with the SOPs included in **Appendix A**. Shallow wells will be installed using 4¼-inch-inner-diameter hollow-stem auger (HSA) and will be drilled one foot into the Yorktown confining unit. Deep monitoring well installation will be initiated with 8¼-inch-inner-diameter HSA. Once the Yorktown confining unit is reached, a 6-inch steel casing will be set into the confining unit and grouted in place to prevent cross-contamination to the deep aquifer. The grout will then be allowed to cure for at least 24 hours. Subsequently, the remainder of the boring will be completed using mud rotary to a depth of 15 feet beneath the bottom of the Yorktown confining unit.

During well installation, lithology data will be collected using 4-foot direct-push technology cores, collected continuously. Soil descriptions, including grain size, color, moisture content, relative density, consistency, soil structure, mineralogy, and other relevant information such as possible evidence of contamination, will be recorded as detailed in the SOP included in **Appendix A**. If paired wells are located within a few feet of one another, the deep well may be installed and logged first, allowing for straight drilling of the paired shallow well without soil logging.

Wells will be constructed of 2-inch polyvinyl chloride (PVC) casing and 10-foot-long 0.010 machine-slotted screens. Sand filter pack (DSI #1 or equivalent) will be added to a depth of 2 feet above the screened interval. Two to 4 feet of bentonite pellets or chips will be added and then hydrated in the annular space above the sand pack. The remainder of the annular space will be grouted to the surface. Wells will be completed with stick up protective casings and bollards unless the Navy informs CH2M differently.

Newly installed monitoring wells will be developed in accordance with the SOP included in **Appendix A**.

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

On-base Influent Drinking Water Sampling

Unfinished drinking water will be collected directly from the on-base holding tank using the sample port. After letting the water run into a 5-gallon bucket for at least 30 seconds, turbidity, pH, specific conductivity, and temperature of the water will be measured. Following purging, the sample will be collected directly into the laboratory prepared sample container.

Cross-contamination of PFCs in accordance with the SOP (**Appendix A**) will be considered during sampling.

On-base Effluent (Finished) Drinking Water Sampling

Finished drinking water samples for on-base (and potentially off-base) finished drinking water will be collected in accordance with the potable water sampling SOP (**Appendix A**). Water will be sampled by first purging the water supply at least 15 minutes. The sampling port is usually the port at the bottom of a pressure tank. In instances where there is no port or the valve cannot be used without damage or leaking, the next closest pre-treatment location will be selected. Any port with the possibility of being used for sampling is questioned if a hose was ever hooked up to it or if there is a possibility Teflon-lined dishes (pots and pans) or Teflon tape were ever used in the location. After purging, the turbidity, pH, specific conductivity, and temperature of the water are measured. These parameters are monitored until three consistent readings are obtained indicating stabilization. After three consistent readings have been obtained, samples will be collected directly into laboratory provided containers.

A FB is collected at the site of collection for the water sample. The FB is collected by transferring deionizing water pre-mixed (by the laboratory) with preservative from one bottle to a blank bottle. This blank is used to determine if PFCs are in the air at the sampling location; if any contamination was introduced during the sample management and shipment process; and if there were any laboratory errors.

Cross-contamination of PFCs in accordance with the SOP (**Appendix A**) will be considered during sampling.

Monitoring Well Groundwater Sampling

Groundwater samples will be collected from new and existing monitoring wells using low flow sampling and PFC sampling methodology and in accordance with the SOPs included in **Appendix A**. Based on the depths of the deep wells, it is anticipated that a Grundfos submersible pump will be utilized to collect samples. The pump will be set in the middle of the well screen. Teflon tubing will not be used for sampling. Groundwater quality parameters comprising pH, conductivity, turbidity, dissolved oxygen (DO), temperature, salinity, and oxidation-reduction potential (ORP) will be collected during purging of each well using a water quality meter and a flow-through cell. Purging will continue until water quality readings collected 5 minutes apart are stabilized to within 10 percent of one another. After the parameters have stabilized, the flow-through cell will be disconnected and samples will be collected into laboratory-prepared, pre-preserved sample bottles and packed on ice for overnight shipment to an offsite laboratory.

Cross-contamination of PFCs in accordance with the SOP (**Appendix A**) will be considered during sampling.

Water-level Survey and Slug Testing

Following monitoring well installation and development, and prior to the start of groundwater sampling, the depth to groundwater will be measured according to the SOP included in **Appendix A** at all new and existing wells in order to better determine groundwater flow directions at the site. Rising and falling slug tests will be performed in accordance with the SOP included in **Appendix A** at six wells (three shallow and three deep) in order to evaluate hydraulic conductivity at the site. The hydraulic conductivity data will be used in conjunction with the measured gradient and estimated effective porosity based on soil type in order to calculate groundwater flow velocity.

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

Soil Sampling

Based on the results of the Phase I investigation, soil sampling may be necessary to determine if sources are still present in soils. The Partnering Team will decide on locations of any future soil samples. Soil samples will be collected using the SOPs included in **Appendix A**. Samples will be collected using stainless steel hand augers or trowels and placed into laboratory-prepared sample containers. Soil logs will provide information regarding grain size, color, moisture content, grading, and evidence of contamination.

Cross-contamination of PFCs in accordance with the SOP (**Appendix A**) will be considered during sampling.

Off-base Effluent (Finished) Drinking Water Sampling

Contact is made with the off-base well-owner and a sampling appointment is arranged. Appointments are anticipated to be a 45-minute window. During the initial visit, an access agreement is signed and a home well survey is conducted. During the survey, cold water from a faucet (normally a kitchen or bathroom sink) is turned on to drain the pressure tank and force the well pump to turn on. Depending on the configuration of the household, the pump will either cycle on and off or it will remain on while the water is running. After purging, the turbidity, pH, specific conductivity, and temperature of the water are measured. These parameters are monitored until the pump has either cycled three times and/or the water has run for 10 to 15 minutes prior to the collection of a sample. After purging, the turbidity, pH, specific conductivity, and temperature of the water are measured. Samples will be collected directly into laboratory provided containers. Photographs are collected of each off-base pump/pressure tank/treatment. After the collection of the sample, a GPS point is collected of the wellhead.

A FB is collected at the site of collection for the water sample. The FB is collected by transferring deionizing water pre-mixed (by the laboratory) with preservative from one bottle to a blank bottle. This blank is used to determine if PFCs are located in the air at the sampling location; if any contamination was introduced during the sample management and shipment process; and if there were any laboratory errors.

Cross-contamination of PFCs in accordance with the SOP (**Appendix A**) will be considered during sampling.

Equipment Decontamination

All nondisposable sampling equipment will be decontaminated immediately after each use in general accordance with the SOP included in **Appendix A**. Nondisposable equipment will be decontaminated using the following solutions in this order:

1. Distilled water (laboratory certified, PFC-free) and Liquinox solution
2. Distilled water (laboratory certified, PFC-free) rinse 10 percent isopropanol and distilled water solution (laboratory certified, PFC-free) and air-dried
3. Laboratory grade deionized water (laboratory, certified PFC-free)

The Grundfos submersible pump will be decontaminated by pumping the solutions directly through the pump in the specified order. Nitric acid solution will not be used in the decontamination processes because of potential H&S concerns and because an acid solution can leach metals from metallic equipment. Decontamination fluids will be contained in a tank or 55-gallon drum and disposed of offsite as described below.

Cross-contamination of PFCs in accordance with the SOP (**Appendix A**) will be considered during equipment decontamination.

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

Investigation Derived Waste Management

IDW is expected to consist of drill cuttings from the soil borings completed for monitoring well installations, purge water (from well development and groundwater sampling), and decontamination fluids. Aqueous IDW will be contained in 55-gallon drums or a Baker tank. Soil IDW will be stored in 55-gallon drums or a lined roll-off container with a hard, water-resistant lid. A location at NALF Fentress will be identified before initiating field work where IDW will temporarily be stored. IDW drums will be labeled in accordance with the SOP included in **Appendix A**.

Disposable equipment, including personal protective equipment, will be decontaminated in accordance with the SOP included in **Appendix A** and disposed of with normal facility trash. The IDW subcontractor has not been determined for this sampling event; however, once the subcontractor is identified, the Navy will be notified.

Surveying

Each new monitoring well will be surveyed by a licensed surveyor both vertically and horizontally using the Virginia State Plane Coordinate System. The vertical elevation accuracy will be ± 0.01 feet, and the horizontal location will have an accuracy of ± 0.1 feet. Specifically, the elevation for each monitoring well will be established at the top of the monitoring well’s inner PVC casing (this elevation point will be designated by a permanent notch placed on the top of each well’s inner casing) and at ground surface. The surveying subcontractor has not been determined for this sampling event; however, once the subcontractor is identified, the Navy will be notified.

Shipments

All analytical samples and equipment will be shipped by FedEx. All samples will be shipped in accordance with the SOP included in **Appendix A**.

Quality Control

All QC samples are listed on **Worksheet #20**. In reference to the field tasks, all field work will be overseen by a FTL who is responsible for the QC of the sampling and making sure the proper SOPs are followed for each task.

Sample Analysis

The laboratory will maintain, test, inspect, and calibrate analytical instruments (**Worksheets #24** and **#25**). The laboratory will analyze aqueous samples for various groups of parameters as shown on **Worksheets # 15** and **#18**. QC samples are described on **Worksheet #28**. SOPs for all laboratory analytical tasks are tabulated on **Worksheet #23** and will be provided upon request.

Analytical analyses will be conducted by various laboratories as listed in **Worksheet #30**.

Data Management

The PC is responsible for data tracking and storage. Definitive analytical laboratory data will be validated prior to use for risk assessment purposes and prior to use by the Navy. All screening data will be checked by the PC prior to use. See **Worksheet #36** for more information. All analytical data will be loaded into the NIRIS database.

Procedures for Recording and Correcting Data

- Field data will be recorded in field logbooks or on a digital tablet
- Project Assessment/Audit: **Worksheets #31** and **#32**
- Data Validation: **Worksheets #35** and **#36**
- Data Usability Assessment: **Worksheet #37**

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

Analytical and Validation Tasks

The analytical laboratory will process and prepare samples for analyses and will analyze all samples per **Worksheet #18**. QC samples are described on **Worksheet #28**. SOPs for all laboratory analytical tasks are tabulated on **Worksheet #23**.

- The laboratory will maintain, test, inspect, and calibrate analytical instruments. (**Worksheets #24** and **#25**).
- The laboratory will process and prepare samples for analysis.
- All analytical data to be used for chemical characterization of the site will be validated. See **Worksheet #36** for more details.
- A data usability assessment will be performed on the PFC Investigation data. See **Worksheet #37** for more details.

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SAP Worksheet #15-1—Reference Limits and Evaluation Table

Matrix: Groundwater, Effluent, Influent

Analytical Group: SVOCs (PFCs)

Analyte	CAS	USEPA Provisional Health Advisory[1] (µg/L)	Tapwater Regional Screening Level (RSL) (November 2015) (µg/L)	Project QL Goal[2] (µg/L)	Laboratory Limits (µg/L)			LCS and MS/MSD Recovery Limits and RPD[3](%)		
					LOQ	**LOD**	**DL**	**LCL**	**UCL**	**RPD**
Perfluorooctanesulfonic Acid (PFOS)	1763-23-1	0.2	--	0.08	0.004	0.003	0.00128	60	140	30
Perfluorooctanoic Acid (PFOA)	335-67-1	0.4	--	0.2	0.0025	0.002	0.000748	60	140	30
Perfluorononanoic Acid (PFNA)	375-95-1	--	--	--	0.0025	0.002	0.000654	60	140	30
Perfluorohexanesulfonic Acid (PFHxS)	355-46-4	--		--	0.0025	0.002	0.00087	60	140	30
Perfluoroheptanoic Acid (PFHpA)	375-85-9	--	--	--	0.0025	0.002	0.000802	60	140	30
Perfluorobutanesulfonic Acid (PFBS)	375-73-5	--	38	19	0.0025	0.002	0.000918	50	150	30

Notes:

[1] The PFOS and PFOA USEPA Provisional Health Advisories are from the USEPA Office of Water.

[2] The Project Quantitation Limit (PQL) Goal is half the lesser of applicable screening levels.

[3] Accuracy and precision limits are in house laboratory limits.

µg/L = microgram per liter; CAS = Chemical Abstracts Service; DL = detection limit; LCS = laboratory control sample; LOD = limit of detection; LOQ = limit of quantitation

SAP Worksheet #15-2—Reference Limits and Evaluation Table

Matrix: Soil

Analytical Group: SVOCs (PFCs)

Analyte	CAS	Residential Soil RSL (November 2015)[1] (µg/kg)	Project QL Goal[2] (µg/kg)	Laboratory Limits (µg/kg)			LCS and MS/MSD Recovery Limits and RPD[3](%)		
				LOQ	LOD	DL	LCL	UCL	RPD
Perfluorooctanesulfonic Acid (PFOS)	1763-23-1	6,000	--	0.5	0.3	0.126	60	140	30
Perfluorooctanoic Acid (PFOA)	335-67-1	16,000	--	0.5	0.3	0.102	60	140	30
Perfluorononanoic Acid (PFNA)	375-95-1	--	--	0.5	0.3	0.083	60	140	30
Perfluorohexanesulfonic Acid (PFHxS)	355-46-4	--	--	0.5	0.3	0.118	60	140	30
Perfluoroheptanoic Acid (PFHpA)	375-85-9	--	--	0.5	0.3	0.088	60	140	30
Perfluorobutanesulfonic Acid (PFBS)	375-73-5	160,000	80,000	0.4	0.3	0.103	50	150	30

Notes:

[1] The residential soil RSLs were derived for PFOS and PFOA using the RSL calculator tool and the subchronic RfDs (from USEPA’s October 28, 2009 technical memorandum, *The Toxicity of PFOA and PFOS*, a chronic RfD is not available) based on a hazard index of 0.1.

[1] The PQL Goal is ½ the lesser of applicable screening levels.

[3] Accuracy and precision limits are in-house laboratory limits.

µg/kg = microgram per kilogram

SAP Worksheet #16—Project Schedule / Timeline Table

Date	Planned Activity
7-Dec-15	Initiate Utility Location and Well Installation for Phase I Event
To be determined (TBD)	Finalize SAP
TBD	Begin sampling in key locations (Site 17 wells, water supply samples)
TBD	Complete Well Installation
TBD	Complete Water Level Survey
TBD	Complete Groundwater Sampling
TBD	Receive Unvalidated Results, determine if rush validation is necessary
TBD	Scope Phase II or plan reporting schedule as necessary

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SAP Worksheet #17—Sampling Design and Rationale

Matrix	Depth of Samples	Analysis	Method	Number of Samples	Strategy and Rationale
Columbia Groundwater	Approximately 18-20 feet bgs	PFOS	WS-LC-0025 (Modified USEPA 537)	12	Three shallow samples will be collected in new wells in the most likely source areas (Site 17, abandoned aircraft site, and the crash truck equipment test site), as shown on **Figure 2**. Additionally, two shallow wells at the Site 14 Landfill will be sampled to assess impacts downgradient of the other sites and potential impacts from the landfill. Two existing irrigation wells, and five new perimeter wells are also to be sampled to assess potential migration of contaminants.
		PFOA	WS-LC-0025 (Modified USEPA 537)	12	
		PFNA	WS-LC-0025 (Modified USEPA 537)	12	
		PFHxS	WS-LC-0025 (Modified USEPA 537)	12	
		PFHpA	WS-LC-0025 (Modified USEPA 537)	12	
		PFBS	WS-LC-0025 (Modified USEPA 537)	12	
Yorktown Groundwater	Approximately 50 feet bgs	PFOS	WS-LC-0025 (Modified USEPA 537)	8	Deep samples will be collected from one well to be installed at Site 17 (to assess potential impacts in the most likely source area), two wells at the Site 14 Landfill (to assess impacts downgradient of Site 17 and the Site 14 Landfill), and five new wells to be installed along the base perimeter to assess possible offsite migration (**Figure 2**).
		PFOA	WS-LC-0025 (Modified USEPA 537)	8	
		PFNA	WS-LC-0025 (Modified USEPA 537)	8	
		PFHxS	WS-LC-0025 (Modified USEPA 537)	8	
		PFHpA	WS-LC-0025 (Modified USEPA 537)	8	
		PFBS	WS-LC-0025 (Modified USEPA 537)	8	
		PFOS	WS-LC-0025 (Modified USEPA 537)	8	
Drinking Water	Unknown – will consist of unfinished and treated drinking water	PFOS	WS-LC-0025 (Modified USEPA 537)	2 (one unfinished, one treated)	One unfinished and one treated water sample will be collected from the installation’s water supply to evaluate impacts to on-base drinking water from PFCs before and after treatment.
		PFOA	WS-LC-0025 (Modified USEPA 537)	2 (one unfinished, one treated)	
		PFNA	WS-LC-0025 (Modified USEPA 537)	2 (one unfinished, one treated)	
		PFHxS	WS-LC-0025 (Modified USEPA 537)	2 (one unfinished, one treated)	
		PFHpA	WS-LC-0025 (Modified USEPA 537)	2 (one unfinished, one treated)	
		PFBS	WS-LC-0025 (Modified USEPA 537)	2 (one unfinished, one treated)	

Notes:

Additional samples may be added as part of a Phase II investigation.

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

Sampling Station	Sample ID[1]	Matrix	Depth (feet bgs)	Analytical Group	Number of Samples[2,3]	Sampling SOP Reference
Monitoring Wells						
OF14-MW06S	OF14-MW06S-MMYY	GW	Middle of well screen	SVOCs (PFCs)	1	See Worksheet #21
OF14-MW06D	OF14-MW06D-MMYY				1	
OF14-MW07S	OF14-MW07S-MMYY				1	
OF14-MW07D	OF14-MW07D-MMYY				1	
OF-MW08	OF-MW08-MMYY				2 (FD)	
	OF-MW08P-MMYY					
OF-MW09	OF-MW09-MMYY				1	
OF-MW09D	OF-MW09D-MMYY				1	
OF-MW10	OF-MW10-MMYY				1	
OF-MW10D	OF-MW10D-MMYY				3 (MS/MSD)	
	OF-MW10D-MMYY-MS					
	OF-MW10D-MMYY-SD					
OF-MW11	OF-MW11-MMYY				1	
OF-MW11D	OF-MW11D-MMYY				1	
OF-MW12	OF-MW12-MMYY				1	
OF-MW12D	OF-MW12D-MMYY				1	
OF-MW13	OF-MW13-MMYY				1	
OF-MW13D	OF-MW13D-MMYY				2 (FD)	
	OF-MW13D-MMYY					
OF-MW14	OF-MW14-MMYY				1	
OF-MW15	OF-MW15-MMYY				1	
OF-MW15D	OF-MW15D-MMYY				3 (MS/MSD)	
	OF-MW15D-MMYY-MS					
	OF-MW15D-MMYY-SD					

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

Sampling Station	Sample ID[1]	Matrix	Depth (feet bgs)	Analytical Group	Number of Samples[2,3]	Sampling SOP Reference
Irrigation Wells						
OF-MW16	OF-MW16-MMYY	GW	Middle of well screen	SVOCs (PFCs)	2 (FD)	See Worksheet #21
	OF-MW16P-MMYY					
OF-MW17	OF-MW17-MMYY				1	
Drinking Water						
OF-EFF01	OF-EFF01-MMYY	EFF	N/A	SVOCs (PFCs)	1	See Worksheet #21
Untreated Water						
OF-INF01	OF-INF01-MMYY	INF	N/A	SVOCs (PFCs)	1	See Worksheet #21

Notes:

[1] Additional nomenclature instructions are as follows.

- equipment blanks and FBs will be identified with the two-digit month, day and year, for example: OF-EBMMDDYY or OF-FBMMDDYY

[2] Field QC counts are dependent upon the duration of the field event. Frequency of QA/QC collection is as follows:

- Field Duplicate - One per 10 field samples of similar matrix.
- MS/MSD - One per 20 field samples of similar matrix (including field duplicates)
- FB - One per week
- Equipment Blank - For decontaminated equipment, one per type of sampling equipment, per day of sampling; for disposable equipment, one per lot.

[3] Additional groundwater samples and soil samples may be collected according to team agreement following initial groundwater results.

SAP Worksheet #19—Analytical SOP Requirements Table

Matrix	Analytical Group	Analytical and Preparation Method/ SOP Reference	Containers	Sample Volume	Preservation Requirements	Maximum Holding Time[1] (preparation / analysis)
Groundwater, Effluent, Influent	SVOCs (PFCs)	WS-LC-0025	1 X 1000 mL HDPE	1,000 mL	≤6°C but not frozen	7 days / 40 days
Soil	SVOCs (PFCs)	WS-LC-0025	1 x 4 oz HDPE jar	5 g		14 days / 40 days

Notes:

[1] Maximum holding time is calculated from the time the sample is collected to the time the sample is prepared/extracted.

HDPE = high-density polyethylene

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SAP Worksheet #20—Field Quality Control Sample Summary Table

Matrix	Analytical Group	No. of Sampling Locations	No. of Field Duplicates	No. of MS/MSDs	No. of Ambient FBs[1]	No. of Equipment Blanks[1]	No. of Trip Blanks[1]	Total No. of Samples to Lab[2]
Groundwater, Effluent, Influent	SVOCs (PFCs)	22	3	2/2	5	5		63
Soil	SVOCs (PFCs)	TBD[2]	TBD[2]	TBD[2]	TBD[2]	TBD[2]		TBD[2]

Notes:

[1] The number of blanks shown is based on a fundamental assumption of the number of days during which sampling occurs. Refer to **Worksheet #12** for the required frequencies.

[2] Additional groundwater samples and soil samples may be collected based upon team agreement following initial groundwater results.

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SAP Worksheet #21—Project Sampling SOP References Table

Reference Number	Title, Revision Date, and/or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
001_Decon	*Decontamination of Personnel and Equipment, QCed and revised 06/2015*	CH2M	Deionized water, distilled water, potable water, 2.5 percent Liquinox® and water solution, methanol, plastic pails, 55-gallon drum for waste, nitrile gloves, decontamination pad, steam cleaner	N	
002_Dispose	*Disposal of Waste Fluids and Solids, QCed and reviewed 08/2013*	CH2M	Fluids: 55-gallon drum, tools to secure drum, funnel, labels, marking pen, seals for drum Solids: 55-gallon drum, tools to secure drum, plastic sheets, labels, marking pen	N	
003_DeconRig	*Decontamination of Drilling Rigs and Equipment, QCed and reviewed 08/2013*	CH2M	Steam cleaner, potable water, Liquinox®, buckets, brushes, distilled water, methanol, deionized water, aluminum foil	N	
004_DPSoil	*Direct-Push Soil Sample Collection, QCed and reviewed 04/2015*	CH2M	Drill rig, hydraulic percussion hammer, sampling rods, acetate liners, sample containers, nitrile gloves	N	
005_Shallow Soil	*Shallow Soil Sampling, QCed and revised 4/2015*	CH2M	Sample jars, hand auger, stainless steel spatula, GPS unit	N	
006_Log Books	*Preparing Field Log Books, QCed and reviewed 4/2015*	CH2M	Log book, black indelible pen	N	
007_Soils	*Soil Sampling, QCed and revised 4/2015*	CH2M	Drill rig, hydraulic percussion hammer, sampling rods, acetate liners, sample containers, gloves, hand auger, trowel	N	
008_COC	*Chain-of-Custody. QCed and reviewed 4/2015*	CH2M	Chain-of-custody, indelible pen	N	
009_Utility	*Locating and Clearing Underground Utilities, QCed and revised 4/2015*	CH2M	Utility location subcontractor to provide all equipment, phone number for Miss Utility	N	
010_BlankPrep	*Equipment Blank and Field Blank Preparation, QCed and reviewed 4/2015*	CH2M	Plastic sample bottles, nitrile gloves, blank liquid, preservatives	N	
011_WaterQual	*Field Measurement of pH, Specific Conductance, Turbidity, DO, ORP, and Temperature Using A water Quality Parameter Meter with Flow-through Cell, QCed and reviewed 4/2015*	CH2M	Water Quality Parameter Meter such as a Horiba® U-22 Water Quality Monitoring System or YSI with flow-through cell, distilled water in squirt bottle, Horiba® U-22 Auto-Calibration Standard Solution.	N	
012_LowFlow-EPA RegI&III	*Low-Flow Groundwater Sampling from Monitoring Wells – EPA Region I and III, revised 4/2015*	CH2M	Adjustable-rate positive-displacement pump, submersible pump, or peristaltic pump, Horiba U-ss or equivalent water quality meter, flow-through cell, generator, water-level indicator, disposable Teflon tubing, plastic sheeting, well-construction information, calibrated container and stopwatch, sample containers, in-line disposable 0.45 µm filters, shipping supplies, field book	N	
013_WaterLevels	*Water-Level Measurements, QCed and reviewed 08/2012*	CH2M	Electronic water-level meter with 100-foot tape, interface probe	N	
014_PFC	*OPNAV PFC Sampling Policy*	OPNAV	Sample bottles, gloves, non-Teflon tubing, sampling equipment and clothing without potential to contain PFCs, as per SOP.	N	
015_MWInstal	*General Guidance for Monitoring Well Installation, QCed and reviewed 4/2015*	CH2M	Drilling rig, well construction materials, development equipment	N	
016_MWShall	*Installation of Shallow Monitoring Wells, QCed and reviewed 04/2015*	CH2M	Drilling rig, well riser/screen and associated materials, sand, bentonite, protective casing, well development equipment	N	
017_MWDeep	*Installation of Deep Monitoring Wells, QCed and reviewed 04/2015*	CH2M	Drilling rig, well riser/screen and associated materials, sand, bentonite, protective casing, well development equipment	N	
018_SlugTest	*Aquifer Slug Testing, QCed and reviewed 4/2015*	CH2M	In situ data logger, well-testing assembly, compressed air, soil displacement device	N	
019_PotableWater	*Potable Water Supply Sampling, Effective date, March 2013*	USEPA	Sample bottles, gloves, non-Teflon tubing, sampling equipment and clothing without potential to contain PFCs, as per SOP.	N	

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

Field Equipment	Activity1	Frequency	Acceptance Criteria	CA	Resp. Person	SOP Reference2	Comments
Horiba U-22 pH probe	Calibration	Daily, before use	pH reads 4.0 +/- 3%	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly	FTL	HoribaU22	
Horiba U-22 Specific conductance probe	Calibration	Daily, before use	Conductivity reads 4.49 +/- 3%	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	FTL	HoribaU22	
Horiba U-22 Turbidity probe	Calibration	Daily, before use	Turbidity reads 0 +/- 3%	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	FTL	HoribaU22	
Horiba U-22 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.	FTL	HoribaU22	
Horiba U-22	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 +/- 3% conductivity reads 4.49 +/- 3% turbidity reads 0 +/- 3%	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	FTL	HoribaU22	

Notes:

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

[2] References from **Worksheet #21**.

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SAP Worksheet #23—Analytical SOP References Table

Lab SOP Number	Title, Revision Date, and/or Number	Date Last Reviewed if not Revised[1]	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis[2]	Variance to QSM	Modified for Project Work?
WS-LC-0025	*Perfluorinated Compounds (PFCs) in Water, Soils, Sediments and Tissue by LC/MS/MS; Rev. 1.5; 11/01/15*		Definitive	Groundwater, Effluent, Influent, Soil / SVOCs (PFCs)	LC/MS/MS	TestAmerica-West Sacramento	N	N
WS-EHS-0001	*Waste Disposal; Rev. 4.4; 9/5/14*		N/A (Disposal)	Groundwater, Effluent, Influent, Soil / SVOCs (PFCs)	N/A (Disposal)	TestAmerica-West Sacramento	N	N
WS-QA-0003	*Sample Receipt and Procedures; Rev. 11.9; 9/30/14*		N/A (Receiving)	Groundwater, Effluent, Influent, Soil / SVOCs (PFCs)	N/A (Receiving)	TestAmerica-West Sacramento	N	N

Notes:

[1] Non-analytical SOPs do not require an annual review cycle. This worksheet was prepared in November 2015.

[2] TestAmerica-West Sacramento's DoD ELAP accreditation through A2LA is granted through 1/31/16.

QSM = Quality Systems Manual

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SAP Worksheet #24—Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
LC/MS/MS	Tune Check	Prior to ICAL and after any mass calibration or maintenance is performed.	Tuning standard must contain analytes of interest or appropriate substitute. Mass assignments of tuning standard within 0.5 amu of true value.	Retune instrument. If the tuning will not meet acceptance criteria, an instrument mass calibration must be performed and the tuning redone.	Lab Manager / Analyst	WS-LC-0025
	Minimum five-point initial calibration for target analytes, lowest concentration standard at or below the RL	Initial calibration prior to sample analysis	Each calibration point for each analyte must calculate to be within 75 to 125 percent, except the lowest cal point which must calculate to within 70 to 130 percent.	Evaluate standards, chromatography, and mass spectrometer response. If problem found with above, correct as appropriate, then repeat initial calibration.		
	Second-source calibration verification	Once per initial calibration, following initial calibration.	All reported analytes and labelled compounds within ± 25 percent of true value.	Evaluate data. If problem (e.g., concentrated standard, plugged transfer line) found, correct, then repeat second source verification. If it still fails, then repeat initial calibration.		
	Daily calibration verification	Before sample analysis, after every 10 samples, and at the end of the sequence.	All reported analytes and labelled compounds within ± 25 percent of true value.	Evaluate failure and impact on samples. If samples non-detect for analytes which have a high bias, report non-detect results with case narrative comment. For closing CCVs, if compounds are not identified as critical compounds of concern report results with qualifiers. For closing CCVs, if the compound is identified as a critical compound of concern, then recalibrate, and reanalyze all affected samples since the last acceptable CCV;or Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take CAs and re-calibrate; then reanalyze all affected samples since the last acceptable CCV.		

Notes:

DoD QSM v.5.0 is the basis for specifications on this table

CCV = continuing calibration verification.

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

Instrument / Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	CA	Responsible Person	SOP Reference
LC/MS/MS	Replace columns as needed, check eluent reservoirs	Sensitivity check	Instrument performance and sensitivity	Daily or as needed	CCV pass criteria	Recalibrate	TestAmerica Chemist	WS-LC-0025

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SAP Worksheet #26—Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Field Team/CH2M Sample Packaging (Personnel/Organization): FTL/ CH2M Coordination of Shipment (Personnel/Organization): FTL/ CH2M Type of Shipment/Carrier: Overnight Carrier/ FedEx
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Sample Receipt Personnel/TestAmerica-West Sacramento Sample Custody and Storage (Personnel/Organization): Sample Receipt Personnel/TestAmerica-West Sacramento **Sample Preparation (Personnel/Organization):** Extractions Personnel/TestAmerica-West Sacramento Sample Determinative Analysis (Personnel/Organization): Analysts/TestAmerica-West Sacramento
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 90 Days **Sample Extract/Digestate Storage** (No. of days from extraction/digestion): Extracts and may be disposed of 90 days after extraction **Microbial Sample Storage** (No. of days from sample collection): N/A
SAMPLE DISPOSAL
Personnel/Organization: Environmental HSO/TestAmerica-West Sacramento **Number of Days from Analysis:** Samples may be disposed of 90 days after report mail date

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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 °C until they are received by the laboratory. The chain-of-custody form 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 form (to relinquish custody). Upon delivery, the laboratory will log in each cooler and report the status of the samples to CH2M. See **Worksheet #21** for SOPs containing sample custody guidance. All PFC samples will be sent to TestAmerica in Sacramento, California.
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 COC 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: Chain-of-custody forms 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

Analytical Group: SVOCs (PFCs)

Analytical Method/ SOP Reference: WS-LC-0025

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Method Blank	One per preparation batch	No target analytes ≥ ½ LOQ and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater).	Verify instrument clean (evaluate calibration blank & samples prior to method blank), then reanalyze. Evaluate to determine if systematic issue within laboratory, correct, then re-prepare and reanalyze the method blank and all samples processed with the contaminated blank in accordance with DoD QSM requirements.	Lab Manager / Analyst	Bias / Contamination	Same as Method / SOP QC Acceptance Limits
Internal Standards (Isotope Dilution Analytes, spiked prior to extraction)	Every sample, spiked sample, standard, and method blank	% recovery for each IS in the original sample (prior to dilutions) must be within 25-150%	Reanalyze once. Assess matrix, dilute and/or re-extract as needed. Evaluate impact on data.		Accuracy / Bias	
LCS	One LCS per preparation batch	See Worksheet #15	Reanalyze LCS once. If acceptable, report. Evaluate samples for detections, and LCS for high bias. If LCS has high bias, and samples non-detect, report with case narrative comment. If LCS has low bias, or if there are detections for critical chemicals of concern, evaluate and reprep and reanalyze the LCS and all samples in the associated prep batch for failed analytes, if sufficient sample material is available.		Accuracy / Bias	
Matrix Spike/Matrix Spike Duplicate (MS/MSD)	One MS/MSD pair per preparation batch	See Worksheet #15	Evaluate the data, and re-prepare/reanalyze the native sample and MS/MSD pair if laboratory error is indicated.		Precision / Accuracy / Bias	

Notes:

DoD QSM v.5.0 s is the basis for specifications on this table.

SAP Worksheet #28-2—Laboratory QC Samples Table

Matrix: Soil

Analytical Group: SVOCs (PFCs)

Analytical Method/ SOP Reference: WS-LC-0025

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Method Blank	One per preparation batch	No target analytes ≥ ½ LOQ and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater).	Verify instrument clean (evaluate calibration blank & samples prior to method blank), then reanalyze. Evaluate to determine if systematic issue within laboratory, correct, then re-prepare and reanalyze the method blank and all samples processed with the contaminated blank in accordance with DoD QSM requirements.	Lab Manager/ Analyst	Bias / Contamination	Same as Method/ SOP QC Acceptance Limits
Internal Standards (Isotope Dilution Analytes, spiked prior to extraction)	Every sample, spiked sample, standard, and method blank	% recovery for each IS in the original sample (prior to dilutions) must be within 25-150%	Reanalyze once. Assess matrix, dilute and/or re-extract as needed. Evaluate impact on data.		Accuracy / Bias	
LCS	One LCS per preparation batch	See Worksheet #15	Reanalyze LCS once. If acceptable, report. Evaluate samples for detections, and LCS for high bias. If LCS has high bias, and samples non-detect, report with case narrative comment. If LCS has low bias, or if there are detections for critical chemicals of concern, evaluate and reprep and reanalyze the LCS and all samples in the associated prep batch for failed analytes, if sufficient sample material is available.		Accuracy / Bias	
Matrix Spike/Matrix Spike Duplicate (MS/MSD)	One MS/MSD pair per preparation batch	See Worksheet #15	Evaluate the data, and re-prepare/reanalyze the native sample and MS/MSD pair if laboratory error is indicated.		Precision / Accuracy / Bias	

Notes:

DoD QSM v.5.0 s is the basis for specifications on this table.

SAP Worksheet #29—Project Documents and Records Table

Document	Where Maintained 1
• Field Notebooks • Chain-of-Custody Records • Air Bills • Custody Seals • CA Forms • Electronic Data Deliverables (EDDs) • Identification of QC Samples • Meteorological Data from Field • Sampling instrument calibration logs • Sampling locations and sampling plan • Sampling notes and drilling logs • Water quality parameters • 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) • Data Validation Reports • CA Forms • Method Detection Limit Study Information	• Field data deliverables (e.g., logbooks entries, chains-of-custody, air bills, EDDs) will be kept on CH2M's local intranet server. • Field parameter data will be loaded with the analytical data into Data Warehouse • Analytical laboratory hardcopy deliverables and data validation reports will be saved on the network server. Electronic data from the laboratory will be loaded into the Data Warehouse and NIRIS

Notes:

[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 Numbers	Analytical SOP	Data Package Turnaround Time	Laboratory / Organization	Backup Laboratory / Organization[1]
Groundwater	SVOCs (PFCs)	40	WS-LC-0025	7 calendar days for Form 1s, 28 calendar days for full Level IV deliverable	TestAmerica Laboratories, Inc. Attn: Sample Receiving 880 Riverside Parkway West Sacramento, CA 95605 (916) 373-5600 POC: Laura Turpen	TBD
Soil	SVOCs (PFCs)	TBD[2]	WS-LC-0025	TBD[2]		

Notes:

[1] A backup laboratory has not been identified at this time. If circumstances arise that render TestAmerica unable to perform analytical services, a backup laboratory will be selected at that time.

[2] Soil sampling locations and TAT will be determined based on the results of initial groundwater samples.

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SAP Worksheet #31—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
Third Party Laboratory Technical Systems Audit	Laboratories must have current DoD ELAP accreditation which will identify the period of performance.	External	Third party accrediting body	TBD, Third party accrediting body	TBD, TestAmerica QAO	TBD, TestAmerica QAO	Anita Dodson, Program Chemist, CH2M
Project Review	Once	Internal	CH2M	Janna Staszak	PM, FTL and Field Staff	Laura Cook	Janna Staszak

DoD ELAP accreditation is required for definitive data only.

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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
Project Review	Checklist	Laura Cook, PM, CH2M	Within 1 week of audit	Memorandum	Paul Landin, AQM	Within 1 week of receipt of CA Form
Laboratory Performance and Systems Audits	Written Audit Report	TBD, TestAmerica QAO	Within 2 months of audit	Memorandum	TBD, Third-party accrediting body	Within 2 months of receipt of initial notification.

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SAP Worksheet #32-1—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 Navy CLEAN Program Chemist

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SAP Worksheet #32-2—Field Performance Audit Checklist

Project Responsibilities

Project No.: ____ Date: ____

Project Location: ____________________________________ Signature: ____________________________________

Team Members:

Yes ___ No ___ 1) Is the approved Work Plan being followed?

Comments ____

____

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

Comments ____

____

Yes ___ No ___ 2) Were additional instructions given to project participants?

Comments ____

____

Sample Collection

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

Comments ____

____

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

Comments ____

____

Yes ___ No ___ 3) Are samples collected in the type of containers specified in the Work Plan?

Comments ____

____

Yes ___ No ___ 4) Are samples preserved as specified in the Work Plan?

Comments ____

____

SAP Worksheet #32-2—Field Performance Audit Checklist (continued)

Yes ___ No ___ 5) Are the number, frequency, and type of samples collected as specified in the Work Plan?
Comments ____________________
____

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

Yes ___ No ___ 7) Are photographs taken and documented?
Comments ____________________
____

Document Control

Yes ___ No ___ 1) Have any accountable documents been lost?
Comments ____________________
____

Yes ___ No ___ 2) Have any accountable documents been voided?
Comments ____________________
____

Yes ___ No ___ 3) Have any accountable documents been disposed of?
Comments ____________________
____

Yes ___ No ___ 4) Are the samples identified with sample tags?
Comments ____________________
____

Yes ___ No ___ 5) Are blank and duplicate samples properly identified?
Comments ____________________
____

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

Yes ___ No ___ 7) Is chain-of-custody documented and maintained?
Comments ____________________
____

SAP Worksheet #33—QA Management Reports Table

Type of Report	Frequency	Projected Delivery Date	Person Responsible for Report Preparation	Report Recipient(s)
Final Report	Post-field Event	March 2016	Laura Cook/CH2M	Stakeholders, see **Worksheet #4**

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

Data Review Input	Description	Responsible for Verification	Step I / IIa / IIb[1]	Int. / Ext
Field Notebooks	Field notebooks will be reviewed internally and placed into the project file for archival at project closeout.	FTL/CH2M	Step I	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 chain-of-custody retained in the site file, and the original and remaining copies taped inside the cooler for shipment.	FTL/CH2M PC/CH2M	Step I	Internal / External
Sample Condition Upon Receipt	Any discrepancies, missing, or broken containers will be communicated to the project data manager in the form of laboratory logins.	PC/CH2M	Step I	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	Step I	External
Electronic Data Deliverables	Electronic Data Deliverables will be compared against hardcopy laboratory results (10 percent check).	PC/CH2M	Step I	External
Case Narrative	Case narratives will be reviewed by the DV during the data validation process. This is verification that they were generated and applicable to the data packages.	Herb Kelly/CH2M (DV)	Step I	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.	Laura Turpen/TestAmerica (Laboratory PM)	Step I	Internal
Laboratory Data	The data will be verified for completeness by the PC.	PC/CH2M	Step I	External
CA 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 PC/CH2M	Step I	Internal / External
	CA reports will be reviewed by the PC or PM and placed into the project file for archival at project closeout.	PM/CH2M PC/CH2M	Step I	External
Laboratory Methods	Ensure the laboratory analyzed samples using the correct methods.	PC/CH2M	Step IIa	External
Target Compound List	Ensure the laboratory reported all analytes from each analysis group as per Worksheet 15.	PC/CH2M	Step IIa	External
RLs	Ensure the laboratory met the project-designated RLs as per Worksheet 15. If RLs were not met, the reason will be determined and documented.	PC/CH2M	Step IIb	External
Laboratory SOPs	Ensure that approved analytical laboratory SOPs were followed.	Herb Kelly/CH2M (DV)	Step IIa	External
Sample Chronology	Holding times from collection to extraction or analysis and from extraction to analysis will be considered by the data validator during the data validation process.	Herb Kelly/CH2M (DV)	Step IIa / IIb	External
Raw Data[2]	10 percent of results are recalculated from the raw data to confirm laboratory calculations.	Herb Kelly/CH2M (DV)	Step IIa	External
Onsite Screening	All non-analytical field data will be reviewed against UFP-SAP requirements for completeness and accuracy based on the field calibration records.	FTL/CH2M	Step IIb	Internal
Documentation of Method QC Results	Establish that all required QC samples were run and met limits.	Herb Kelly/CH2M (DV)	Step IIa	External
Documentation of Field QC Sample Results	Establish that all required UFP-SAP QC samples were run and met limits.	PC/CH2M Herb Kelly/CH2M (DV)	Step IIb	External
Data Validation[2] (SVOCs)	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. National Functional Guidelines will be used for data validation; however, the qualifiers K and L from Region III Modifications to the National Functional Guidelines for Organic Data Review (USEPA, 1994) will be used to indicate the direction of bias of the estimated result. Additionally, B-qualifiers will be used as the USEPA Region 3 website indicates its acceptable use.	Herb Kelly/CH2M (DV)	Step IIa and IIb	External

Notes:

[1] I = verification
IIa = compliance with methods, procedures, and contracts [see Table 10, page 117, UFP-QAPP manual, V.1, March 2005.]
IIb = comparison with measurement performance criteria in the UFP-SAP [see Table 11, page 118, UFP-QAPP manual, V.1, March 2005]

[2] Level IV data validation will be performed on 100% of definitive analyses. Of the 100% validated, 10% of results will be recalculated from the raw data in order to verify calculations.

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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 PQL goals in **Worksheet #15** were achieved. If PQLs were achieved and the verification and validation steps yielded acceptable data, then the data are considered usable.
- During verification and validation steps, data may be qualified as estimated with the following qualifiers: J, UJ, K, L, or UL. These qualifiers represent minor QC deficiencies that 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 is not considered usable for project decisions. If R-qualified data are used in evaluations and, ultimately, project decisions, the rationale for their use will be included in the investigation report
  - J = Analyte present. Reported value may or may not be accurate or precise.
  - UJ = Analyte not detected. QL may be inaccurate or imprecise.
  - K = Analyte present. Reported value may be biased high. Actual value is expected to be lower.
  - L = Analyte present. Reported value may be biased low. Actual value is expected to be higher.
  - UL = Analyte not detected. QL is probably higher.
  - R = Rejected result. Result not reliable.
- If statistical comparisons are necessary, non-detect values will be represented by a concentration equal to one-half the sample RL. For duplicate sample results, the most conservative value will be used for project decisions.
- Additional qualifiers that may be given by the validator are:
  - B = Not detected substantially above the level reported in laboratory or FBs.
  - 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.
- 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 EDD. Once the data has been uploaded into the electronic database, another check will be performed to ensure all results were loaded accurately.
- Field and laboratory precision will be compared as RPD between the two results.
- Deviations from the SAP will be reviewed to assess whether CA is warranted and to assess impacts to achievement of project objectives.
- Describe the evaluative procedures used to assess overall measurement error associated with the project.
- To assess whether a sufficient quantity of acceptable data are available for decision-making, the data will be reconciled with measurement performance criteria following validation and review of DQIs.
- If significant biases are detected with laboratory QA/QC samples, the samples will be evaluated to assess impact on decision-making. Low biases will be described in detail as they represent a possible inability to detect compounds that may be present at the site.
- If significant deviations are noted between laboratory and field precision the cause will be further evaluated to assess impact on decision-making.

SAP Worksheet #37—Usability Assessment (continued)

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

- Data tables will be produced to reflect detected and non-detected analytes. Data qualifiers will be reflected in the tables and discussed in the data quality evaluation.
- A data quality evaluation will be provided as part of the Investigation Report.
- The Investigation Report will identify any data usability limitations and make recommendations for CA if necessary.

Identify the personnel responsible for performing the usability assessment.

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

References

Baker Environmental, Inc. (Baker). 1992. *Site Inspection Report, Site 14 - Fentress Landfill, Site 17 - Firefighting Training Area, Naval Auxiliary Landing Field, Fentress, Virginia*. July.

Baker. 1993. *Supplemental Site Investigation Report, Site 14 - Fentress Landfill and Site 17 - Firefighting Training Area, Naval Auxiliary Landing Field, Fentress, Virginia.* October.

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Earth Technology Corporation (EarthTech). 1989. *Resource Conservation and Recovery Act (RCRA) Facility Assessment Revised Phase II Report, Oceana Naval Air Station, Virginia Beach, Virginia.* March.

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Kearney, A.T. 1989. *RCRA Facility Assessment Revised Phase II Report, Oceana Naval Air Station, Virginia Beach, Virginia.* March.

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USEPA. 2006. *Guidance on Systematic Planning Using the Data Quality Objectives Process. EPA QA/G-4.* EPA/240/B-06/001. February.

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United States Geological Survey (USGS), 2006. *The Virginia Coastal Plain Hydrogeologic Framework Professional Paper 1731*.

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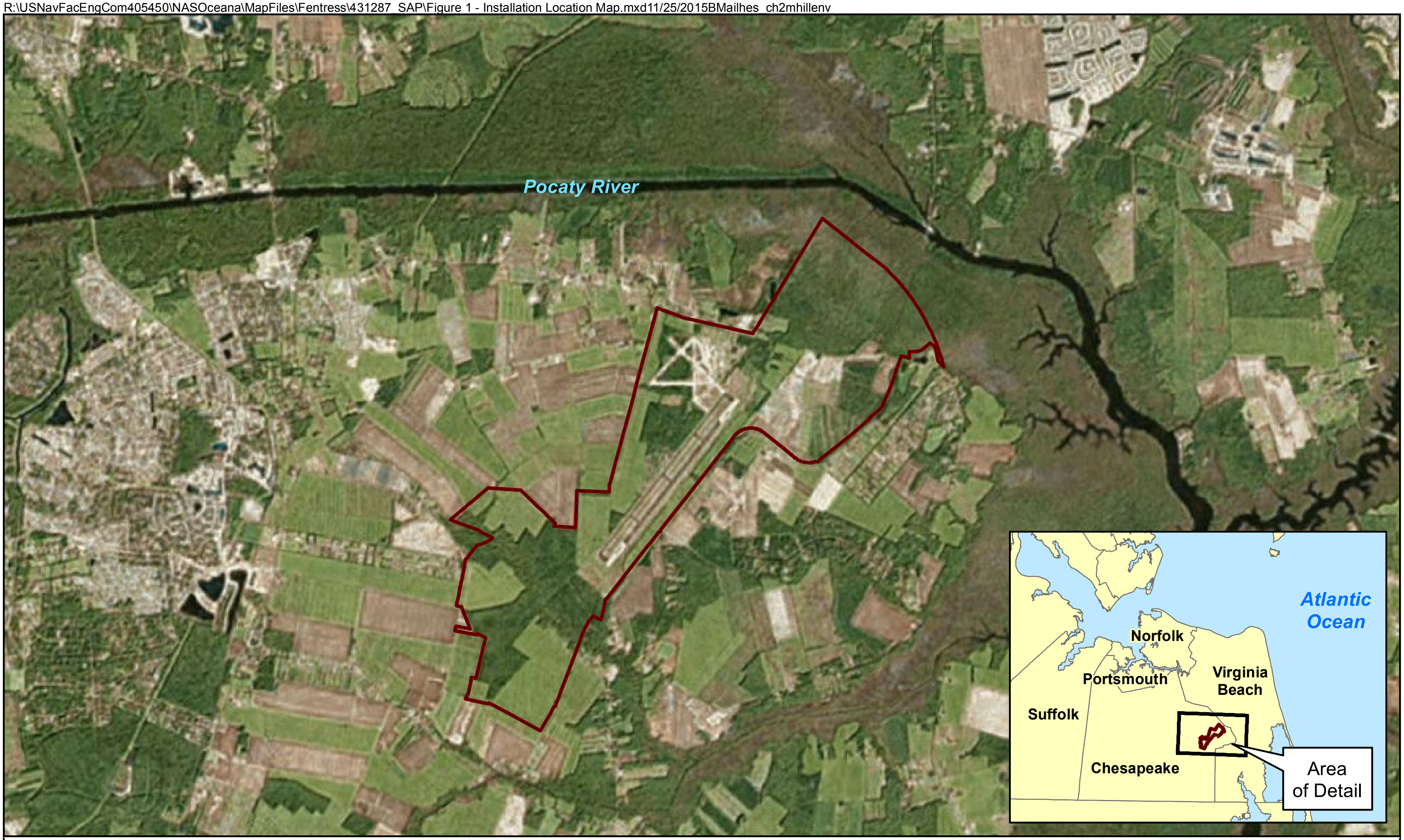
Figures

R:\USNavFacEngCom405450\NASOceana\MapFiles\Fentress\431287_SAP\Figure 1 - Installation Location Map.mxd11/25/2015BMailhes_ch2mhillenv



Legend

🟥 Fentress Boundary

N
W E
S

0 0.5 1 Miles

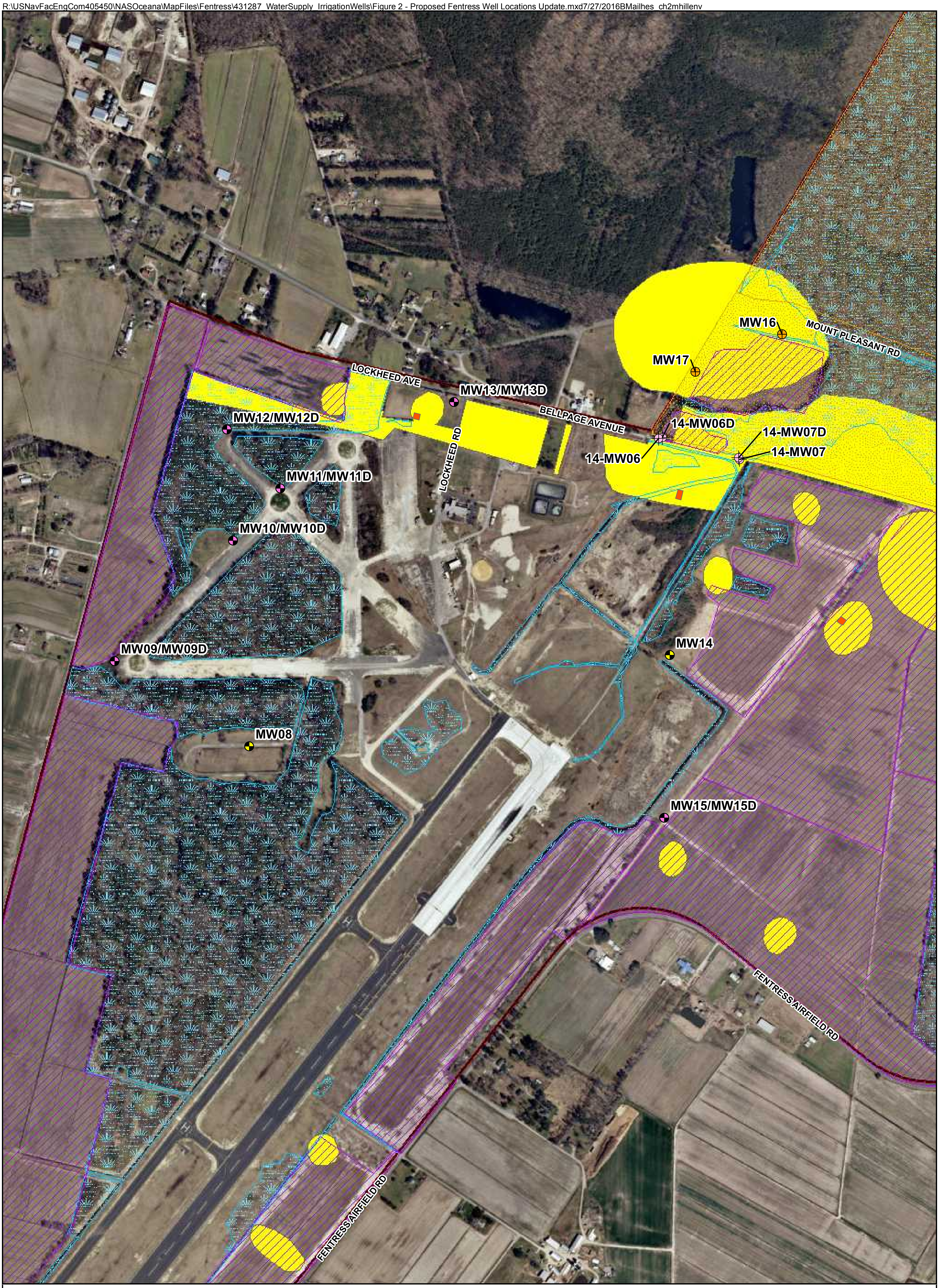
1 inch = 1 mile

Imagery Source: ©2015 Esri

Figure 1
Installation Location Map
Perfluorinated Compound Investigation Sampling and Analysis Plan
NALF Fentress, Chesapeake, Virginia

ch2m

R:\USNavFacEngCom405450\NASOceana\MapFiles\Fentress\431287_WaterSupply_IrrigationWells\Figure 2 - Proposed Fentress Well Locations Update.mxd7/27/2016BMailhes_ch2mhillenv



Legend

- ● Proposed Co-located Shallow and Deep Monitoring Wells
- ● Proposed Shallow Monitoring Well
- ⊕ Irrigation Well Location
- ⊕ Wells Associated with Site 14
- ☐ Fentress Boundary
- ▨ Natural Heritage Inventory Area
- ▨ Agricultural Outlease Area
- 🟥 Cemetery Or Burial Site
- 🟨 Cultural Resource Potential Area
- ▨ Wetland

N
W E
S

0 350 700
Feet

1 inch = 700 feet
Imagery Source: ©2015 Esri

Figure 2
Proposed Monitoring Well Locations
Perfluorinated Compound Investigation Sampling and Analysis Plan
NALF Fentress, Chesapeake, Virginia

ch2m

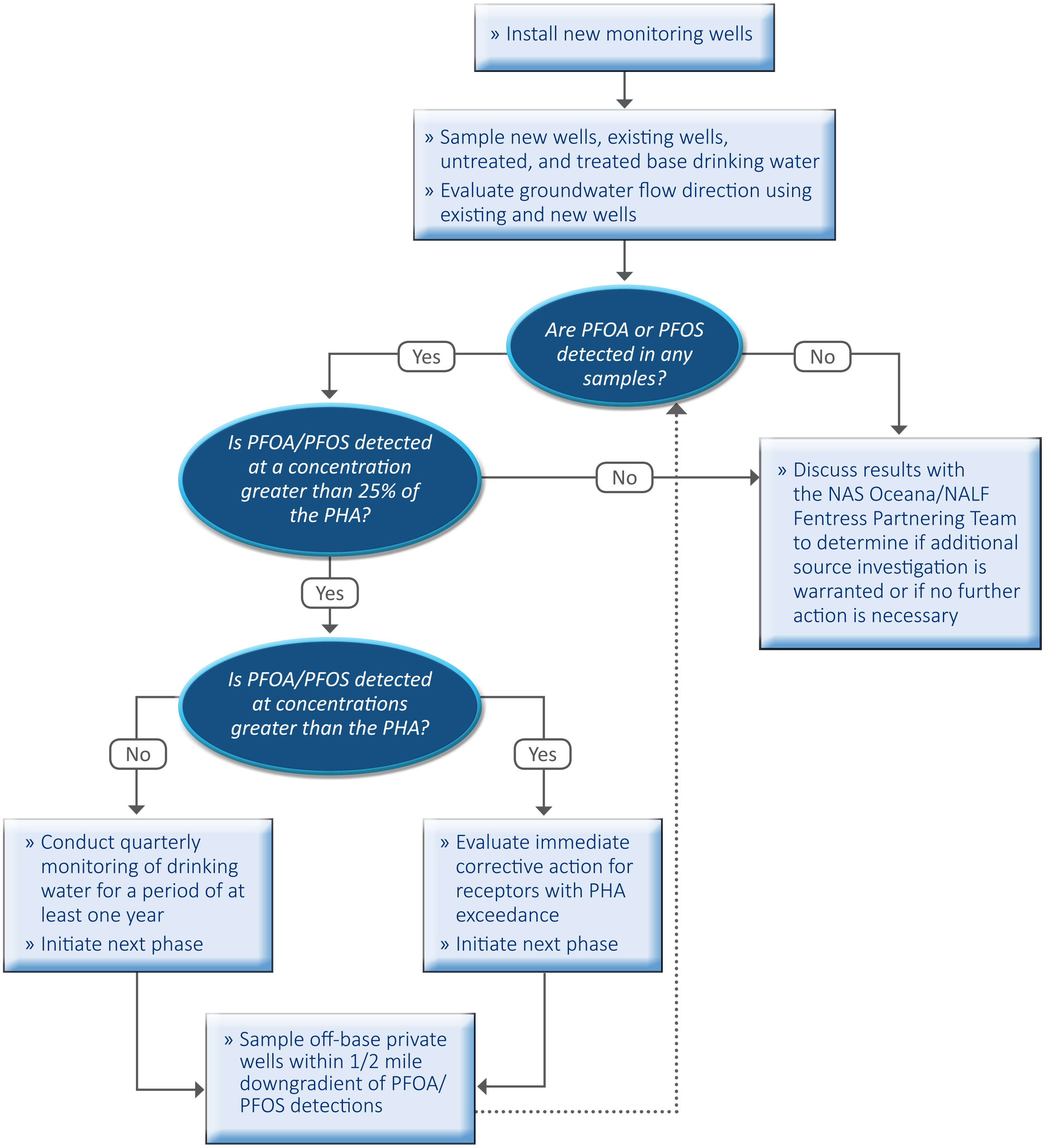


Figure 3
Decision Logic
Perfluorinated Compound Investigation
Naval Auxiliary Landing Field, Fentress
Chesapeake, Virginia

Appendix A
Field SOPs

STANDARD OPERATING PROCEDURE

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® 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). (Optional)
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). (Optional)
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®, Liquinox® solution (optional), and distilled water.
- Do not use acetone for decontamination.
- Drum all contaminated rinsate and materials.
- Decontaminate filled sample bottles before relinquishing them to anyone.

STANDARD OPERATING PROCEDURE

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.

STANDARD OPERATING PROCEDURE

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 (Optional)
   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.

STANDARD OPERATING PROCEDURE

Direct-Push Soil Sample Collection

I. Purpose

To provide a general guideline for the collection of soil samples using direct-push (e.g., Geoprobe®) sampling methods.

II. Scope

Standard direct-push (e.g., Geoprobe®) soil sampling methods.

III. Equipment and Materials

- Truck-mounted hydraulic percussion hammer
- Sampling rods
- Sampling tubes and acetate liners
- Pre-cleaned sample containers and stainless-steel sampling implements
- Personal Protective Equipment as specified by the Health and Safety Plan

IV. Procedures and Guidelines

1. Decontaminate sampling tubes and other non-dedicated downhole equipment in accordance with SOP *Decontamination of Personnel and Equipment*.
2. Drive sampling tube to the desired sampling depth using the truck-mounted hydraulic percussion hammer. If soil above the desired depth is not to be sampled, first drive the lead rod, without a sampling tube, to the top of the desired depth.
3. Remove the rods and sampling tube from the borehole and remove the sampling tube from the lead rod.
4. Cut open the acetate liner using a specific knife designed to slice the acetate liners (see below).

5. Fill all sample containers, beginning with the containers for VOC analysis, using a decontaminated or dedicated sampling implement. For the VOC samples, place the sample into a pre-preserved VOA vial or direct sample container such as an **En Core®** or **Terra Core®** sampler and seal the cap tightly. Ideally, the operation should be completed in one minute. Label the vials and immediately place samples on ice for shipment to the laboratory.
6. Decontaminate all non-dedicated downhole equipment (rods, sampling tubes, etc.) in accordance with SOP *Decontamination of Personnel and Equipment*.
7. Backfill borehole at each sampling location with grout or bentonite and repair the surface with like material (bentonite, asphalt patch, concrete, etc.), as required.

V. Key Checks and Items

1. Verify that the hydraulic percussion hammer is clean and in proper working order.
2. Ensure that the direct-push operator thoroughly completes the decontamination process between sampling locations.
3. Verify that the borehole made during sampling activities has been properly backfilled.

STANDARD OPERATING PROCEDURE

Shallow Soil Sampling

I. Purpose

To provide general guidelines for the collection and handling of surface soil samples during field operations.

II. Scope

The method described for surface soil sampling is applicable for loosely packed earth and is used to collect disturbed-soil samples.

III. Equipment and Materials

- Sample jars.
- A hand auger or other device that can be used to remove the soil from the ground. Only stainless steel, Teflon, or glass materials should be used. The only exception is split spoons, which are most commonly available in carbon steel; these are acceptable for use only if they are not rusty.
- A stainless steel spatula or disposable plastic scoop should be used to remove material from the sampling device.
- Unpainted wooden stakes or pin flags
- Fiberglass measuring tape (at least 200 feet in length)
- GPS Unit (if available)

IV. Procedures and Guidelines

A. Wear protective gear, as specified in the Health and Safety Plan.

B. To locate samples, identify the correct location using the pin flags or stakes. Proceed to collect a sample from the undisturbed soil adjacent to the marker following steps C and D. If markers are not present, the following procedures will be used.

   1. For samples on a grid:

      a. Use measuring tape to locate each sampling point on the first grid line as prescribed in the sampling plan. As each point is located, drive a numbered stake in the ground and record its location on the site map and in the logbook.

b. Proceed to sample the points on the grid line.

c. Measure to location where next grid line is to start and stake first sample. For subsequent samples on the line take two orthogonal measurements: one to the previous grid line, and one to the previous sample on the same grid line.

d. Proceed to sample the points on the grid line as described in Section C below.

e. Repeat 1c and 1d above until all samples are collected from the area.

f. Or, a GPS unit can be used to identify each location based on map coordinated, if available.

2. For non-grid samples:

a. Use steel measuring tape to position sampling point at location described in the sampling plan by taking two measurements from fixed landmarks (e.g., corner of house and fence post).

b. Note measurements, landmarks, and sampling point on a sketch in the field notebook, and on a site location map.

c. Proceed to sample as described in Section C below.

d. Repeat 2a through 2c above until all samples are collected from the area.

e. Or, a GPS unit can be used to identify each location based on map coordinated, if available.

C. To the extent possible, differentiate between fill and natural soil. If both are encountered at a boring location, sample both as prescribed in the field sampling plan. Do not locate samples in debris, tree roots, or standing water. In residential areas, do not sample in areas where residents' activities may impact the sample (e.g., barbecue areas, beneath eaves of roofs, driveways, garbage areas). If an obstacle prevents sampling at a measured grid point, move as close as possible, but up to a distance of one half the grid spacing in any direction to locate an appropriate sample. If an appropriate location cannot be found, consult with the Field Team Leader (FTL). If the FTL concurs, the sampling point will be deleted from the program. The FTL will contact the CH2M HILL project manager (PM) immediately. The PM and Navy Technical Representative (NTR) will discuss whether the point should be deleted from the program. If it is deleted, the PM will follow-up with the NTR in writing.

D. To collect samples:

1. Use a decontaminated stainless steel scoop/trowel or disposable plastic scoop to scrape away surficial organic material (grass, leaves, etc.) adjacent to

the stake. New disposable scoops or trowels may also be used to reduce the need for equipment blanks.

2. If sampling:
   a. Surface soil: Obtain soil sample by scooping soil using the augering scoop/trowel, starting from the surface and digging down to a depth of about 6 inches, or the depth specified in the workplan.
   b. Subsurface soil: Obtain the subsurface soil sample using an auger down to the depths prescribed in the field sampling plan.
3. Take a photo ionization detector (PID) reading of the sampled soil if organics are anticipated to be present and record the response in the field notebook. Also record lithologic description and any pertinent observations (such as discoloration) in the logbook.
4. Empty the contents of the scoop/trowel into a decontaminated stainless steel pan or dedicated sealable bag.
5. Repeat this procedure until sufficient soil is collected to meet volume requirements.
6. For TCL VOC and field GC aliquots, fill sample jars directly with the trowel or scoop or specialized sampling equipment (i.e. Encore® or Terra Core® sampler) and cap immediately upon filling. DO NOT HOMOGENIZE.
7. For TCL pesticides/PCBs and SVOCs, TAL metals, and field XRF aliquots, homogenize cuttings in the pan using a decontaminated stainless steel utensil in accordance with SOP *Decontamination of Drilling Rigs and Equipment*.
8. Transfer sample for analysis into appropriate containers with a decontaminated utensil.
9. Immediately upon collection, all samples for chemical analysis are to be placed in a closed container on ice unless it is not possible to do so. Although unusual and uncommon, there may be instances where it is not possible to have containers with ice at the sample location. In these instances, the samples should be placed on ice as soon as practical and during the time between collection and placing the samples on ice, the samples should be kept as cool as possible
10. Backfill the hole with soil removed from the borehole. To the extent possible, replace topsoil and grass and attempt to return appearance of sampling area to its pre-sampled condition. For samples in non-residential, unmowed areas, mark the sample number on the stake and leave stake in place. In mowed areas, remove stake.

V. Attachments

None.

VI. Key Checks and Items

- Use phthalate-free latex or surgical gloves and other personal protective equipment.
- Transfer volatiles first, avoid mixing.
- Decontaminate utensils before reuse, or use dedicated, disposable utensils.

STANDARD OPERATING PROCEDURE

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. Heath 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:

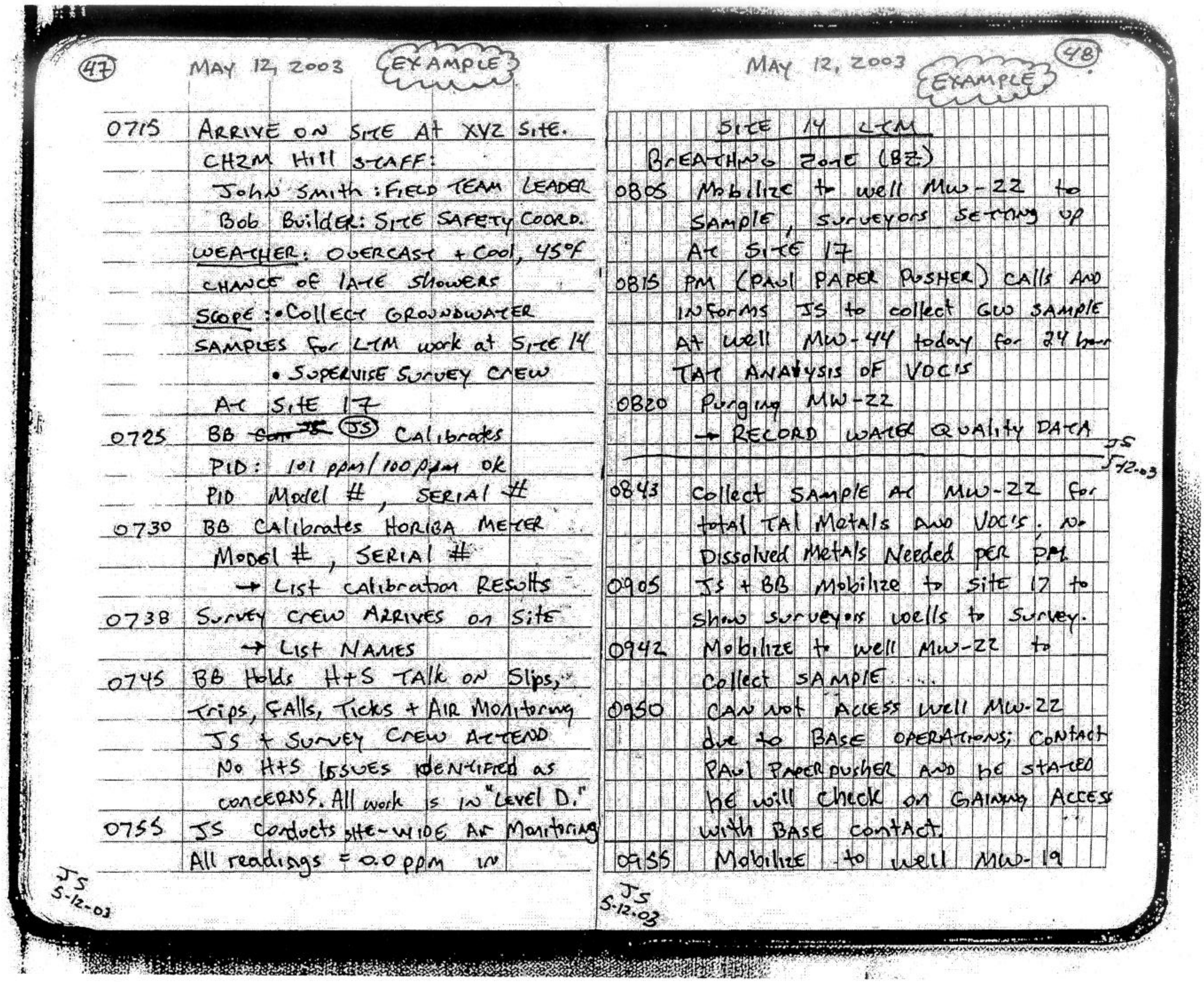
    - Description of the general sampling area – site name, buildings and streets in the area, etc.
    - Station/Location identifier
    - Description of the sample location – estimate location in comparison to two fixed points – draw a diagram in the field log book indicating sample location relative to 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.



(47) 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 IATE ShowERS
SCOPE : • Collect GROUNDWATER
SAMPLES for LTM work at SITE 14
• SUPERVISE SURVEY CREW
At SitE 17
0725 BB ~~Con JS~~ JS Calibrates
PID: 101 ppm/100 ppm ok
PID Model #, SERIAL #
0730 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
JS + SURVEY CREW ATTEND
No H+S ISSUES IDENTIFIED as
CONCERNS. All work is in "Level D."
0755 JS Conducts site-wide Air Monitoring
All readings = 0.0 ppm in

JS
5-12-03

MAY 12, 2003 EXAMPLE (48)

SITE 14 LTM
BREATHING ZONE (BZ)
0805 Mobilize to well MW-22 to
SAMPLE, surveyors setting up
At SITE 17
0815 PM (PAUL PAPER PUSHER) CAlls AND
INforms JS to collect GW SAMPLE
At well MW-44 today for 24 hour
TAT ANALYSIS OF VOC'S
0820 Purging MW-22
→ RECORD WATER QUALity DATA

JS
5-12-03

0843 Collect SAMPLE At MW-22 for
total TAl Metals AND VOC'S, No
Dissolved Metals Needed PER PM
0905 JS + 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 stated
he will check on GAINING ACCESS
with BASE contact.
0955 Mobilize to well MW-19

JS
5-12-03

STANDARD OPERATING PROCEDURE

Soil Sampling

I. Purpose and Scope

The purpose of this procedure is to provide guidelines for obtaining samples of surface and subsurface soils using hand and drilling-rig mounted equipment.

II. Equipment and Materials

- Stainless-steel trowel, shovel, scoop, coring device, hand auger, or other appropriate hand tool
- Stainless-steel, split-spoon samplers
- Thin-walled sampling tubes
- Drilling rig or soil-coring rig
- Stainless-steel pan/bowl or disposable sealable bags
- Sample bottles

III. Procedures and Guidelines

Before sampling begins, equipment will be decontaminated using the procedures described in SOP *Decontamination of Drilling Rigs and Equipment*. The sampling point is located and recorded in the field logbook. Debris should be cleared from the sampling location.

A. Surface and Shallow Subsurface Sampling

A shovel, post-hole digger, or other tool can be used to remove soil to a point just above the interval to be sampled. A decontaminated sampling tool will be used to collect the sample when the desired sampling depth has been reached. Soil for semivolatile organic and inorganic analyses is placed in the bowl and mixed; soil for volatile organic analysis is not mixed or composited but is placed directly into the appropriate sample bottles. A stainless-steel or dedicated wooden tongue depressor is used to transfer the sample from the bowl to the container.

The soils removed from the borehole should be visually described in the field log book, including approximated depths.

When sampling is completed, photo-ionization device (PID) readings should be taken directly above the hole, and the hole is then backfilled.

More details are provided in the SOP *Shallow Soil Sampling.*

B. Split-Spoon Sampling

Using a drilling rig, a hole is advanced to the desired depth. For split-spoon sampling, the samples are then collected following the ASTM D 1586 standard (attached). The sampler is lowered into the hole and driven to a depth equal to the total length of the sampler; typically this is 24 inches. The sampler is driven in 6-inch increments using a 140-pound weight ("hammer") dropped from a height of 30 inches. The number of hammer blows for each 6-inch interval is counted and recorded. To obtain enough volume of sample for subsequent laboratory analysis, use of a 3-inch ID sampler may be required. Blow counts obtained with a 3-inch ID spoon would not conform to ASTM D 1586 and would therefore not be used for geotechnical evaluations.

Once retrieved from the hole, the sampler is carefully split open. Care should be taken not to allow material in the sampler to fall out of the open end of the sampler. To collect the sample, the surface of the sample should be removed with a clean tool and disposed of. Samples collected for volatiles analysis should be placed directly into the sample containers from the desired depth in the split spoon. Material for samples for all other parameters should be removed to a decontaminated stainless steel tray or disposable sealable bag. The sample for semivolatile organic and inorganic analyses should be homogenized in the field by breaking the sample into small pieces and removing gravel. The homogenized sample should be placed in the sample containers. If sample volume requirements are not met by a single sample collection, additional sample volume may be obtained by collecting a sample from below the sample and compositing the sample for non-volatile parameters only.

Split-spoon samples also will be collected using a tripod rig. When using a tripod rig the soil samples are collected using an assembly similar to that used by the drilling rig.

C. Thin-Walled Tube Sampling

Undisturbed fine grained samples may be collected for analysis for geotechnical parameters such as vertical hydraulic conductivity. These samples will be collected using thin-walled sampling tubes (sometimes called Shelby tubes) according to ASTM D 1587 (attached). Tubes will be 24- to 36 inches long and 3- to 4-inches in diameter, depending upon the quantity of sample required. Undisturbed samples will be obtained by smoothly pressing the sampling tube through the interval to be sampled using the weight of the drilling rig. Jerking the sample should be avoided. Once the sample is brought to the surface, the ends will be sealed with bees wax and then sealed with end caps and heavy tape. The sample designation, data and time of sampling, and the up direction will be noted on the sampling tube. The tube shall be kept upright as much as possible and will be protected from freezing, which could disrupt the undisturbed nature of the sample. Samples for geochemical analysis normally are not collected from thin-walled tube samples.

IV. Attachments

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

ASTM D 1587 *Standard Practice for Thin-Walled Tube Sampling of Soils* (ASTM D1587.pdf)

V. Key Checks and Preventative Maintenance

- Check that decontamination of equipment is thorough.
- Check that sample collection is swift to avoid loss of volatile organics during sampling.

CH2MHILL

PROJECT NUMBER | **BORING NUMBER**

SOIL BORING LOG

PROJECT : LOCATION :
ELEVATION : DRILLING CONTRACTOR :
DRILLING METHOD AND EQUIPMENT USED :
ATD WATER LEVEL : START : END : LOGGER :

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	SAMPLE #/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N')	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	USCS	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. DRILLING ACTIONS/DRILLER COMMENTS PID Readings: Breathing Zone: Above Hole:

CH2M HILL

PROJECT NUMBER	BORING NUMBER SHEET OF

SOIL BORING LOG

PROJECT ______ LOCATION ______

ELEVATION ______ DRILLING CONTRACTOR ______

DRILLING METHOD AND EQUIPMENT ______

WATER LEVELS ______ START ______ FINISH ______ LOGGER ______

DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION	COMMENTS
	INTERVAL	NUMBER AND TYPE	RECOVERY (FT)	6"-6"-6" (N)	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION

Figure 1
SOIL BORING LOG, FORM D1586

REV 11/89 FORM D1586

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 5136 Feet DRILLING CONTRACTOR Kendall Explorations, Ashcan, 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)	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0	2.5				Surface material consist of 4 inches AC underlain by 6 inches of 3/4 inch minus base rock	Start Drilling @ 3:00
	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	5.0 6.5	2-S	0.9	WOH/12"-1	ORGANIC SILT, (OL), very dark, gray to black, wet, very soft; strong H_2S odor, many fine roots up to about 1/4 inch	Driller notes very soft drilling 4ft. dark grey, wet silty cuttings.
	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 @ 13ft
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 21.0	6-S	1.0	12-50/6"	LEAN CLAY WITH SAND, (CL), medium to light green, moist, very stiff	Driller notes smoother, firm drilling @ 19 ft 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

REV 11 89 FORM D1586

Designation: D 1586 – 08

Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils[1]

This standard is issued under the fixed designation D 1586; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This test method describes the procedure, generally known as the Standard Penetration Test (SPT), for driving a split-barrel sampler to obtain a representative disturbed soil sample for identification purposes, and measure the resistance of the soil to penetration of the sampler. Another method (Test Method D 3550) to drive a split-barrel sampler to obtain a representative soil sample is available but the hammer energy is not standardized.

1.2 Practice D 6066 gives a guide to determining the normalized penetration resistance of sands for energy adjustments of N-value to a constant energy level for evaluating liquefaction potential.

1.3 Test results and identification information are used to estimate subsurface conditions for foundation design.

1.4 Penetration resistance testing is typically performed at 5-foot depth intervals or when a significant change of materials is observed during drilling, unless otherwise specified.

1.5 This test method is limited to use in nonlithified soils and soils whose maximum particle size is approximately less than one-half of the sampler diameter.

1.6 This test method involves use of rotary drilling equipment (Guide D 5783, Practice D 6151). Other drilling and sampling procedures (Guide D 6286, Guide D 6169) are available and may be more appropriate. Considerations for hand driving or shallow sampling without boreholes are not addressed. Subsurface investigations should be recorded in accordance with Practice D 5434. Samples should be preserved and transported in accordance with Practice D 4220 using Group B. Soil samples should be identified by group name and symbol in accordance with Practice D 2488.

1.7 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D 6026, unless superseded by this test method.

1.8 The values stated in inch-pound units are to be regarded as standard, except as noted below. The values given in parentheses are mathematical conversions to SI units, which are provided for information only and are not considered standard.

1.8.1 The gravitational system of inch-pound units is used when dealing with inch-pound units. In this system, the pound (lbf) represents a unit of force (weight), while the unit for mass is slugs.

1.9 Penetration resistance measurements often will involve safety planning, administration, and documentation. This test method does not purport to address all aspects of exploration and site safety. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* Performance of the test usually involves use of a drill rig; therefore, safety requirements as outlined in applicable safety standards (for example, OSHA regulations,[2] NDA Drilling Safety Guide,[3] drilling safety manuals, and other applicable state and local regulations) must be observed.

2. Referenced Documents

2.1 *ASTM Standards:* [4]

D 653 Terminology Relating to Soil, Rock, and Contained Fluids

D 854 Test Methods for Specific Gravity of Soil Solids by Water Pycnometer

D 1587 Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes

D 2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

D 2487 Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

D 2488 Practice for Description and Identification of Soils

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[1] This method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Evaluations.

Current edition approved Feb. 1, 2008. Published March 2008. Originally approved in 1958. Last previous edition approved in 1999 as D 1586 – 99.

[2] Available from Occupational Safety and Health Administration (OSHA), 200 Constitution Ave., NW, Washington, DC 20210, http://www.osha.gov.

[3] Available from the National Drilling Association, 3511 Center Rd., Suite 8, Brunswick, OH 44212, http://www.nda4u.com.

[4] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard.**

(Visual-Manual Procedure)

D 3550 Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils

D 3740 Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D 4220 Practices for Preserving and Transporting Soil Samples

D 4633 Test Method for Energy Measurement for Dynamic Penetrometers

D 5434 Guide for Field Logging of Subsurface Explorations of Soil and Rock

D 5783 Guide for Use of Direct Rotary Drilling with Water-Based Drilling Fluid for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices

D 6026 Practice for Using Significant Digits in Geotechnical Data

D 6066 Practice for Determining the Normalized Penetration Resistance of Sands for Evaluation of Liquefaction Potential

D 6151 Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling

D 6169 Guide for Selection of Soil and Rock Sampling Devices Used With Drill Rigs for Environmental Investigations

D 6286 Guide for Selection of Drilling Methods for Environmental Site Characterization

D 6913 Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

3. Terminology

3.1 *Definitions:* Definitions of terms included in Terminology D 653 specific to this practice are:

3.1.1 *cathead, n*—the rotating drum or windlass in the rope-cathead lift system around which the operator wraps a rope to lift and drop the hammer by successively tightening and loosening the rope turns around the drum.

3.1.2 *drill rods, n*—rods used to transmit downward force and torque to the drill bit while drilling a borehole.

3.1.3 *N-value, n*—the blow count representation of the penetration resistance of the soil. The *N*-value, reported in blows per foot, equals the sum of the number of blows (*N*) required to drive the sampler over the depth interval of 6 to 18 in. (150 to 450 mm) (see 7.3).

3.1.4 *Standard Penetration Test (SPT), n*—a test process in the bottom of the borehole where a split-barrel sampler having an inside diameter of either 1-1/2-in. (38.1 mm) or 1-3/8-in. (34.9 mm) (see Note 2) is driven a given distance of 1.0 ft (0.30 m) after a seating interval of 0.5 ft (0.15 m) using a hammer weighing approximately 140-lbf (623-N) falling 30 ± 1.0 in. (0.76 m ± 0.030 m) for each hammer blow.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *anvil, n*—that portion of the drive-weight assembly which the hammer strikes and through which the hammer energy passes into the drill rods.

3.2.2 *drive weight assembly, n*—an assembly that consists of the hammer, anvil, hammer fall guide system, drill rod attachment system, and any hammer drop system hoisting attachments.

3.2.3 *hammer, n*—that portion of the drive-weight assembly consisting of the 140 ± 2 lbf (623 ± 9 N) impact weight which is successively lifted and dropped to provide the energy that accomplishes the sampling and penetration.

3.2.4 *hammer drop system, n*—that portion of the drive-weight assembly by which the operator or automatic system accomplishes the lifting and dropping of the hammer to produce the blow.

3.2.5 *hammer fall guide, n*—that part of the drive-weight assembly used to guide the fall of the hammer.

3.2.6 *number of rope turns, n*—the total contact angle between the rope and the cathead at the beginning of the operator's rope slackening to drop the hammer, divided by 360° (see Fig. 1).

3.2.7 *sampling rods, n*—rods that connect the drive-weight assembly to the sampler. Drill rods are often used for this purpose.

4. Significance and Use

4.1 This test method provides a disturbed soil sample for moisture content determination, for identification and classification (Practices D 2487 and D 2488) purposes, and for laboratory tests appropriate for soil obtained from a sampler that will produce large shear strain disturbance in the sample such as Test Methods D 854, D 2216, and D 6913. Soil deposits containing gravels, cobbles, or boulders typically result in penetration refusal and damage to the equipment.

4.2 This test method provides a disturbed soil sample for moisture content determination and laboratory identification. Sample quality is generally not suitable for advanced laboratory testing for engineering properties. The process of driving the sampler will cause disturbance of the soil and change the engineering properties. Use of the thin wall tube sampler (Practice D 1587) may result in less disturbance in soft soils. Coring techniques may result in less disturbance than SPT sampling for harder soils, but it is not always the case, that is, some cemented soils may become loosened by water action during coring; see Practice D 6151, and Guide D 6169.

4.3 This test method is used extensively in a great variety of geotechnical exploration projects. Many local correlations and widely published correlations which relate blow count, or *N*-value, and the engineering behavior of earthworks and foundations are available. For evaluating the liquefaction potential of sands during an earthquake event, the *N*-value should be normalized to a standard overburden stress level. Practice D 6066 provides methods to obtain a record of normalized resistance of sands to the penetration of a standard sampler driven by a standard energy. The penetration resistance is adjusted to drill rod energy ratio of 60 % by using a hammer system with either an estimated energy delivery or directly measuring drill rod stress wave energy using Test Method D 4633.

NOTE 1—The reliability of data and interpretations generated by this practice is dependent on the competence of the personnel performing it

(*a*) counterclockwise rotation
approximately 1¾ turns

(*b*) clockwise rotation
approximately 2¼ turns

FIG. 1 Definitions of the Number of Rope Turns and the Angle for (*a*) Counterclockwise Rotation and (*b*) Clockwise Rotation of the Cathead

and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D 3740 generally are considered capable of competent testing. Users of this practice are cautioned that compliance with Practice D 3740 does not assure reliable testing. Reliable testing depends on several factors and Practice D 3740 provides a means of evaluating some of these factors. Practice D 3740 was developed for agencies engaged in the testing, inspection, or both, of soils and rock. As such, it is not totally applicable to agencies performing this practice. Users of this test method should recognize that the framework of Practice D 3740 is appropriate for evaluating the quality of an agency performing this test method. Currently, there is no known qualifying national authority that inspects agencies that perform this test method.

5. Apparatus

5.1 *Drilling Equipment*—Any drilling equipment that provides at the time of sampling a suitable borehole before insertion of the sampler and ensures that the penetration test is performed on undisturbed soil shall be acceptable. The following pieces of equipment have proven to be suitable for advancing a borehole in some subsurface conditions:

5.1.1 *Drag, Chopping, and Fishtail Bits*, less than 6½ in. (165 mm) and greater than 2¼ in. (57 mm) in diameter may be used in conjunction with open-hole rotary drilling or casing-advancement drilling methods. To avoid disturbance of the underlying soil, bottom discharge bits are not permitted; only side discharge bits are permitted.

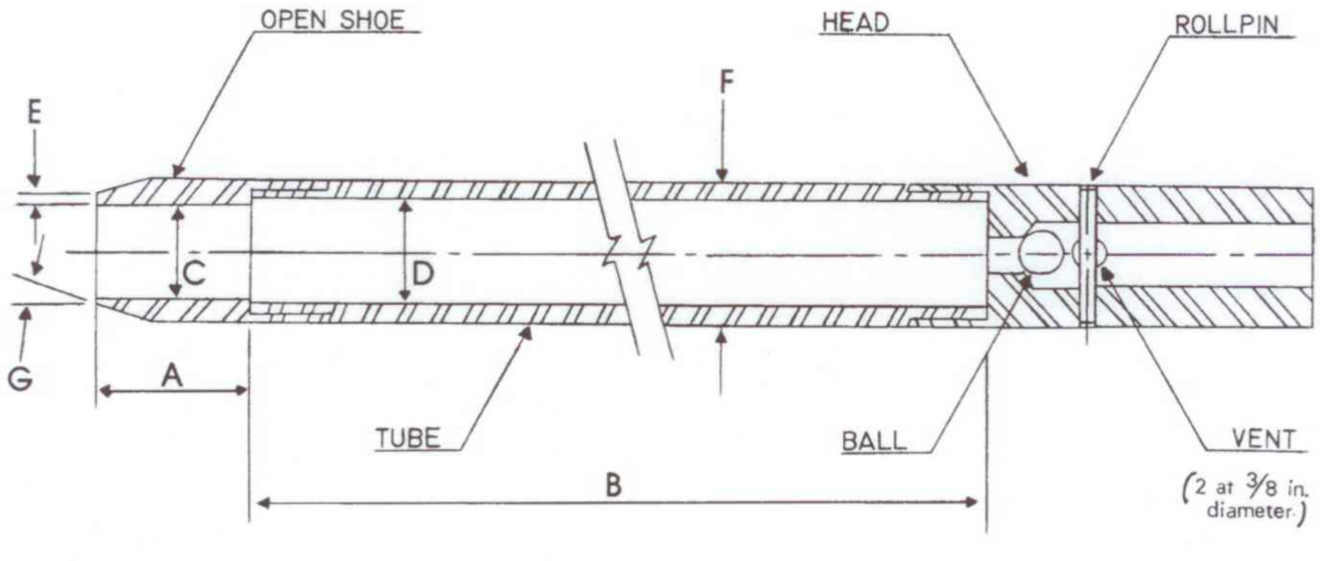
5.1.2 *Roller-Cone Bits*, less than 6½ in. (165 mm) and greater than 2¼ in. (57 mm) in diameter may be used in conjunction with open-hole rotary drilling or casing-advancement drilling methods if the drilling fluid discharge is deflected.

5.1.3 *Hollow-Stem Continuous Flight Augers*, with or without a center bit assembly, may be used to drill the borehole. The inside diameter of the hollow-stem augers shall be less than 6½ in. (165 mm) and not less than 2¼ in. (57 mm).

5.1.4 *Solid, Continuous Flight, Bucket and Hand Augers*, less than 6½ in. (165 mm) and not less than 2¼ in. (57 mm) in diameter may be used if the soil on the side of the borehole does not cave onto the sampler or sampling rods during sampling.

5.2 *Sampling Rods*—Flush-joint steel drill rods shall be used to connect the split-barrel sampler to the drive-weight assembly. The sampling rod shall have a stiffness (moment of inertia) equal to or greater than that of parallel wall "A" rod (a steel rod that has an outside diameter of 1-5/8 in. (41.3 mm) and an inside diameter of 1-1/8 in. (28.5 mm).

5.3 *Split-Barrel Sampler*—The standard sampler dimensions are shown in Fig. 2. The sampler has an outside diameter of 2.00 in. (50.8 mm). The inside diameter of the of the split-barrel (dimension D in Fig. 2) can be either 1½-in. (38.1



A = 1.0 to 2.0 in. (25 to 50 mm)
B = 18.0 to 30.0 in. (0.457 to 0.762 m)
C = 1.375 ± 0.005 in. (34.93 ± 0.13 mm)
D = 1.50 ± 0.05 – 0.00 in. (38.1 ± 1.3 – 0.0 mm)
E = 0.10 ± 0.02 in. (2.54 ± 0.25 mm)
F = 2.00 ± 0.05 – 0.00 in. (50.8 ± 1.3 – 0.0 mm)
G = 16.0° to 23.0°

FIG. 2 Split-Barrel Sampler

mm) or 1⅜-in. (34.9 mm) (see Note 2). A 16-gauge liner can be used inside the 1½-in. (38.1 mm) split barrel sampler. The driving shoe shall be of hardened steel and shall be replaced or repaired when it becomes dented or distorted. The penetrating end of the drive shoe may be slightly rounded. The split-barrel sampler must be equipped with a ball check and vent. Metal or plastic baskets may be used to retain soil samples.

NOTE 2—Both theory and available test data suggest that *N*-values may differ as much as 10 to 30 % between a constant inside diameter sampler and upset wall sampler. If it is necessary to correct for the upset wall sampler refer to Practice D 6066. In North America, it is now common practice to use an upset wall sampler with an inside diameter of 1½ in. At one time, liners were used but practice evolved to use the upset wall sampler without liners. Use of an upset wall sampler allows for use of retainers if needed, reduces inside friction, and improves recovery. Many other countries still use a constant ID split-barrel sampler, which was the original standard and still acceptable within this standard.

5.4 *Drive-Weight Assembly*:

5.4.1 *Hammer and Anvil*—The hammer shall weigh 140 ± 2 lbf (623 ± 9 N) and shall be a rigid metallic mass. The hammer shall strike the anvil and make steel on steel contact when it is dropped. A hammer fall guide permitting an unimpeded fall shall be used. Fig. 3 shows a schematic of such hammers. Hammers used with the cathead and rope method shall have an unimpeded over lift capacity of at least 4 in. (100 mm). For safety reasons, the use of a hammer assembly with an internal anvil is encouraged as shown in Fig. 3. The total mass of the hammer assembly bearing on the drill rods should not be more than 250 ± 10 lbm (113 ± 5 kg).

NOTE 3—It is suggested that the hammer fall guide be permanently marked to enable the operator or inspector to judge the hammer drop height.

5.4.2 *Hammer Drop System*—Rope-cathead, trip, semi-automatic or automatic hammer drop systems, as shown in Fig. 4 may be used, providing the lifting apparatus will not cause penetration of the sampler while re-engaging and lifting the hammer.

5.5 *Accessory Equipment*—Accessories such as labels, sample containers, data sheets, and groundwater level measuring devices shall be provided in accordance with the requirements of the project and other ASTM standards.

6. Drilling Procedure

6.1 The borehole shall be advanced incrementally to permit intermittent or continuous sampling. Test intervals and locations are normally stipulated by the project engineer or geologist. Typically, the intervals selected are 5 ft (1.5 m) or less in homogeneous strata with test and sampling locations at every change of strata. Record the depth of drilling to the nearest 0.1 ft (0.030 m).

6.2 Any drilling procedure that provides a suitably clean and stable borehole before insertion of the sampler and assures that the penetration test is performed on essentially undisturbed soil shall be acceptable. Each of the following procedures has proven to be acceptable for some subsurface conditions. The subsurface conditions anticipated should be considered when selecting the drilling method to be used.

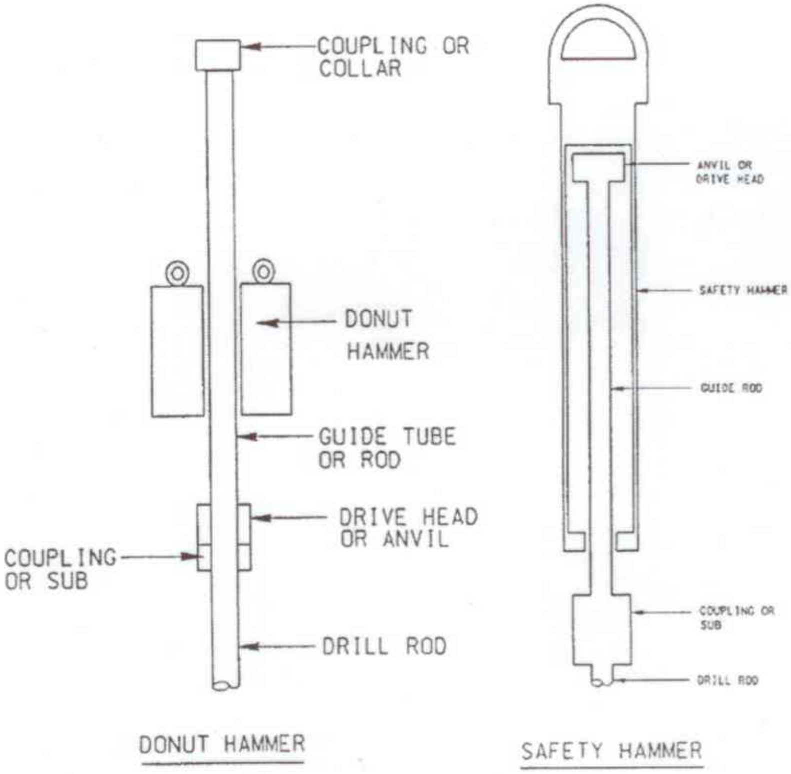
6.2.1 Open-hole rotary drilling method.

6.2.2 Continuous flight hollow-stem auger method.

6.2.3 Wash boring method.

6.2.4 Continuous flight solid auger method.

6.3 Several drilling methods produce unacceptable boreholes. The process of jetting through an open tube sampler and



DONUT HAMMER

SAFETY HAMMER

FIG. 3 Schematic Drawing of the Donut Hammer and Safety Hammer

then sampling when the desired depth is reached shall not be permitted. The continuous flight solid auger method shall not be used for advancing the borehole below a water table or below the upper confining bed of a confined non-cohesive stratum that is under artesian pressure. Casing may not be advanced below the sampling elevation prior to sampling. Advancing a borehole with bottom discharge bits is not permissible. It is not permissible to advance the borehole for subsequent insertion of the sampler solely by means of previous sampling with the SPT sampler.

6.4 The drilling fluid level within the borehole or hollow-stem augers shall be maintained at or above the in situ groundwater level at all times during drilling, removal of drill rods, and sampling.

7. Sampling and Testing Procedure

7.1 After the borehole has been advanced to the desired sampling elevation and excessive cuttings have been removed, record the cleanout depth to the nearest 0.1 ft (0.030 m), and prepare for the test with the following sequence of operations:

7.1.1 Attach either split-barrel sampler Type A or B to the sampling rods and lower into the borehole. Do not allow the sampler to drop onto the soil to be sampled.

7.1.2 Position the hammer above and attach the anvil to the top of the sampling rods. This may be done before the sampling rods and sampler are lowered into the borehole.

7.1.3 Rest the dead weight of the sampler, rods, anvil, and drive weight on the bottom of the borehole. Record the sampling start depth to the nearest 0.1 ft (0.030 m). Compare the sampling start depth to the cleanout depth in 7.1. If excessive cuttings are encountered at the bottom of the borehole, remove the sampler and sampling rods from the borehole and remove the cuttings.

7.1.4 Mark the drill rods in three successive 0.5-foot (0.15 m) increments so that the advance of the sampler under the impact of the hammer can be easily observed for each 0.5-foot (0.15 m) increment.

7.2 Drive the sampler with blows from the 140-lbf (623-N) hammer and count the number of blows applied in each 0.5-foot (0.15-m) increment until one of the following occurs:

7.2.1 A total of 50 blows have been applied during any one of the three 0.5-foot (0.15-m) increments described in 7.1.4.

7.2.2 A total of 100 blows have been applied.

7.2.3 There is no observed advance of the sampler during the application of 10 successive blows of the hammer.

7.2.4 The sampler is advanced the complete 1.5 ft. (0.45 m) without the limiting blow counts occurring as described in 7.2.1, 7.2.2, or 7.2.3.

7.2.5 If the sampler sinks under the weight of the hammer, weight of rods, or both, record the length of travel to the nearest 0.1 ft (0.030 m), and drive the sampler through the remainder of the test interval. If the sampler sinks the complete interval, stop the penetration, remove the sampler and sampling rods from the borehole, and advance the borehole through the very soft or very loose materials to the next desired sampling elevation. Record the *N*-value as either weight of hammer, weight of rods, or both.

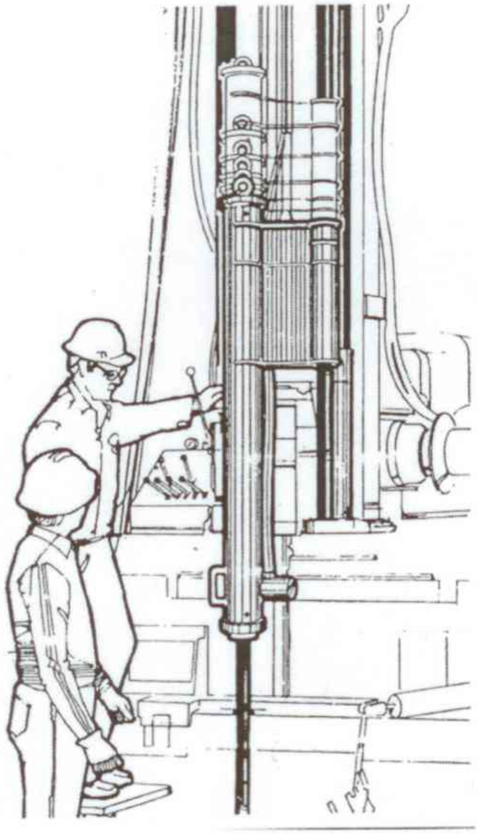


FIG. 4 Automatic Trip Hammer

7.3 Record the number of blows (N) required to advance the sampler each 0.5-foot (0.15 m) of penetration or fraction thereof. The first 0.5-foot (0.15 m) is considered to be a seating drive. The sum of the number of blows required for the second and third 0.5-foot (0.15 m) of penetration is termed the "standard penetration resistance," or the "N-value." If the sampler is driven less than 1.5 ft (0.45 m), as permitted in 7.2.1, 7.2.2, or 7.2.3, the number of blows per each complete 0.5-foot (0.15 m) increment and per each partial increment shall be recorded on the boring log. For partial increments, the depth of penetration shall be reported to the nearest 0.1 ft (0.030 m) in addition to the number of blows. If the sampler advances below the bottom of the borehole under the static weight of the drill rods or the weight of the drill rods plus the static weight of the hammer, this information should be noted on the boring log.

7.4 The raising and dropping of the 140-lbf (623-N) hammer shall be accomplished using either of the following two methods. Energy delivered to the drill rod by either method can be measured according to procedures in Test Method D 4633.

7.4.1 *Method A*—By using a trip, automatic, or semi-automatic hammer drop system that lifts the 140-lbf (623-N) hammer and allows it to drop 30 ± 1.0 in. (0.76 m ± 0.030 m) with limited unimpedence. Drop heights adjustments for automatic and trip hammers should be checked daily and at first indication of variations in performance. Operation of automatic hammers shall be in strict accordance with operations manuals.

7.4.2 *Method B*—By using a cathead to pull a rope attached to the hammer. When the cathead and rope method is used the system and operation shall conform to the following:

7.4.2.1 The cathead shall be essentially free of rust, oil, or grease and have a diameter in the range of 6 to 10 in. (150 to 250 mm).

7.4.2.2 The cathead should be operated at a minimum speed of rotation of 100 RPM.

7.4.2.3 The operator should generally use either 1-3/4 or 2-1/4 rope turns on the cathead, depending upon whether or not the rope comes off the top (1-3/4 turns for counterclockwise rotation) or the bottom (2-1/4 turns for clockwise rotation) of the cathead during the performance of the penetration test, as shown in Fig. 1. It is generally known and accepted that 2-3/4 or more rope turns considerably impedes the fall of the hammer and should not be used to perform the test. The cathead rope should be stiff, relatively dry, clean, and should be replaced when it becomes excessively frayed, oily, limp, or burned.

7.4.2.4 For each hammer blow, a 30 ± 1.0 in. (0.76 m ± 0.030 m) lift and drop shall be employed by the operator. The operation of pulling and throwing the rope shall be performed rhythmically without holding the rope at the top of the stroke.

NOTE 4—If the hammer drop height is something other than 30 ± 1.0 in. (0.76 m ± 0.030 m), then record the new drop height. For soils other than sands, there is no known data or research that relates to adjusting the N-value obtained from different drop heights. Test method D 4633 provides information on making energy measurement for variable drop heights and Practice D 6066 provides information on adjustment of *N*-value to a constant energy level (60 % of theoretical, N60). Practice D 6066 allows the hammer drop height to be adjusted to provide 60 % energy.

7.5 Bring the sampler to the surface and open. Record the percent recovery to the nearest 1 % or the length of sample recovered to the nearest 0.01 ft (5 mm). Classify the soil samples recovered as to, in accordance with Practice D 2488, then place one or more representative portions of the sample into sealable moisture-proof containers (jars) without ramming or distorting any apparent stratification. Seal each container to prevent evaporation of soil moisture. Affix labels to the containers bearing job designation, boring number, sample depth, and the blow count per 0.5-foot (0.15-m) increment. Protect the samples against extreme temperature changes. If there is a soil change within the sampler, make a jar for each stratum and note its location in the sampler barrel. Samples should be preserved and transported in accordance with Practice D 4220 using Group B.

8. Data Sheet(s)/Form(s)

8.1 Data obtained in each borehole shall be recorded in accordance with the Subsurface Logging Guide D 5434 as required by the exploration program. An example of a sample data sheet is included in Appendix X1.

8.2 Drilling information shall be recorded in the field and shall include the following:

8.2.1 Name and location of job,

8.2.2 Names of crew,

8.2.3 Type and make of drilling machine,

8.2.4 Weather conditions,

8.2.5 Date and time of start and finish of borehole,

8.2.6 Boring number and location (station and coordinates, if available and applicable),

8.2.7 Surface elevation, if available,

8.2.8 Method of advancing and cleaning the borehole,

8.2.9 Method of keeping borehole open,

8.2.10 Depth of water surface to the nearest 0.1 ft (0.030 m) and drilling depth to the nearest 0.1 ft (0.030 m) at the time of a noted loss of drilling fluid, and time and date when reading or notation was made,

8.2.11 Location of strata changes, to the nearest 0.5 ft (15 cm),

8.2.12 Size of casing, depth of cased portion of borehole to the nearest 0.1 ft (0.030 m),

8.2.13 Equipment and Method A or B of driving sampler,

8.2.14 Sampler length and inside diameter of barrel, and if a sample basket retainer is used,

8.2.15 Size, type, and section length of the sampling rods, and

8.2.16 Remarks.

8.3 Data obtained for each sample shall be recorded in the field and shall include the following:

8.3.1 Top of sample depth to the nearest 0.1 ft (0.030 m) and, if utilized, the sample number,

8.3.2 Description of soil,

8.3.3 Strata changes within sample,

8.3.4 Sampler penetration and recovery lengths to the nearest 0.1 ft (0.030 m), and

8.3.5 Number of blows per 0.5 foot (0.015 m) or partial increment.

9. Precision and Bias

9.1 *Precision*—Test data on precision is not presented due to the nature of this test method. It is either not feasible or too costly at this time to have ten or more agencies participate in an in situ testing program at a given site.

9.1.1 The Subcommittee 18.02 is seeking additional data from the users of this test method that might be used to make a limited statement on precision. Present knowledge indicates the following:

9.1.1.1 Variations in *N*-values of 100 % or more have been observed when using different standard penetration test apparatus and drillers for adjacent boreholes in the same soil formation. Current opinion, based on field experience, indicates that when using the same apparatus and driller, *N*-values in the same soil can be reproduced with a coefficient of variation of about 10 %.

9.1.1.2 The use of faulty equipment, such as an extremely massive or damaged anvil, a rusty cathead, a low speed cathead, an old, oily rope, or massive or poorly lubricated rope sheaves can significantly contribute to differences in *N*-values obtained between operator-drill rig systems.

9.2 *Bias*—There is no accepted reference value for this test method, therefore, bias cannot be determined.

10. Keywords

10.1 blow count; in-situ test; penetration resistance; soil; split-barrel sampling; standard penetration test

APPENDIX

(Nonmandatory Information)

X1. Example Data Sheet

X1.1 See Fig. 5.

DRILLERS BORING LOG

Project ______________________

Project No ______________________

Boring No ________

Sheet ______ of ______

Location ______________________

Date Started __________ **Date Completed** ______________

Drill Crew:

Boring Location

Station __________ Offset __________

Elevation

Strata Depth		Soil Description and Remarks	Sample Type	No.	Depth		Recovery	N-Values		
From	To				From	To		6"	6"	6"

Drill Rig Type ______________________

Method Of Drilling:

Auger ______________ Size ______________

Wash ________ Water ________ Mud ________

Hammer Type

Auto ______________ Manual ______________

Split-Spoon Type

Length ______________ Liner Used ______________

Boring Size ______________ Bit Used ______________

Casing Size ______________ Length ______________

Weather ______________________

Non-Drilling Time (Hrs.)

Boring Layout ________ Moving ________

Hauling Water ________ Standby ________

Water Level @ ________ Date ________ Time ________

@ ________ Date ________ Time ________

@ ________ Date ________ Time ________

Cave-in Depth

@ ________ Date ________ Time ________

FIG. 5 Example Data Sheet

SUMMARY OF CHANGES

Committee D18 has identified the location of selected changes to this standard since the last issue (D 1586 – 99) that may impact the use of this standard. (Approved February 1, 2008.)

(*1*) There have been numerous changes to this standard to list them separately. From the most recent main ballot process, additional changes were requested and incorporated into this newest revision. Stated below is a highlight of some of the changes.

(*2*) Scope was completely revised.

(*3*) Referenced Documents updated to include new standards.

(*4*) Terminology: added section on Definitions.

(*5*) Significance and Use: clarified use of the SPT test.

(*6*) Apparatus: general editorial changes.

(*7*) Sampling and Testing Procedure: general editorial changes.

(*8*) Data Sheets/Forms: general editorial changes.

(*9*) Precision and Bias: added Sections 9.1.1.1 and 9.1.1.2.

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Designation: D 1587 – 00 (Reapproved 2007)$^{\epsilon 1}$

Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes[1]

This standard is issued under the fixed designation D 1587; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

ϵ^1 Note—Editorial changes were made in June 2007.

1. Scope*

1.1 This practice covers a procedure for using a thin-walled metal tube to recover relatively undisturbed soil samples suitable for laboratory tests of engineering properties, such as strength, compressibility, permeability, and density. Thin-walled tubes used in piston, plug, or rotary-type samplers should comply with Section 6.3 of this practice which describes the thin-walled tubes.

Note 1—This practice does not apply to liners used within the samplers.

1.2 This Practice is limited to soils that can be penetrated by the thin-walled tube. This sampling method is not recommended for sampling soils containing gravel or larger size soil particles cemented or very hard soils. Other soil samplers may be used for sampling these soil types. Such samplers include driven split barrel samplers and soil coring devices (D 1586, D 3550, and D 6151). For information on appropriate use of other soil samplers refer to D 6169.

1.3 This practice is often used in conjunction with fluid rotary drilling (D 1452, D 5783) or hollow-stem augers (D 6151). Subsurface geotechnical explorations should be reported in accordance with practice (D 5434). This practice discusses some aspects of sample preservation after the sampling event. For information on preservation and transportation process of soil samples, consult Practice D 4220. This practice does not address environmental sampling; consult D 6169 and D 6232for information on sampling for environmental investigations.

1.4 The values stated in inch-pound units are to be regarded as the standard. The SI values given in parentheses are provided for information purposes only. The tubing tolerances presented in Table 1 are from sources available in North America. Use of metric equivalent is acceptable as long as thickness and proportions are similar to those required in this standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.6 This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 653 Terminology Relating to Soil, Rock, and Contained Fluids

D 1452 Practice for Soil Investigation and Sampling by Auger Borings

D 1586 Test Method for Penetration Test and Split-Barrel Sampling of Soils

D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)

D 3550 Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils

D 3740 Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock

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[1] This practice is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Evaluations.

Current edition approved May 1, 2007. Published July 2007. Originally approved in 1958. Last previous edition approved in 2003 as D 1587 – 03.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard.**

TABLE 1 Dimensional Tolerances for Thin-Walled Tubes

Nominal Tube Diameters from Table 2^A Tolerances						
Size Outside Diameter	2 in.	50.8 mm	3 in.	76.2 mm	5 in.	127 mm
Outside diameter, D_o	+0.007 -0.000	+0.179 -0.000	+0.010 -0.000	+0.254 -0.000	+0.015 -0.000	0.381 -0.000
Inside diameter, D_i	+0.000 -0.007	+0.000 -0.179	+0.000 -0.010	+0.000 -0.254	+0.000 -0.015	+0.000 -0.381
Wall thickness	±0.007	±0.179	±0.010	±0.254	±0.015	±0.381
Ovality	0.015	0.381	0.020	0.508	0.030	0.762
Straightness	0.030/ft	2.50/m	0.030/ft	2.50/m	0.030/ft	2.50/m

[A] Intermediate or larger diameters should be proportional. Specify only two of the first three tolerances; that is, D_o and D_i, or D_o and Wall thickness, or D_i and Wall thickness.

as Used in Engineering Design and Construction

D 4220 Practices for Preserving and Transporting Soil Samples

D 5434 Guide for Field Logging of Subsurface Explorations of Soil and Rock

D 5783 Guide for Use of Direct Rotary Drilling with Water-Based Drilling Fluid for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices

D 6151 Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling

D 6169 Guide for Selection of Soil and Rock Sampling Devices Used With Drill Rigs for Environmental Investigations

D 6232 Guide for Selection of Sampling Equipment for Waste and Contaminated Media Data Collection Activities

3. Terminology

3.1 *Definitions:*

3.1.1 For common definitions of terms in this standard, refer to Terminology D 653.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *inside clearance ratio, %, n*—the ratio of the difference in the inside diameter of the tube, D_i, minus the inside diameter of the cutting edge, D_e, to the inside diameter of the tube, D_i expressed as a percentage (see Fig. 1).

3.2.2 *ovality, n*—the cross section of the tube that deviates from a perfect circle.

4. Summary of Practice

4.1 A relatively undisturbed sample is obtained by pressing a thin-walled metal tube into the in-situ soil at the bottom of a boring, removing the soil-filled tube, and applying seals to the soil surfaces to prevent soil movement and moisture gain or loss.

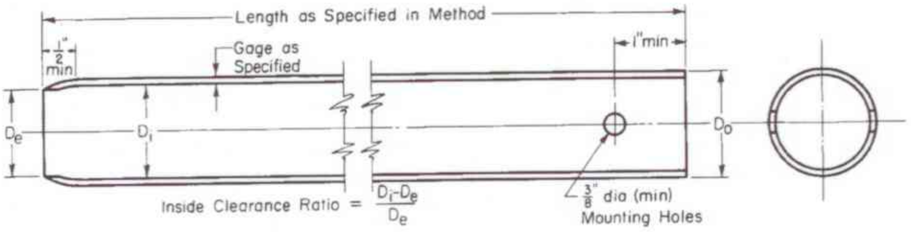
5. Significance and Use

5.1 This practice, or Practice D 3550 with thin wall shoe, is used when it is necessary to obtain a relatively undisturbed specimen suitable for laboratory tests of engineering properties or other tests that might be influenced by soil disturbance.

NOTE 2—The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D 3740 are generally considered capable of competent and objective sampling. Users of this practice. are cautioned that compliance with Practice D 3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D 3740 provides a means of evaluating some of those factors.

6. Apparatus

6.1 *Drilling Equipment*—When sampling in a boring, any drilling equipment may be used that provides a reasonably



NOTE 1—Minimum of two mounting holes on opposite sides for D_o smaller than 4 in. (101.6 mm).

NOTE 2—Minimum of four mounting holes equally spaced for D_o 4 in. (101.6 mm) and larger.

NOTE 3—Tube held with hardened screws or other suitable means.

NOTE 4—2-in (50.8 mm) outside-diameter tubes are specified with an 18-gage wall thickness to comply with area ratio criteria accepted for "undisturbed samples." Users are advised that such tubing is difficult to locate and can be extremely expensive in small quantities. Sixteen-gage tubes are generally readily available.

Metric Equivalent Conversions

in.	mm
3/8	9.53
1/2	12.7
1	25.4
2	50.8
3	76.2
4	101.6
5	127

FIG. 1 Thin-Walled Tube for Sampling

TABLE 2 Suitable Thin-Walled Steel Sample Tubes[A]

Outside diameter (D_o):			
in.	2	3	5
mm	50.8	76.2	127
Wall thickness:			
Bwg	18	16	11
in.	0.049	0.065	0.120
mm	1.24	1.65	3.05
Tube length:			
in.	36	36	54
m	0.91	0.91	1.45
Inside clearance ratio, %	<1	<1	<1

[A] The three diameters recommended in Table 2 are indicated for purposes of standardization, and are not intended to indicate that sampling tubes of intermediate or larger diameters are not acceptable. Lengths of tubes shown are illustrative. Proper lengths to be determined as suited to field conditions.

clean hole; that minimizes disturbance of the soil to be sampled; and that does not hinder the penetration of the thin-walled sampler. Open borehole diameter and the inside diameter of driven casing or hollow stem auger shall not exceed 3.5 times the outside diameter of the thin-walled tube.

6.2 *Sampler Insertion Equipment*, shall be adequate to provide a relatively rapid continuous penetration force. For hard formations it may be necessary, although not recommended, to drive the thin-walled tube sampler.

6.3 *Thin-Walled Tubes*, should be manufactured to the dimensions as shown in Fig. 1. They should have an outside diameter of 2 to 5 in. (50 to 130 mm) and be made of metal having adequate strength for the type of soil to be sampled. Tubes shall be clean and free of all surface irregularities including projecting weld seams. Other diameters may be used but the tube dimensions should be proportional to the tube designs presented here.

6.3.1 *Length of Tubes*—See Table 2 and 7.4.1.

6.3.2 *Tolerances*, shall be within the limits shown in Table 1.

6.3.3 *Inside Clearance Ratio*, should be not greater than 1 % unless specified otherwise for the type of soil to be sampled. Generally, the inside clearance ratio used should increase with the increase in plasticity of the soil being sampled, except for sensitive soils or where local experience indicates otherwise. See 3.2.1 and Fig. 1 for definition of inside clearance ratio.

6.3.4 *Corrosion Protection*—Corrosion, whether from galvanic or chemical reaction, can damage or destroy both the thin-walled tube and the sample. Severity of damage is a function of time as well as interaction between the sample and the tube. Thin-walled tubes should have some form of protective coating, unless the soil is to be extruded less than 3 days. The type of coating to be used may vary depending upon the material to be sampled. Plating of the tubes or alternate base metals may be specified. Galvanized tubes are often used when long term storage is required. Coatings may include a light coat of lubricating oil, lacquer, epoxy, Teflon, zinc oxide, and others.

NOTE 3—Most coating materials are not resistant to scratching by soils that contain sands. Consideration should be given for prompt testing of the sample because chemical reactions between the metal and the soil sample con occur with time.

6.4 *Sampler Head*, serves to couple the thin-walled tube to the insertion equipment and, together with the thin-walled tube, comprises the thin-walled tube sampler. The sampler head shall contain a venting area and suitable check valve with the venting area to the outside equal to or greater than the area through the check valve. In some special cases, a check valve may not be required but venting is required to avoid sample compression. Attachment of the head to the tube shall be concentric and coaxial to assure uniform application of force to the tube by the sampler insertion equipment.

7. Procedure

7.1 Remove loose material from the center of a casing or hollow stem auger as carefully as possible to avoid disturbance of the material to be sampled. If groundwater is encountered, maintain the liquid level in the borehole at or above ground water level during the drilling and sampling operation.

7.2 Bottom discharge bits are not permitted. Side discharge bits may be used, with caution. Jetting through an open-tube sampler to clean out the borehole to sampling elevation is not permitted.

NOTE 4—Roller bits are available in downward-jetting and diffused-jet configurations. Downward-jetting configuration rock bits are not acceptable. Diffuse-jet configurations are generally acceptable.

7.3 Lower the sampling apparatus so that the sample tube's bottom rests on the bottom of the hole and record depth to the bottom of the sample tube to the nearest 0.1-ft (.03 m)

7.3.1 Keep the sampling apparatus plumb during lowering, thereby preventing the cutting edge of the tube from scraping the wall of the borehole.

7.4 Advance the sampler without rotation by a continuous relatively rapid downward motion and record length of advancement to the nearest 1 in. (25 mm).

7.4.1 Determine the length of advance by the resistance and condition of the soil formation, but the length shall never exceed 5 to 10 diameters of the tube in sands and 10 to 15 diameters of the tube in clays. In no case shall a length of advance be greater than the sample-tube length minus an allowance for the sampler head and a minimum of 3-in. (75 mm) for sludge and end cuttings.

NOTE 5—The mass of sample, laboratory handling capabilities, transportation problems, and commercial availability of tubes will generally limit maximum practical lengths to those shown in Table 2.

7.5 When the soil formation is too hard for push-type insertion, the tube may be driven or Practice D 3550 may be used. If driving methods are used, the data regarding weight and fall of the hammer and penetration achieved must be shown in the report. Additionally, that tube must be prominently labeled a "driven sample."

7.6 Withdraw the sampler from the soil formation as carefully as possible in order to minimize disturbance of the sample. The tube can be slowly rotated to shear the material at the end of the tube, and to relieve water and/or suction pressures and improve recovery. Where the soil formation is soft, a delay before withdraw of the sampler (typically 5 to 30 minutes) may improve sample recovery.

8. Sample Measurement, Sealing and Labeling

8.1 Upon removal of the tube, remove the drill cuttings in the upper end of the tube and measure the length of the soil sample recovered to the nearest 0.25 in. (5 mm) in the tube. Seal the upper end of the tube. Remove at least 1 in. (25 mm) of material from the lower end of the tube. Use this material for soil description in accordance with Practice D 2488. Measure the overall sample length. Seal the lower end of the tube. Alternatively, after measurement, the tube may be sealed without removal of soil from the ends of the tube.

8.1.1 Tubes sealed over the ends, as opposed to those sealed with expanding packers, should be provided with spacers or appropriate packing materials, or both prior to sealing the tube ends to provide proper confinement. Packing materials must be nonabsorbent and must maintain their properties to provide the same degree of sample support with time.

8.1.2 Depending on the requirements of the investigation, field extrusion and packaging of extruded soil samples can be performed. This allows for physical examination and classification of the sample. Samples are extruded in special hydraulic jacks equipped with properly sized platens to extrude the core in a continuous smooth speed. In some cases, further extrusion may cause sample disturbance reducing suitability for testing of engineering properties. In other cases, if damage is not significant, cores can be extruded and preserved for testing (D 4220). Bent or damaged tubes should be cut off before extruding.

8.2 Prepare and immediately affix labels or apply markings as necessary to identify the sample (see Section 9). Assure that the markings or labels are adequate to survive transportation and storage.

NOTE 6—Top end of the tube should be labeled "top".

9. Field Log

9.1 Record the information that may be required for preparing field logs in general accordance to ASTM D 5434 "Guide for Field Logging of Subsurface Explorations of Soil and Rock". This guide is used for logging explorations by drilling and sampling. Some examples of the information required include;

9.1.1 Name and location of the project,

9.1.2 Boring number,

9.1.3 Log of the soil conditions,

9.1.4 Surface elevation or reference to a datum to the nearest foot (0.5 m) or better,

9.1.5 Location of the boring,

9.1.6 Method of making the borehole,

9.1.7 Name of the drilling foreman and company, and

9.1.8 Name of the drilling inspector(s).

9.1.9 Date and time of boring-start and finish,

9.1.10 Depth to groundwater level: date and time measured,

9.2 Recording the appropriate sampling information is required as follows:

9.2.1 Depth to top of sample to the nearest 0.1 ft. (.03 m) and number of sample,

9.2.2 Description of thin-walled tube sampler: size, type of metal, type of coating,

9.2.3 Method of sampler insertion: push or drive,

9.2.4 Method of drilling, size of hole, casing, and drilling fluid used,

9.2.5 Soil description in accordance with Practice D 2488,

9.2.6 Length of sampler advance (push), and

9.2.7 Recovery: length of sample obtained.

10. Keywords

10.1 geologic investigations; sampling; soil exploration; soil investigations; subsurface investigations; undisturbed

SUMMARY OF CHANGES

In accordance with committee D18 policy, this section identifies the location of changes to this standard since the last edition, 200, which may impact the use of this standard.

(1) Added parts of speech to terms.

(2) Corrected reference in Note 2 from D 5740 to D 3740.

STANDARD OPERATING PROCEDURE

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

QAL

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

CH2M HI
APPLIED S ENCES LABORATORY

CHAIN OF CUSTODY CORD AND AGREEMENT TO PERFORM SERVICES

CH2M Hill Project # ☐☐☐☐☐☐☐☐.☐☐.☐☐
Purchase Order #
Project Name
Company Name CH2M HILL Office
Project Manager & Phone #
Mr. [ ]
Ms. [ ]
Dr. [ ]
Report Copy to:
Requested Completion Date:
Sampling Requirements: SDWA ☐ NPDES ☐ RCRA ☐ OTHER ____
Sample Disposal: Dispose ☐ Return ☐

OF CONTAINERS

LAB TEST CODES

ANALYSES REQUESTED

SHADED AREA– FOR LAB USE ONLY
Lab 1 #
Lab 2 #
Quote #
Kit Request #
Project #
No. of Samples
Page of
Login
LIMS Ver

Sampling		Type		Matrix			CLIENT SAMPLE ID (9 CHARACTERS)	# OF CONTAINERS	ANALYSES REQUESTED	REMARKS	LAB 1 ID	LAB 2 ID
Date	Time	COMP	GRAB	WATER	SOIL	AIR						

Sampled By & Title (Please sign and print name) Date/Time
Received By (Please sign and print name) Date/Time
Received By (Please sign and print name) Date/Time
Received By (Please sign and print name) Date/Time
Work Authorized By (Please sign and print name)
Relinquished By (Please sign and print name) Date/Time
Relinquished By (Please sign and print name) Date/Time
Relinquished By (Please sign and print name) Date/Time
Shipped Via UPS BUS Fed-Ex Hand Other ____
Shipping #
Remarks

QC Level: 1 2 3 Other: ____

COC Rec	ICE
Ana Req	TEMP
Cust Seal	Ph

Instructions and Agreement Provisions on Reverse Side

DISTRIBUTION: Original - LAB, Yellow - LAB, Pink - Client
REV 3/94 FORM 340

Attachment C

Example Custody Seal

CH2M HILL

CUSTODY SEAL

Date

Signature

Standard Operating Procedure

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

1. 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.

[1] Equipment 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

[2] Other 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

Buried Utility Location Tracking Form

(Submit to CH2M HILL PM within 24 hrs of location activities)

Project Location:
CH2M HILL Project No.:
CH2M HILL Project Manager: Name/Phone:
Fax:
Email:
CH2M HILL Field Team Leader: Name/Phone:

CH2M HILL Purchase Order:

Utility Location Subcontractor:
Subcontractor POC:

Dates of location activities:

	Check each box using an "X" if a buried utility is present within 5 feet of a marked Station ID. If color of the flag or paint differs from listed color, note change in color on the form.																	
Station ID	**Gas (Yellow)**	**Electric (Red)**	**Fiber optic (Orange)**	**Cable (Orange)**	**Water (Blue)**	**San. Sewer (Green)**	**Storm Sewer (Green)**	**Steam (Yellow)**	**Petroleum (Yellow)**	**Compressed air (Yellow)**	**Other ____**	**Other ____**	**Other ____**	**Other ____**	**Date completed**	**Technician initials**	Notes (methods/tools used

The findings of the buried utility location activities summarized herein were conducted in strict accordance with the CH2M HILL scope of work.

Subcontractor's Signature

Date

PMS 219

PMS 1795*

PMS 108

PMS 144*

13.5 parts process
2.5 parts reflex

PMS 253

PMS 3415

APWA 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

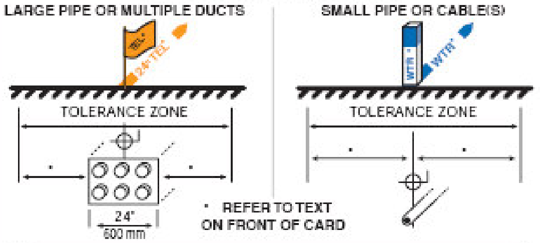
ORANGE - Communication, Alarm or Signal Lines, Cables or Conduit

BLUE - Potable Water

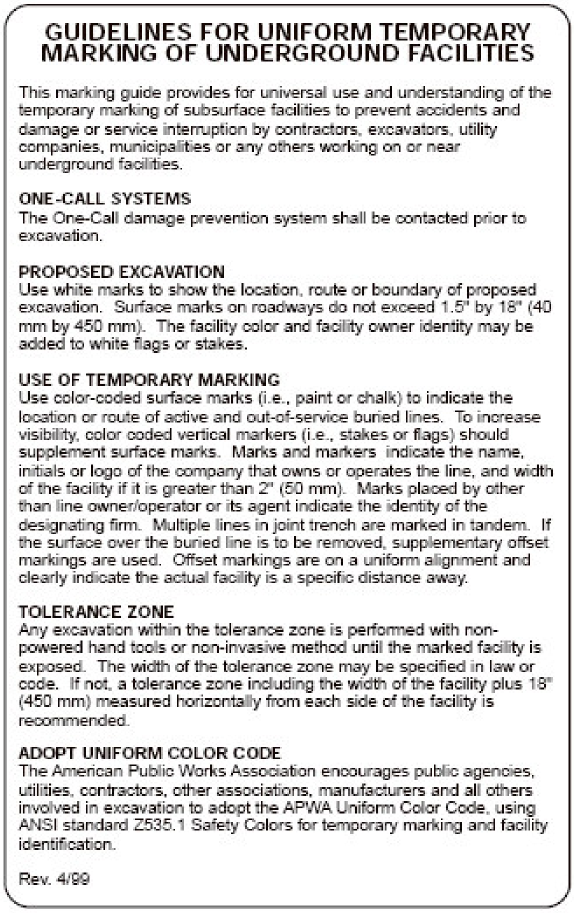
PURPLE - Reclaimed Water, Irrigation and Slurry Lines

GREEN - Sewers and Drain Lines

TYPICAL MARKING



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. 4/99

STANDARD OPERATING PROCEDURE

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.

STANDARD OPERATING PROCEDURE

Field Measurement of pH, Specific Conductance, Turbidity, Dissolved Oxygen, ORP, and Temperature Using a Horiba or YSI Water Quality Parameter 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 parameter meter (e.g., Horiba® or YSI) for field measurements of pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature of aqueous samples. The YSI instrument does not measure turbidity. A separate turbidity meter (i.e., Hanna Turbidity Meter) will need to be used in conjunction with the YSI meter. The operator's manual should be consulted for detailed operating procedures.

II. Equipment and Materials

- Water Quality Parameter Meter such as a Horiba® Water Quality Monitoring System or YSI with flow-though cell
- Auto-Calibration Standard Solution (provided by rental company)
- Distilled water in squirt bottle

III. Procedures and Guidelines

A. Parameters and Specifications:

Parameter	Range of measurement	Accuracy
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.

Horiba Calibration procedure:

1. Fill a calibration beaker with standard solution to the recommended fill line.
2. Insert the probe into the beaker. All the parameter sensors will now be immersed in the standard solution except the D.O. sensor; the D.O. calibration is done using atmospheric air.
3. Turn power on and allow some time for the machine to warm-up prior to starting the calibration. When the initial readings appear to stabilize the instrument is ready to calibrate.
4. Press CAL key to put the unit in the calibration mode.
5. Press the ENT key to start automatic calibration. Wait a moment, and the upper cursor will gradually move across the four auto-calibration parameters one by one: pH, COND, TURB, and DO. When the calibration is complete, the readout will briefly show END. The instrument is now calibrated.
6. If the unit is calibrated properly the instrument readings, while immersed in the standard solution, will match the standard solution values provided on the solution container. The typical standard solution values are: pH = 4.0 +/- 3%, conductivity 4.49 mS/cm +/- 3%, and turbidity = 0 NTU +/- 3%.
7. Record the calibration data (e.g. time, instrument ID, solution lot number and expiration date, final calibrated readings, and solution temperature in the field logbook.

YSI Calibration procedure:

1. Press the **On/off** key to display the run screen
2. Press the **Escape** key to display the main menu screen
3. Use the arrow keys to highlight the **Calibrate**
4. Press the **Enter** key. The Calibrate screen is displayed
5. Choose the parameter to calibrate

A. Conductivity Calibration:

This procedure calibrates specific conductance (recommended), conductivity and salinity. Calibrating any one option automatically calibrates the other two.

1) Use the arrow keys to highlight the **Conductivity** selection
2) Press **Enter.** The Conductivity Calibration Selection Screen is displayed.
3) Use the arrow keys to highlight the Specific Conductance selection.
4) Press **Enter.** The Conductivity Calibration Entry Screen is displayed.
5) Place the correct amount of conductivity standard (see Instrument Manual) into a clean, dry or pre-rinsed transport/calibration cup.
6) Carefully immerse the sensor end of the probe module into the solution.

7) Gently rotate and/or move the probe module up and down to remove any bubbles from the conductivity cell.

   NOTE: The sensor must be completely immersed past its vent hole. Using the recommended volumes from the Instrument Manual Calibration Volumes should ensure that the vent hole is covered.

8) Screw the transport/calibration cup on the threaded end of the probe module and securely tighten.

   NOTE: Do not over tighten as this could cause damage to the threaded portions.

9) Use the keypad to enter the calibration value of the standard you are using.

   NOTE: Be sure to enter the value in **mS/cm at 25°C**.

10) Press **Enter**. The Conductivity Calibration Screen is displayed.
11) Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.
12) Observe the reading under Specific Conductance. When the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.
13) Press **Enter**. This returns you to the Conductivity Calibrate Selection Screen
14) Press **Escape** to return to the calibrate menu.
15) Rinse the probe module and sensors in tap or purified water and dry.

B. *Dissolved Oxygen Calibration:*

This procedure calibrates dissolved oxygen. Calibrating any one option (% or mg/L) automatically calibrates the other.

1) Go to the calibrate screen as described in Section

   NOTE: The instrument must be on for at least 20 minutes to polarize the DO sensor before calibrating.

2) Use the arrow keys to highlight the **Dissolved Oxygen** selection.
3) Press **Enter**. The dissolved oxygen calibration screen is displayed.
4) DO calibration in mg/L is carried out in a water sample which has a known concentration of dissolved oxygen (usually determined by a Winkler titration).
5) Use the arrow keys to highlight the **DO mg/L** selection.
6) Press **Enter**. The DO mg/L Entry Screen is displayed.
7) Place the probe module in water with a known DO concentration.

   NOTE: Be sure to completely immerse all the sensors.

8) Use the keypad to enter the known DO concentration of the water.
9) Press **Enter**. The Dissolved Oxygen mg/L Calibration Screen is displayed.
10) Stir the water with a stir bar, or by rapidly moving the probe module, to provide fresh sample to the DO sensor.
11) Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.
12) Observe the DO mg/L reading, when the reading is stable (shows no significant change for approximately 30 seconds), press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.
13) Press **Enter**. This returns you to the DO calibration screen.
14) Press **Escape** to return to the calibrate menu.

15) Rinse the probe module and sensors in tap or purified water and dry.

C. *pH Calibration:*

1) Go to the calibrate screen.
2) Use the arrow keys to highlight the **pH** selection.
3) Press **Enter**. The pH calibration screen is displayed.
    - ➢ Select the **1-point** option only if you are adjusting a previous calibration. If a 2-point or 3-point calibration has been performed previously, you can adjust the calibration by carrying out a one point calibration. The procedure for this calibration is the same as for a 2-point calibration, but the software will prompt you to select only one pH buffer.
    - ➢ Select the **2-point** option to calibrate the pH sensor using only two calibration standards. Use this option if the media being monitored is known to be either basic or acidic. For example, if the pH of a pond is known to vary between 5.5 and 7, a two-point calibration with pH 7 and pH 4 buffers is sufficient. A three point calibration with an additional pH 10 buffer will not increase the accuracy of this measurement since the pH is not within this higher range.
    - ➢ Select the **3-point** option to calibrate the pH sensor using three calibration solutions. In this procedure, the pH sensor is calibrated with a pH 7 buffer and two additional buffers. The 3-point calibration method assures maximum accuracy when the pH of the media to be monitored cannot be anticipated. The procedure for this calibration is the same as for a 2-point calibration, but the software will prompt you to select a third pH buffer.
4) Use the arrow keys to highlight the **2-point** selection.
5) Press **Enter**. The pH Entry Screen is displayed.
6) Place the correct amount of pH buffer into a clean, dry or pre-rinsed transport/calibration cup.

    NOTE: For maximum accuracy, the pH buffers you choose should be within the same pH range as the water you are preparing to sample.

    NOTE: Before proceeding, ensure that the sensor is as dry as possible. Ideally, rinse the pH sensor with a small amount of buffer that can be discarded. Be certain that you avoid cross-contamination of buffers with other solutions.
7) Carefully immerse the sensor end of the probe module into the solution.
8) Gently rotate and/or move the probe module up and down to remove any bubbles from the pH sensor.

    NOTE: The sensor must be completely immersed. Using the recommended volumes from Table 6.1 Calibration Volumes, should ensure that the sensor is covered.
9) Screw the transport/calibration cup on the threaded end of the probe module and securely tighten.

    NOTE: Do not over tighten as this could cause damage to the threaded portions.
10) Use the keypad to enter the calibration value of the buffer you are using **at the current temperature**.

    NOTE: pH vs. temperature values are printed on the labels of all YSI pH buffers.
11) Press **Enter**. The pH calibration screen is displayed.

12) Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.
13) Observe the reading under pH, when the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.
14) Press **Enter**. This returns you to the Specified pH Calibration Screen.
15) Rinse the probe module, transport/calibration cup and sensors in tap or purified water and dry.
16) Repeat steps 6 through 13 above using a second pH buffer.
17) Press **Enter**. This returns you to the pH Calibration Screen.
18) Press **Escape** to return to the calibrate menu.
19) Rinse the probe module and sensors in tap or purified water and dry.

D. ORP Calibration:

1) Go to the calibrate screen.
2) Use the arrow keys to highlight the **ORP** selection.
3) Press **Enter**. The ORP calibration screen is displayed.
4) Place the correct amount of a known ORP solution into a clean, dry or pre-rinsed transport/calibration cup.

   NOTE: Before proceeding, ensure that the sensor is as dry as possible. Ideally, rinse the ORP sensor with a small amount of solution that can be discarded. Be certain that you avoid cross-contamination with other solutions.
5) Carefully immerse the sensor end of the probe module into the solution.
6) Gently rotate and/or move the probe module up and down to remove any bubbles from the ORP sensor.

   NOTE: The sensor must be completely immersed.
7) Screw the transport/calibration cup on the threaded end of the probe module and securely tighten.
8) Use the keypad to enter the correct value of the calibration solution you are using at the current temperature.
9) Press **Enter**. The ORP calibration screen is displayed.
10) Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.
11) Observe the reading under ORP, when the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.
12) Press **Enter**. This returns you to the Calibrate Screen.
13) Rinse the probe module and sensors in tap or purified water and dry.

    Record the calibration data (e.g. time, instrument ID, solution lot number and expiration date, final calibrated readings, and solution temperature in the field logbook.

C. Sample Measurement:

Horiba measurement procedure:

As water passes through the flow-through the flow cell, press MEAS to obtain reading;

record data in a field notebook.

YSI measurement procedure:

As water passes through the flow-through the flow cell, the readings are displayed for each parameter. Record the water quality parameter data in a field notebook. In addition, the data is recorded in the YSI and can be downloaded to a computer following completion of the sampling event.

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.

V. References

YSI 556 Multi Probe System Operator Manual

YSI **Environmental**

Pure Data for a Healthy Planet.™

YSI 556 MPS
Multi Probe System

Operations Manual

Contents

1. Safety

1.1 General Safety Information

Read all safety information in this manual carefully before using the YSI 556 Multi-Probe System (MPS). Reagents that are used to calibrate and check this instrument may be hazardous to your health. Take a moment to review *Appendix D Health and Safety*.

⚠ **WARNING**

Warnings are used in this manual when misuse of the instrument could result in death or serious injury to a person.

⚠ **CAUTION**

Cautions are used in this manual when misuse of the instrument could result in mild or serious injury to a person and/or damage to equipment.

⚠ **IMPORTANT SAFETY INSTRUCTIONS!**

⚠ **SAVE THESE INSTRUCTIONS!**

⚠ In essence, the most important safety rule for use of the YSI 556 MPS is to utilize the instrument ONLY for purposes documented in this manual. This is particularly true of the YSI 6117 rechargeable battery pack that contains nickel metal hydride (NiMH) batteries. The user should be certain to read all of the safety precautions outlined below before using the instrument.

⚠ YSI 6117 Rechargeable Battery Pack Safety Information

⚠ **Restrictions on Usage**

1. Never dispose of the battery pack in a fire.
2. Do not attempt to disassemble the YSI 6117 battery pack.
3. Do not tamper with any of the electronic components or the batteries within the battery pack. Tampering with either the electronic circuitry or the batteries will result in the voiding of the warranty and the compromising of the system performance, but, more importantly, can cause safety

hazards which result from overcharging such as overheating, venting of gas, and loss of corrosive electrolyte.

4. Do not charge the battery pack outside the 0–40°C temperature range.
5. Do not use or store the battery at high temperature, such as in strong direct sunlight, in cars during hot weather, or directly in front of heaters.
6. Do not expose the battery pack to water or allow the terminals to become damp.
7. Avoid striking or dropping the battery pack. If the pack appears to have sustained damage from these actions or malfunctions after an impact or drop, the user should not attempt to repair the unit. Instead, contact YSI Customer Service. Refer to *Appendix E Customer Service*.
8. If the battery pack is removed from the YSI 556 MPS, do not store it in pockets or packaging where metallic objects such as keys can short between the positive and negative terminals.

⚠ Precautions for Users with Small Children

Keep the battery pack out of reach of babies and small children.

⚠ Danger Notifications – Misuse creates a STRONG possibility of death or serious injury.

FAILURE TO CAREFULLY OBSERVE THE FOLLOWING PROCEDURES AND PRECAUTIONS CAN RESULT IN LEAKAGE OF BATTERY FLUID, HEAT GENERATION, BURSTING, AND SERIOUS PERSONAL INJURY.

1. Never dispose of the battery pack in a fire or heat it.
2. Never allow the positive and negative terminals of the battery pack to become shorted or connected with electrically conductive materials. When the battery pack has been removed from the YSI 556 MPS, store it in a heavy plastic bag to prevent accidental shorting of the terminals.

3. Never disassemble the battery pack and do not tamper with any of the electronic components or the batteries within the battery pack. The battery pack is equipped with a variety of safety features. Accidental deactivation of any of these safety features can cause a serious hazard to the user.
4. The NiMH batteries in the battery pack contain a strong alkaline solution (electrolyte). The alkaline solution is extremely corrosive and will cause damage to skin or other tissues. If any fluid from the battery pack comes in contact with a user's eyes, immediately flush with clean water and consult a physician immediately. The alkaline solution can damage eyes and lead to permanent loss of eyesight.

⚠ Warning Notifications – Misuse creates a possibility of death or serious injury

1. Do not allow the battery pack to contact freshwater, seawater, or other oxidizing reagents that might cause rust and result in heat generation. If a battery becomes rusted, the gas release vent may no longer operate and this failure can result in bursting.
2. If electrolyte from the battery pack contacts the skin or clothing, thoroughly wash the area immediately with clean water. The battery fluid can irritate the skin.

⚠ Caution Notifications – Misuse creates a possibility of mild or serious injury or damage to the equipment.

1. Do not strike or drop the battery pack. If any impact damage to the battery pack is suspected, contact YSI Customer Service. Refer to *Appendix E Customer Service*.
2. Store the battery pack out of reach of babies and small children.
3. Store the battery pack between the temperatures of -20 and 30°C.
4. Before using the battery pack, be sure to read the operation manual and all precautions carefully. Then store this information carefully to use as a reference when the need arises.

⚠ YSI 616 Cigarette Lighter Charger Safety Information

1. This section contains important safety and operating instructions for the YSI 556 MPS cigarette lighter battery charger (YSI 616; RadioShack Number 270-1533E). BE SURE TO SAVE THESE INSTRUCTIONS.
2. Before using the YSI 616 cigarette lighter charger, read all instructions and cautionary markings on battery charger, battery pack, and YSI 556 MPS.
3. Charge the YSI 6117 battery pack with the YSI 616 cigarette lighter charger ONLY when the YSI 6117 is installed in the YSI 556 MPS.
4. Do not expose charger to rain, moisture, or snow.
5. Use of an attachment not recommended or sold by the battery charger manufacturer may result in a risk of fire, electric shock, or injury to persons.
6. To reduce risk of damage to cigarette lighter and cord, pull by cigarette lighter rather than cord when disconnecting charger.
7. Make sure that the cord is located so that it will not be stepped on, tripped over, or otherwise subjected to damage or stress.
8. Do not operate charger with damaged cord or cigarette lighter connector – replace it immediately.
9. Do not operate charger if it has received a sharp blow, been dropped, or otherwise damaged in any way; contact YSI Customer Service. Refer to *Appendix E Customer Service*.
10. Do not disassemble charger other than to change the fuse as instructed. Replace the part or send it to YSI Product Service if repair is required (refer to *Appendix E Customer Service*). Incorrect reassembly may result in a risk of electric shock or fire.
11. To reduce risk of electric shock, unplug charger before attempting any maintenance or cleaning. Turning off controls will not reduce this risk.

⚠ YSI 556 MPS Water Leakage Safety Information

The YSI 556 MPS has been tested and shown to comply with IP67 criterion, i.e. submersion in 1 meter of water for 30 minutes with no leakage into either the battery compartment or the main case. However, if the instrument is submersed for periods of time in excess of 30 minutes, leakage may occur with subsequent damage to the batteries, the rechargeable battery pack circuitry, and/or the electronics in the main case.

If leakage into the battery compartment is observed when using alkaline C cells, remove batteries, dispose of batteries properly, and dry the battery compartment completely, ideally using compressed air. If corrosion is present on the battery terminals, contact YSI Customer Service for instructions. Refer to *Appendix E Customer Service*.

If leakage into the battery compartment is observed when using the YSI 6117 rechargeable battery pack, remove the battery assembly and set aside to dry. Return the battery pack to YSI Product Service for evaluation of possible damage. Finally dry the battery compartment completely, ideally using compressed air. If corrosion is present on the battery terminals, contact YSI Customer Service for instructions. Refer to *Appendix E Customer Service*.

⚠ **CAUTION:** If water has contacted the rechargeable battery pack, do not attempt to reuse it until it has been evaluated by YSI Product Service (refer to *Appendix E Customer Service*). Failure to follow this precaution can result in serious injury to the user.

If it is suspected that leakage into the main cavity of the case has occurred, remove the batteries immediately and return the instrument to YSI Product Service for damage assessment. Refer to *Appendix E Customer Service*.

⚠ **CAUTION:** Under no circumstances should the user attempt to open the main case.

2. General Information

2.1 Description

The rugged and reliable YSI 556 MPS (Multi-Probe System) combines the versatility of an easy-to-use, easy-to-read handheld unit with all the functionality of a multi-parameter system. Featuring a waterproof, impact-resistant case, the YSI 556 MPS simultaneously measures dissolved oxygen, conductivity, temperature, and optional pH and ORP. A simple cellular phone style keypad and large display make the instrument easy to use. The YSI 556 MPS is compatible with YSI EcoWatch^{TM} for Windows^{TM} software.

The YSI 556 MPS assists the user in conforming to Good Laboratory Practice (GLP) standards which help ensure that quality control/quality assurance methods are followed. Battery life is displayed with a fuel gauge, and the user can choose standard alkaline batteries or an optional rechargeable battery pack.

The 1.5 MB memory can store more than 49,000 data sets. Other options include a flow cell and barometer. The internal barometer can be user-calibrated and displayed along with other data, used in dissolved oxygen calibrations, and logged to memory for tracking changes in barometric pressure.

Features

- Waterproof - meets IP67 specifications
- Field-replaceable DO electrode module; pH and pH/ORP sensors
- Compatible with Ecowatch^{TM} for Windows^{TM} data analysis software
- Assists with Good Laboratory Practice Standards (GLP)
- Choice of DO membrane material for different applications
- Easy-to-use, screw-on cap DO membranes
- User-upgradable software from YSI website
- Three-year warranty on the instrument; one-year on the probe modules
- Available with 4,10, and 20 m cable lengths
- Stores over 49,000 data sets, time and date stamped

- Auto temperature compensating display contrast
- Optional barometer
- Optional rechargeable battery pack or standard alkaline batteries

2.2 Unpacking the Instrument

1. Remove the instrument from the shipping box. Note that the probe module and sensors are shipped in a separate box and will be unpacked later in Section *3.2 Unpacking the Probe Module*.

   NOTE: Do not discard any parts or supplies.

2. Use the packing list to ensure all items are present.

3. Visually inspect all components for damage.

   NOTE: If any parts are missing or damaged, contact your YSI Service Center immediately. Refer to *Appendix E Customer Service* or www.ysi.com.

2.3 Features of the YSI 556 Multi-Probe System

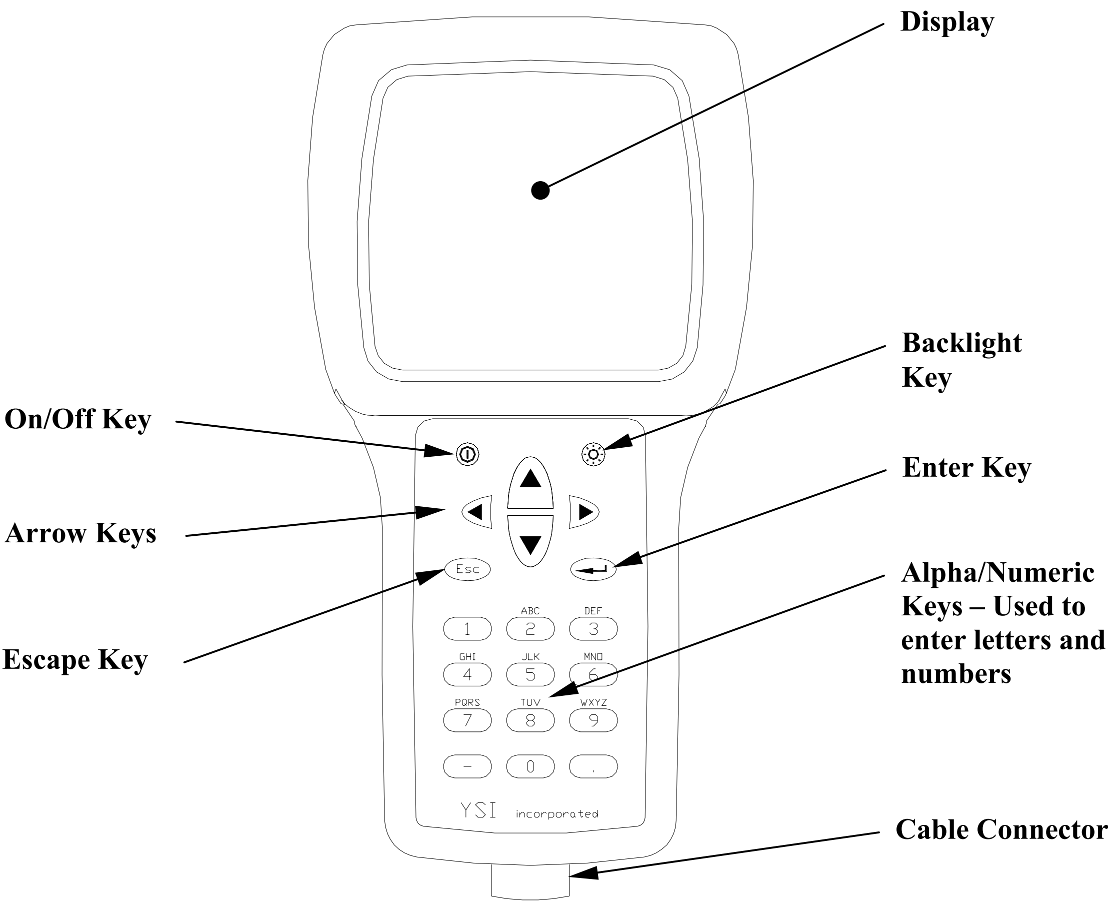


Figure 2.1 Front View of YSI 556 MPS

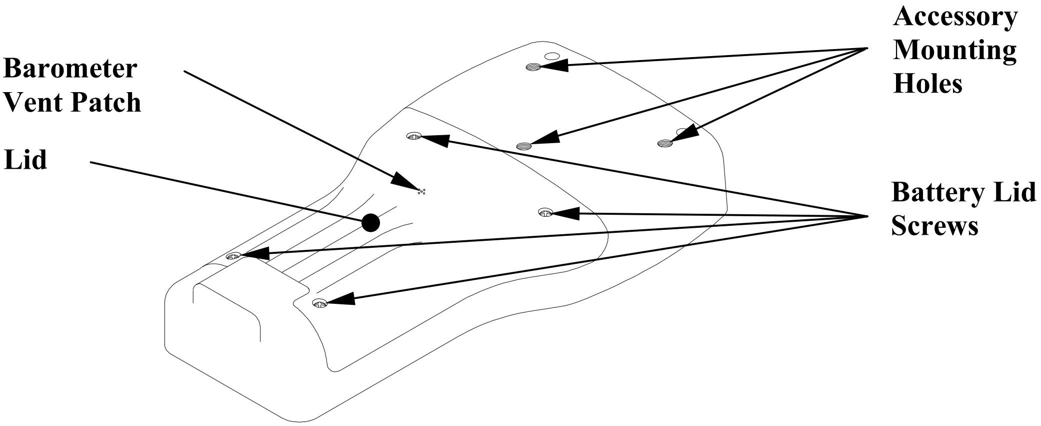


Figure 2.2 Back View of YSI 556 MPS

2.4 Batteries

2.4.1 Battery Life

Standard Alkaline Batteries

With the standard battery configuration of 4 alkaline C cells, the YSI 556 MPS will operate continuously for approximately 180 hours. Assuming a standard usage pattern when sampling of 3 hours of “on time” in a typical day, the alkaline cells will last approximately 60 days.

Optional Rechargeable Battery Pack

When fully charged, the optional rechargeable battery pack will provide approximately 50 hours of battery life.

2.4.2 Inserting 4 C Batteries

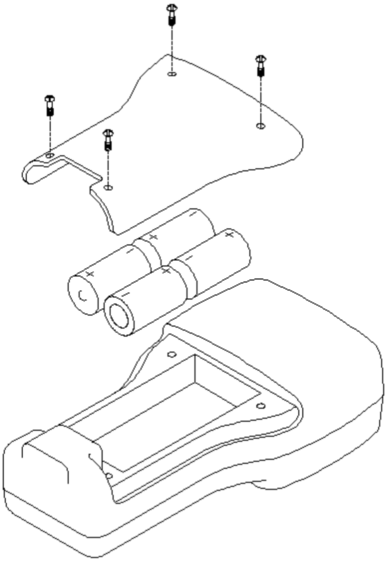


Figure 2.3 Inserting C Cells

⚠ **CAUTION: Install batteries properly to avoid damage to the instrument.**

1. Loosen the four screws in the battery lid on the back of the instrument using any screwdriver.

2. Remove the battery lid.

3. Insert four C batteries between the clips following the polarity (+ and -) labels on the bottom of the battery compartment.

4. Check gasket for proper placement on the battery lid.

5. Replace the battery lid and tighten the 4 screws securely and evenly.

   NOTE: Do not over-tighten the screws.

2.4.3 Inserting Optional Rechargeable Battery Pack

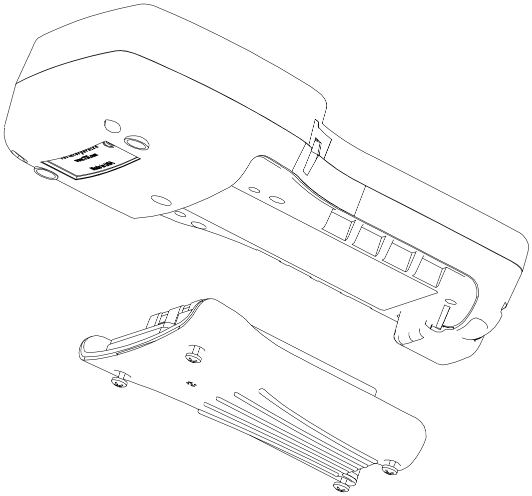


Figure 2.4 Inserting Battery Pack

⚠ **CAUTION: Read all cautions and warnings that come with the battery pack *before* using the battery pack.**

1. Loosen the four screws in the battery lid on the back of the instrument using any screwdriver.

2. Remove the C battery lid and store for future use. Remove C batteries, if installed.

3. Check for proper placement of gasket on the rechargeable battery pack and lid.

4. Install the rechargeable battery pack and lid and tighten the 4 screws securely and evenly.

   NOTE: Do not over tighten the screws.

2.4.4 Charging the Optional Rechargeable Battery Pack

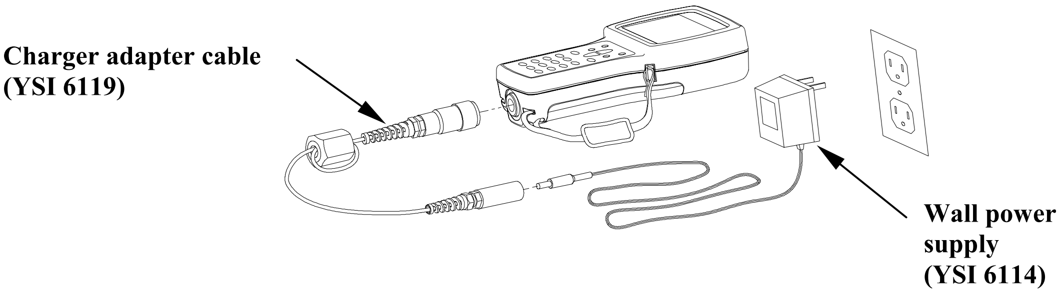


Figure 2.5 Charging the Battery Pack

⚠ **CAUTION: Do not use or store the battery pack at extreme temperatures such as in strong direct sunlight, in cars during hot weather or close to heaters.**

1. Install the rechargeable battery pack into the instrument as described in Section *2.4.3 Inserting Optional Rechargeable Battery Pack.*

2. Attach the charger adapter cable (YSI 6119) to the instrument.

   NOTE: Wall power supplies for use in countries outside the US and Canada can be found in *Appendix B Instrument Accessories*.

3. Insert the barrel connector of the wall power supply into the barrel of the adapter cable.

⚠ **CAUTION: Do not charge the battery pack continuously for more than 48 hours.**

⚠ **CAUTION: Do not drop or expose to water.**

⚠ **CAUTION: Do not charge the battery pack at temperatures below 0°C or above 40°C.**

4. Plug the wall power supply into an AC power outlet for approximately 2 hours to obtain an 80% to 90% charge and for 6 hours to get a full charge.

   NOTE: The battery pack can be recharged whether the instrument is on or off.

2.4.5 Storing the Battery Pack

Remove the battery pack from the instrument when the instrument will not be used for extended periods of time to prevent over discharge of the battery pack.

Store the battery pack in a heavy plastic bag to prevent accidental shorting of the terminals. Store between –20 and 30°C.

2.4.6 Optional Cigarette Lighter Charger

⚠ **CAUTION: Read all warnings and cautions that come with the charger before using the charger.**

⚠ **CAUTION: Only use cigarette lighter charger when *rechargeable* battery pack is inserted into instrument.**

⚠ **CAUTION: Do not mishandle cigarette lighter charger. Do not expose to moisture.**

1. Plug the barrel connector of the cigarette lighter charger into the mating end of the YSI 6119 Charger Adapter Cable.

2. Attach the MS-19 end of the YSI 6119 Charger Adapter Cable to the instrument.

3. Make one of the following modifications to the other end of the charger:

   Slide the adapter ring off the plug to use the device with an American or Japanese vehicle.

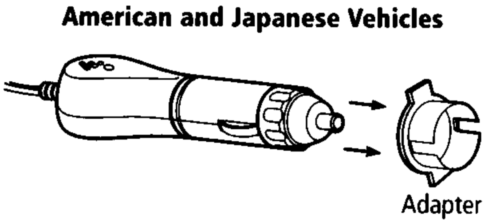


Figure 2.6 Charger Plug Adapter Use

Leave the adapter ring on the plug and position it so that the slots on the adapter ring line up with the plug's spring clips to use the device on a European vehicle.

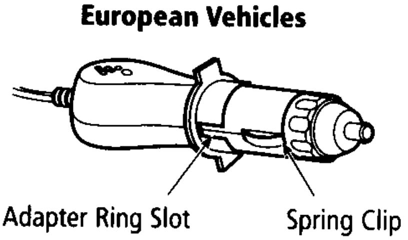


Figure 2.7 European Charger Plug Adapter Use

NOTE: If the charger stops working properly, refer to Section *13 Troubleshooting*.

2.5 Power On

Press and release the on/off button in the upper left corner of the instrument keypad to turn the instrument on or off. See Figure 2.1 Front View of YSI 556 MPS.

2.6 Setting Display Contrast

The display contrast automatically compensates for temperature changes. However, under extreme temperature conditions you may wish to optimize the display by manual adjustment as follows:

1. Press and *hold down* the backlight key in the upper right corner of the keypad and press the “up” arrow to increase (darken) the contrast.

2. Press and *hold down* the backlight key in the upper right corner of the keypad and press the “down” arrow to decrease (lighten) the contrast.

2.7 Backlight

Press and *release* the backlight key in the upper right corner of the keypad to turn the backlight on or off. See Figure 2.1 Front View of YSI 556 MPS.

NOTE: The backlight turns off automatically after two minutes of non-use.

2.8 General Screen Features

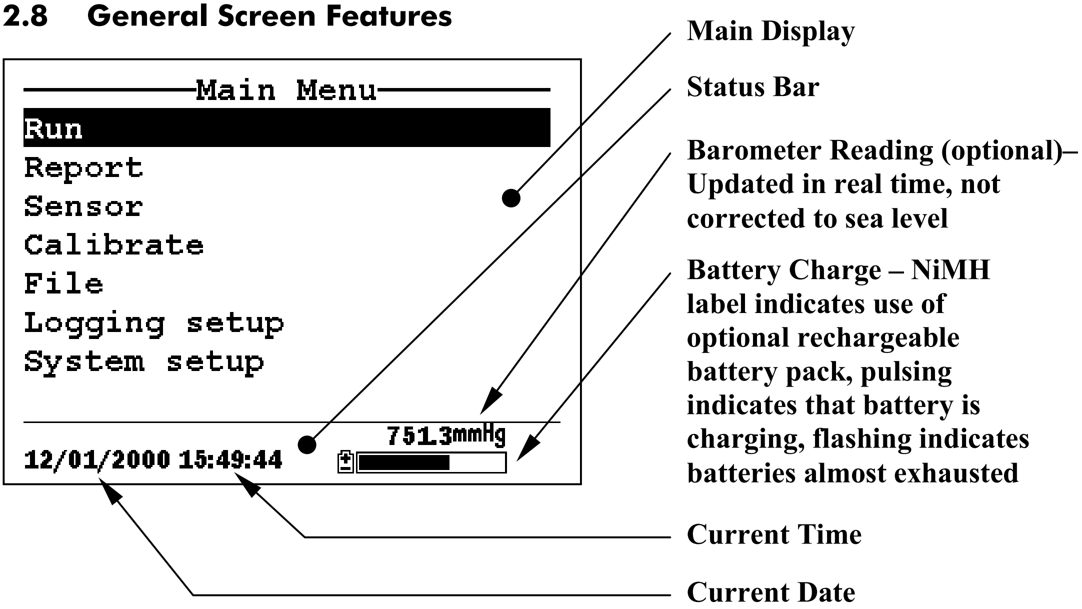


Figure 2.8 Main Menu Screen

2.9 Keypad Use

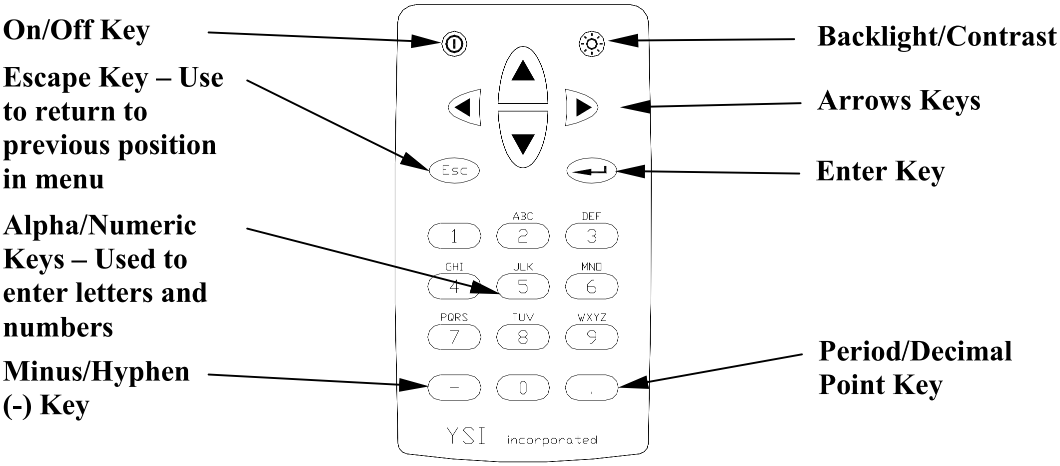


Figure 2.9 Keypad Features

KEY	LETTER/ NUMBER
1	1
2	ABC2abc3
3	DEF3def3
4	GHI4ghi4
5	JKL5jkl5
6	MNO6mno6
7	PQRS7pqrs7
8	TUV8tuv8
9	WXYZ9wxyz9
0	0

Figure 2.10 Keypad Letters & Numbers

1. See Figure 2.10 Keypad Letters & Numbers and press the appropriate key repeatedly until letter or number desired appears in display.

   NOTE: Press the key repeatedly in rapid succession to get to the desired letter or number. If you pause for more than a second, the cursor automatically scrolls to the right to prepare for the next input.

EXAMPLE 1: Press the **6** key *once* and *release* to display an uppercase "M."

EXAMPLE 2: Press the **6** key *four times* and *release* to display the number "6."

EXAMPLE 3: Press the **6** key *five times* and *stop* to display a lowercase "m."

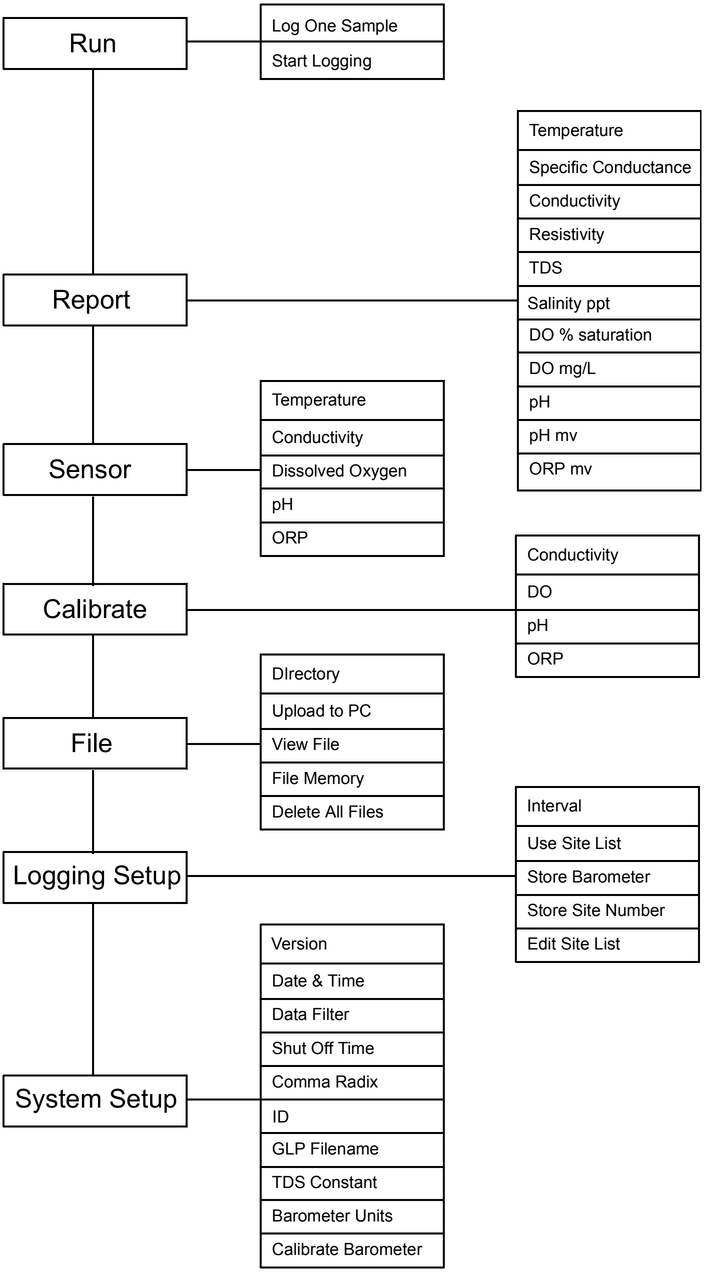
2. Press the left arrow key to go back and reenter a number or letter that needs to be changed.
3. Press the **Enter** key when your entry is complete.

NOTE: The instrument software permits only numeric entries in many instances, such as when setting the clock or entering calibration parameters.

2.10 Instrument Reset

The YSI 556 MPS is characterized by sophisticated software that should provided trouble-free operation. However as with all high-capability software packages, it is always possible that the user will encounter circumstances in which the instrument does not respond to keypad entry. If this occurs, the instrument function can easily be restored by removing and then reapplying battery power. Simply remove either your C-cells or rechargeable battery pack from the battery compartment, wait 30 seconds and then replace the batteries. See Section *2.4 Batteries* for battery removal/reinstallation instructions.

2.11 Menu Flowchart



3. Probe Module

3.1 Introduction

The YSI 5563 Probe module is used for measuring dissolved oxygen, temperature, conductivity, and optional pH and ORP. The probe module is rugged, with the sensors enclosed in a heavy duty probe sensor guard with attached sinking weight. A 4, 10 or 20 meter cable is directly connected to the probe module body making it waterproof. An MS-19 connector at the end of the cable makes the YSI 5563 fully compatible with the YSI 556 Multi-Probe System.

3.2 Unpacking the Probe Module

1. Remove the YSI 5563 Probe module from the shipping boxes.

   NOTE: Do not discard any parts or supplies.

2. Use the packing list to ensure all items are present.

3. Visually inspect all components for damage.

   NOTE: If any parts are missing or damaged, contact your YSI Service Center immediately. Refer to *Appendix E Customer Service* or www.ysi.com.

3.3 Features of the YSI 5563 Probe Module

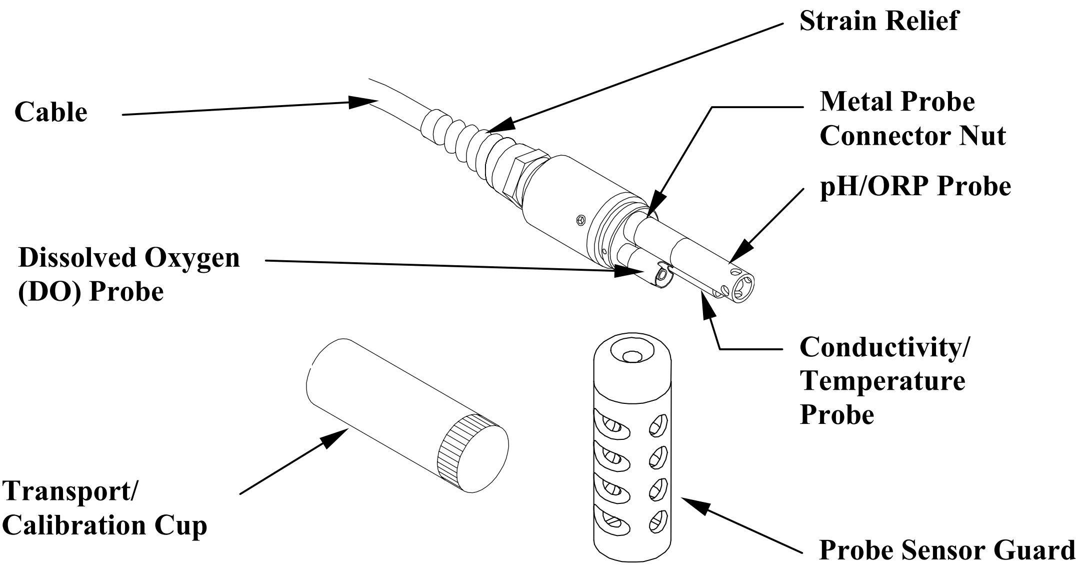


Figure 3.1 Probe Module

3.4 Preparing the Probe Module

To prepare the probe module for calibration and operation, you need to install the sensors into the connectors on the probe module bulkhead. In addition to sensor installation, you need to install a new DO membrane cap.

3.4.1 Sensor Installation

Whenever you install, remove or replace a sensor, it is extremely important that the entire probe module and all sensors be thoroughly dried prior to the removal of a sensor or a sensor port plug. This will prevent water from entering the port. Once you remove a sensor or plug, examine the connector inside the probe module sensor port. If any moisture is present, use compressed air to completely dry the connector. If the connector is corroded, return the probe module to your dealer or directly to YSI Customer Service. Refer to *Appendix E Customer Service*.

Conductivity/Temperature and pH, pH/ORP Sensor Installation

1. Unscrew and remove the probe sensor guard.

2. Using the sensor installation tool supplied in the YSI 5511 maintenance kit, unscrew and remove the sensor port plugs.

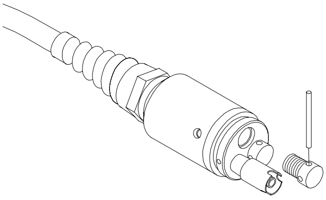


Figure 3.2 Port Plug Removal

3. Locate the port with the connector that corresponds to the sensor that is to be installed.

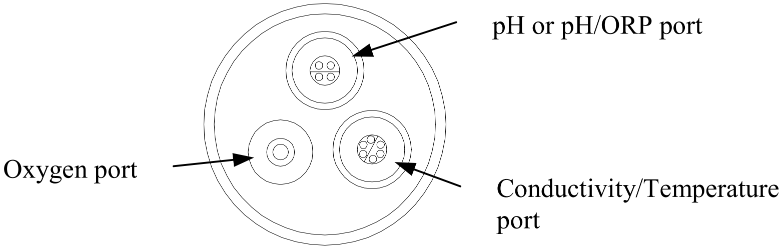


Figure 3.3 Sensor Port Identification

4. Apply a thin coat of o-ring lubricant (supplied in the YSI 5511 maintenance kit) to the o-rings on the connector side of the sensor (see Figure 3.4 O-Ring Lubrication).

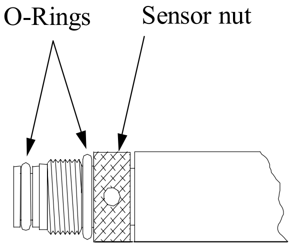


Figure 3.4 O-Ring Lubrication

⚠ **CAUTION:** Make sure that there are NO contaminants between the O-ring and the sensor. Contaminants that are present under the O-ring may cause the O-ring to leak.

5. Be sure the probe module sensor port is free of moisture and then insert the sensor into the correct port. Gently rotate the sensor until the two connectors align.

6. With connectors aligned, screw down the sensor nut using the sensor installation tool.

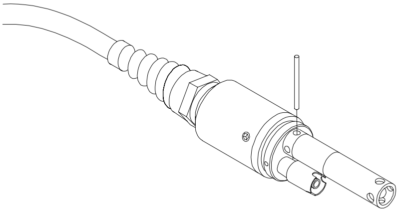


Figure 3.5 Sensor Installation

⚠ **CAUTION:** Do not cross thread the sensor nut. Tighten the nut until it is flush with the face of the probe module bulkhead. Do not over tighten.

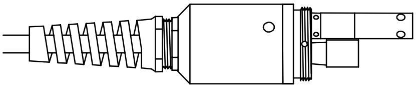


Figure 3.6 Bulkhead Seating

7. Repeat steps 3-6 for any other sensors.

8. Replace the probe sensor guard.

Dissolved Oxygen Sensor Installation

The YSI 5563 comes with the DO sensor already installed. Refer to Section *11.1.2 DO Sensor Replacement* for instructions on installing the YSI 558 Replaceable DO Module Kit.

3.4.2 Membrane Cap Selection

The YSI 5563 is shipped with a YSI 5909 kit that contains membrane caps made with 2 mil polyethylene (PE), a material which should be ideal for most field applications of the 556. However, YSI also offers membrane caps made with two other materials (1 mil polyethylene and 1 mil Teflon) which some users may also prefer. All membranes available for the 556/5563 system provide comparable accuracy if used properly. The difference between the two thicknesses of PE is found in the trade-off of flow dependence and response time as described below. Teflon is offered because some users may prefer to continue using the traditional membrane material used by YSI. To avoid confusion, the membrane caps are color coded as described below and can be ordered in kits as noted:

1 mil Teflon – Black Caps (Kit = YSI 5906)
1 mil Polyethylene (PE) – Yellow Caps (Kit = YSI 5908)
2 mil Polyethylene (PE) – Blue Caps (Kit = YSI 5909)

The 1 mil Teflon caps will offer traditional, reliable performance for most dissolved oxygen applications. The 1 mil PE caps will provide a significantly faster dissolved oxygen response (as long as your 556 Data Filter is set correctly as described below in Sections 10.2 and 10.3.1)) while also giving readings which are significantly less flow dependent than the 1 mil Teflon caps. Finally, 2 mil PE caps will show a large reduction in flow dependence over 1 mil Teflon while not significantly increasing the response time. Generally, one of the PE caps is likely to provide better performance for your application.

IMPORTANT: No matter which type of membrane cap you select, you will also have to confirm your selection in the 556 software from the Sensor menu as described in Section *4 Sensors*.

3.4.3 Membrane Cap Installation

NOTE: The YSI 5563 DO sensor (already installed in the probe module) was shipped dry. A shipping membrane was installed to protect the electrode. **A new membrane cap must be installed before the first use**.

1. Unscrew and remove the probe sensor guard.
2. Unscrew, remove, and discard the old membrane cap.
3. Thoroughly rinse the sensor tip with distilled water.
4. Prepare the electrolyte according to the directions on the electrolyte solution bottle.
5. Hold the new membrane cap and fill it at least 1/2 full with the electrolyte solution.
6. Screw the membrane cap onto the sensor moderately tight. A small amount of electrolyte should overflow.

⚠ **CAUTION:** Do not touch the membrane surface.

7. Screw the probe sensor guard on moderately tight.

3.5 Transport/Calibration Cup

The YSI 5563 Probe module has been supplied with a convenient transport/calibration cup. This cup is an ideal container for calibration of the different sensors, minimizing the amount of solution needed. Refer to Section *6 Calibrate*.

3.5.1 Transport/Calibration Cup Installation

1. Remove probe sensor guard, if already installed.

2. Ensure that an o-ring is installed in the o-ring groove on the threaded end of the probe module body.

3. Screw the transport/calibration cup on the threaded end of the probe module and securely tighten.

   NOTE: Do not overtighten as this could cause damage to the threaded portions.

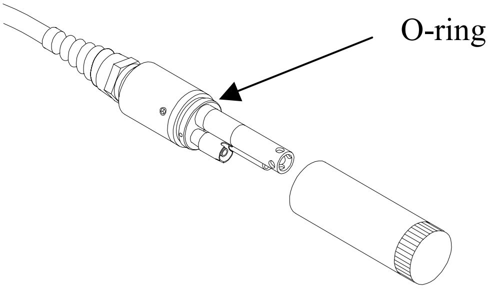


Figure 3.7 Transport/Calibration Cup Installation

3.6 Instrument/Cable Connection

Attach the cable to the instrument as follows:

1. Line up the pins and guides on the cable with the holes and indentations on the cable connector at the bottom of the YSI 556 instrument. See Figure 2.1 Front View of YSI 556 MPS.

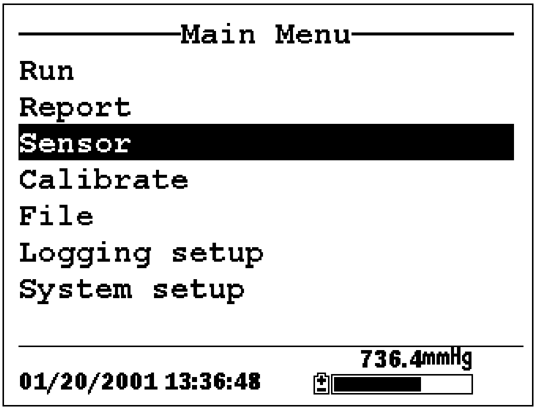
2. Holding the cable firmly against the cable connector, turn the locking mechanism clockwise until it snaps into place.

Remove the cable from the instrument by turning the cable connector counterclockwise until the cable disengages from the instrument.

The Sensors Enabled screen allows the user to enable or disable each of the sensors and select which membrane material will be used for the dissolved oxygen sensor. Disabled sensors will not be displayed on the screen in real time or logged to files.

1. Press the **On/off** key to display the run screen.

2. Press the **Escape** key to display the main menu screen.

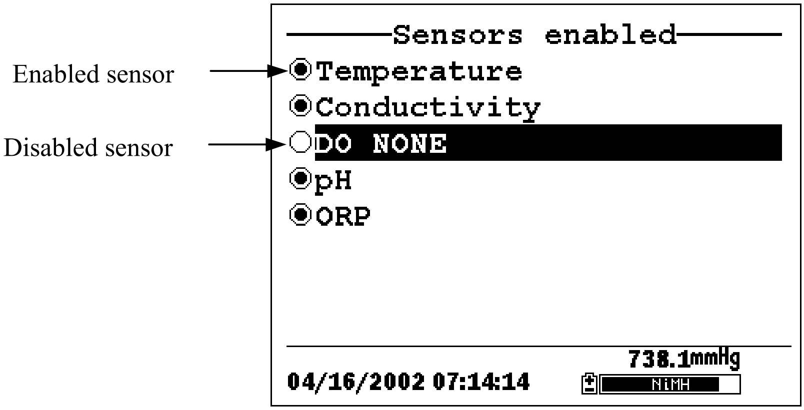


01/20/2001 13:36:48

Figure 4.1 Main Menu Screen

3. Use the arrow keys to highlight the **Sensor** selection.

4. Press the **Enter** key to display the sensors enabled screen.


Sensors enabled

● Temperature
● Conductivity
○ DO NONE
● pH
● ORP

738.1mmHg
04/16/2002 07:14:14 NiMH

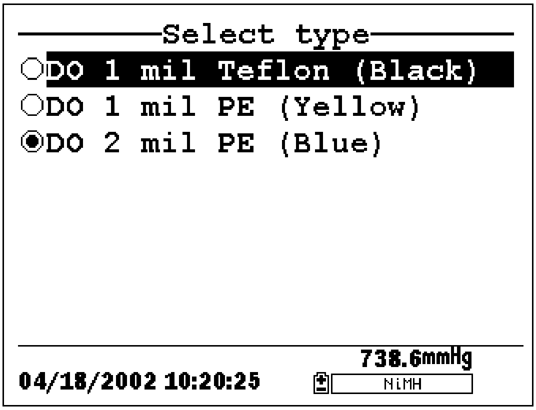
Enabled sensor

Disabled sensor

Figure 4.2 Sensors Enabled Screen Before DO Membrane Selection

A black dot to the left of a sensor indicates that sensor is enabled. Sensors with an empty circle are disabled.

Highlight the “DO None” entry as shown above and press **Enter** to display the membrane choice screen. Consult Section *3.4.2 Membrane Cap Selection* for information on the advantages of each type of membrane material. Blue membrane caps using 2 mil polyethylene (PE) were shipped with your YSI 5563 and are likely to be the best choice for most 556 field applications.



Select type

○DO 1 mil Teflon (Black)

○DO 1 mil PE (Yellow)

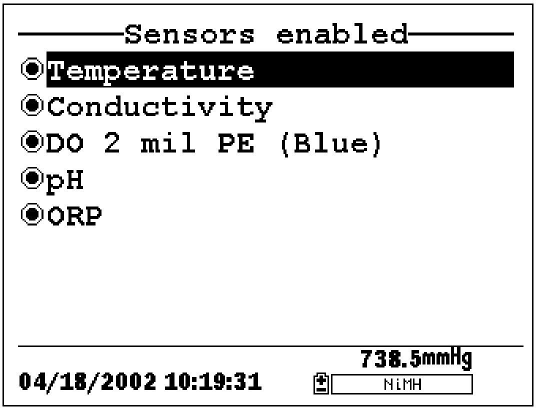
●DO 2 mil PE (Blue)

738.6mmHg

04/18/2002 10:20:25

Figure 4.3 Membrane Selection Screen

Highlight the desired membrane choice – in this case, 2 mil PE -- and press Enter to activate your selection with a dot to the left of the screen. Then press **Escape** to return to the Sensor menu that now shows your DO membrane selection.



Sensors enabled

●Temperature

●Conductivity

●DO 2 mil PE (Blue)

●pH

●ORP

738.5mmHg

04/18/2002 10:19:31

Figure 4.4 Sensors Enabled Screen After DO Membrane Selection

NOTE: The Temperature sensor cannot be disabled. Most other sensors require temperature compensation for accurate readings. In addition, the conductivity sensor must be activated in order to obtain accurate dissolved oxygen mg/L readings.

5. Use the arrow keys to highlight the sensor you want to change, then press the **Enter** key to enable or disable it.
6. Repeat step 5 for each sensor you want to change.
7. Press the **Escape** key to return to the main menu screen.

5. Report

The Report Setup screen allows the user to select which sample parameters and units the YSI 556 MPS will display on the screen. It does NOT determine which parameters are logged to memory. Refer to Section *4 Sensors*.

1. Press the **On/off** key to display the run screen.

2. Press the **Escape** key to display the main menu screen.

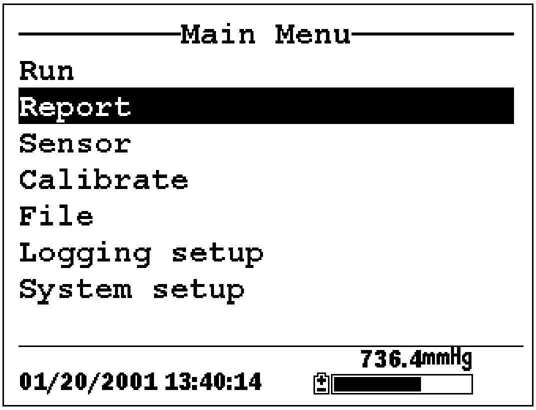
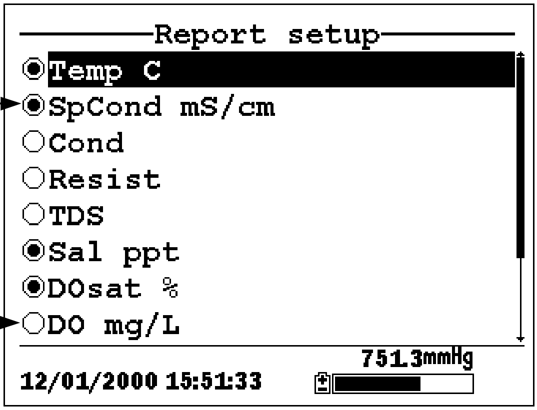


Figure 5.1 Main Menu

3. Use the arrow keys to highlight the **Report** selection.

4. Press the **Enter** key to display the report setup screen.


Report setup

● Temp C
● SpCond mS/cm
○ Cond
○ Resist
○ TDS
● Sal ppt
● DOsat %
○ DO mg/L

751.3mmHg
12/01/2000 15:51:33

Selected for display

NOT selected for display

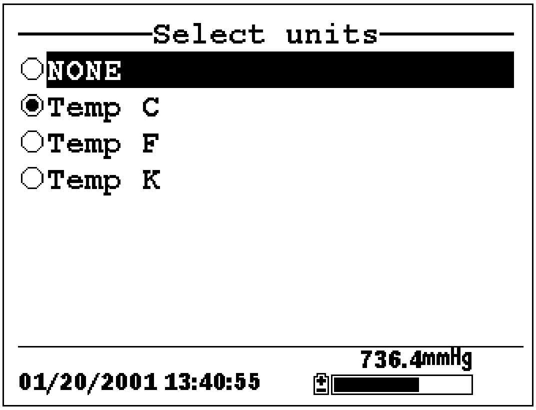
Figure 5.2 Report Setup Screen

NOTE: A black dot to the left of a parameter indicates that parameter is selected for display. Parameters with an empty circle will not be displayed.

NOTE: You may have to scroll down past the bottom of the screen to see all the parameters.

5. Use the arrow keys to highlight the parameter you want to change, then press the **Enter** key. If you can't find the parameter you want, even after scrolling down past the bottom of the screen, the sensor used for that parameter is disabled. Refer to Section *4 Sensors*.

6. If you selected Temperature, Specific Conductivity, Conductivity, Resistance or Total Dissolved Solids, the Units screen will appear.


Select units

○NONE

●Temp C

○Temp F

○Temp K

736.4mmHg

01/20/2001 13:40:55

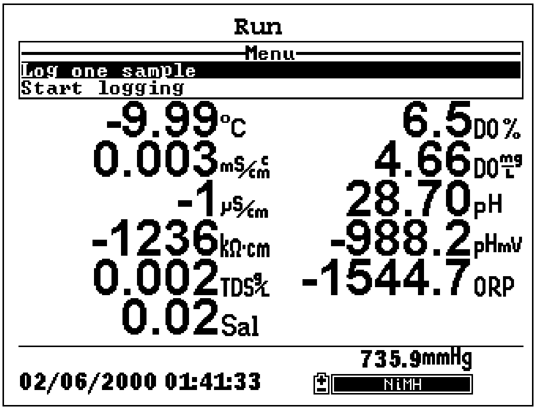
Figure 5.3 Units Screen

7. Use the arrow keys to select the units desired, then press the **Enter** key to return to the report setup screen.

   If you selected Salinity, Dissolved Oxygen %, Dissolved Oxygen mg/L, pH, pH mv or ORP mv, the selection dot will simply toggle on or off.

8. Repeat steps 5 and 6 for each parameter you want to change.

NOTE: All parameters may be enabled at the same time.



-9.99 °C
0.003 mS/cm c
-1 µS/cm
-1236 kΩ·cm
0.002 TDS g/L
0.02 Sal
6.5 DO %
4.66 DO mg/L
28.70 pH
-988.2 pHmV
-1544.7 ORP
735.9mmHg
02/06/2000 01:41:33
NiMH

Figure 5.4 All Parameters Displayed

9. Press the **Escape** key to return to the Main menu screen.

6. Calibrate

All of the sensors, except temperature, require periodic calibration to assure high performance. You will find specific calibration procedures for all sensors that require calibration in the following sections. If a sensor listed is not installed in your probe module, skip that section and proceed to the next sensor until the calibration is complete.

⚠ **CAUTION:** Reagents that are used to calibrate and check this instrument may be hazardous to your health. Take a moment to review *Appendix D Health and Safety*. Some calibration standard solutions may require special handling.

6.1 Getting Ready to Calibrate

6.1.1 Containers Needed to Calibrate the Probe Module

The transport/calibration cup that comes with your probe module serves as a calibration chamber for all calibrations and minimizes the volume of calibration reagents required.

Instead of the transport/calibration cup, you may use laboratory glassware to perform calibrations. If you do not use the transport/calibration cup that is designed for the probe module, you are cautioned to do the following:

- ✓ Perform all calibrations with the Probe Sensor Guard installed. This protects the sensors from possible physical damage.
- ✓ Use a ring stand and clamp to secure the probe module body to prevent the module from falling over. Most laboratory glassware has convex bottoms.
- ✓ Ensure that all sensors are immersed in calibration solutions. Many of the calibrations factor in readings from other sensors (e.g., temperature sensor). The top vent hole of the conductivity sensor must also be immersed during some calibrations.

6.1.2 Calibration Tips

1. If you use the Transport/Calibration Cup for dissolved oxygen (DO) calibration, make certain to loosen the seal to allow pressure equilibration before calibration. The DO calibration is a water-saturated air calibration.
2. The key to successful calibration is to ensure that the sensors are completely submersed when calibration values are entered. Use recommended volumes when performing calibrations.
3. For maximum accuracy, use a small amount of previously used calibration solution to pre-rinse the probe module. You may wish to save old calibration standards for this purpose.
4. Fill a bucket with ambient temperature water to rinse the probe module between calibration solutions.
5. Have several clean, absorbent paper towels or cotton cloths available to dry the probe module between rinses and calibration solutions. Shake the excess rinse water off of the probe module, especially when the probe sensor guard is installed. Dry off the outside of the probe module and probe sensor guard. Making sure that the probe module is dry reduces carry-over contamination of calibrator solutions and increases the accuracy of the calibration.
6. If you are using laboratory glassware for calibration, you do not need to remove the probe sensor guard to rinse and dry the sensors between calibration solutions. The inaccuracy resulting from simply rinsing the sensor compartment and drying the outside of the guard is minimal.
7. If you are using laboratory glassware, remove the stainless steel weight from the bottom of the probe sensor guard by turning the weight counterclockwise. When the weight is removed, the calibration solutions have access to the sensors without displacing a lot of fluid. This also reduces the amount of liquid that is carried between calibrations.
8. Make certain that port plugs are installed in all ports where sensors are not installed. It is extremely important to keep these electrical connectors dry.

6.1.3 Recommended Volumes

Follow these instructions to use the transport/calibration cup for calibration procedures.

- ✓ Ensure that an o-ring is installed in the o-ring groove of the transport/calibration cup bottom cap, and that the bottom cap is securely tightened.

  NOTE: Do not over-tighten as this could cause damage to the threaded portions.
- ✓ Remove the probe sensor guard, if it is installed.
- ✓ Remove the o-ring, if installed, from the probe module and inspect the installed o-ring on the probe module for obvious defects and, if necessary, replace it with the extra o-ring supplied.
- ✓ Some calibrations can be accomplished with the probe module upright or upside down. A separate clamp and stand, such as a ring stand, is required to support the probe module in the inverted position.
- ✓ To calibrate, follow the procedures in the next section, Calibration Procedures. The approximate volumes of the reagents are specified below for both the upright and upside down orientations.
- ✓ When using the Transport/Calibration Cup for dissolved oxygen % saturation calibration, make certain that the vessel is vented to the atmosphere by loosening the bottom cap or cup assembly and that approximately 1/8” of water is present in the cup.

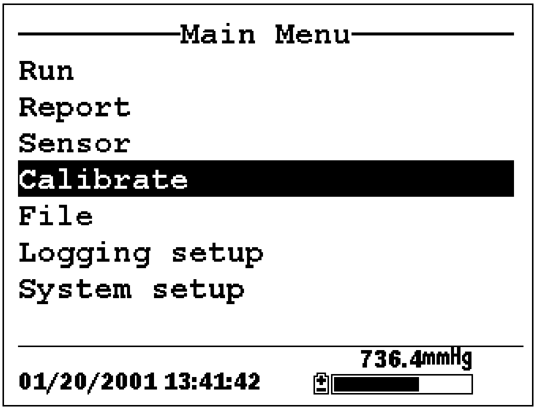
Sensor to Calibrate	**Upright**	**Upside Down**
Conductivity	55ml	55ml
pH/ORP	30ml	60ml

Table 6.1 Calibration Volumes

6.2 Calibration Procedures

6.2.1 Accessing the Calibrate Screen

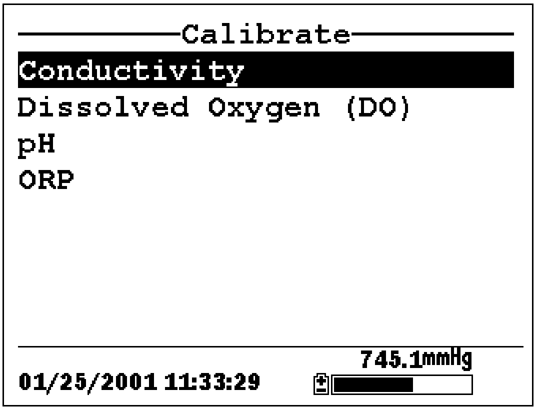
1. Press the **On/off** key to display the run screen.
2. Press the **Escape** key to display the main menu screen.
3. Use the arrow keys to highlight the **Calibrate** selection.



Main Menu
Run
Report
Sensor
Calibrate
File
Logging setup
System setup
736.4mmHg
01/20/2001 13:41:42

Figure 6.1 Main Menu

4. Press the **Enter** key. The Calibrate screen is displayed.



Calibrate
Conductivity
Dissolved Oxygen (DO)
pH
ORP
745.1mmHg
01/25/2001 11:33:29

Figure 6.2 Calibrate Screen

6.2.2 Conductivity Calibration

This procedure calibrates specific conductance (recommended), conductivity and salinity. Calibrating any one option automatically calibrates the other two.

1. Go to the calibrate screen as described in Section 6.2.1 Accessing the Calibrate Screen.

2. Use the arrow keys to highlight the **Conductivity** selection. See Figure 6.2 Calibrate Screen.

3. Press **Enter.** The Conductivity Calibration Selection Screen is displayed.

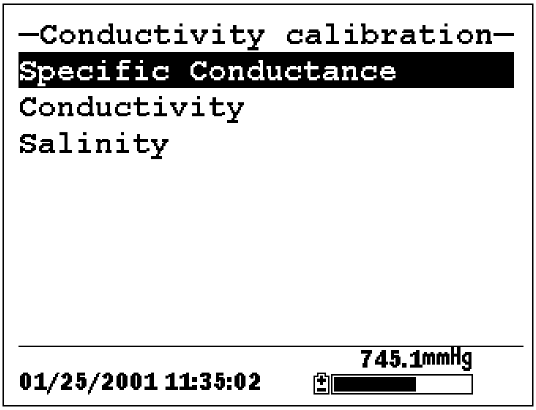
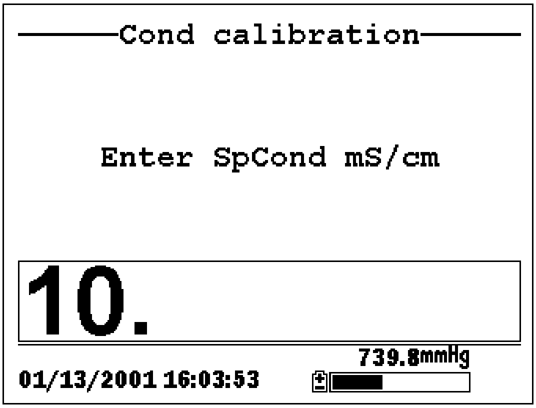


Figure 6.3 Conductivity Calibration Selection Screen

4. Use the arrow keys to highlight the Specific Conductance selection.

5. Press **Enter.** The Conductivity Calibration Entry Screen is displayed.



Cond calibration

Enter SpCond mS/cm

10.

739.8mmHg

01/13/2001 16:03:53

Figure 6.4 Conductivity Calibration Entry Screen

6. Place the correct amount of conductivity standard (see Table 6.1 Calibration Volumes) into a clean, dry or pre-rinsed transport/calibration cup.

⚠ **WARNING**: Calibration reagents may be hazardous to your health. See *Appendix D Health and Safety* for more information.

NOTE: For maximum accuracy, the conductivity standard you choose should be within the same conductivity range as the samples you are preparing to measure. However, we do not recommend using standards less than 1 mS/cm. For example:

- ✓ For fresh water use a 1 mS/cm conductivity standard.
- ✓ For brackish water use a 10 mS/cm conductivity standard.
- ✓ For seawater use a 50 mS/cm conductivity standard.

NOTE: Before proceeding, ensure that the sensor is as dry as possible. Ideally, rinse the conductivity sensor with a small amount of standard that can be discarded. Be certain that you avoid cross-contamination of solutions. Make certain that there are no salt deposits around the oxygen and pH/ORP sensors, particularly if you are employing standards of low conductivity.

7. Carefully immerse the sensor end of the probe module into the solution.

8. Gently rotate and/or move the probe module up and down to remove any bubbles from the conductivity cell.

   NOTE: The sensor must be completely immersed past its vent hole. Using the recommended volumes from Table 6.1 Calibration Volumes, should ensure that the vent hole is covered.

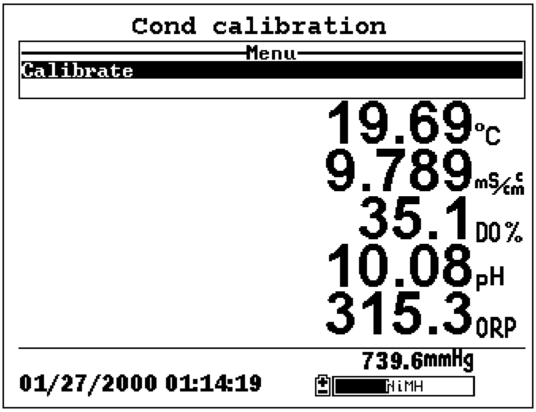
9. Screw the transport/calibration cup on the threaded end of the probe module and securely tighten.

   NOTE: Do not overtighten as this could cause damage to the threaded portions.

10. Use the keypad to enter the calibration value of the standard you are using.

    NOTE: Be sure to enter the value in **mS/cm at 25°C**.

11. Press **Enter**. The Conductivity Calibration Screen is displayed.



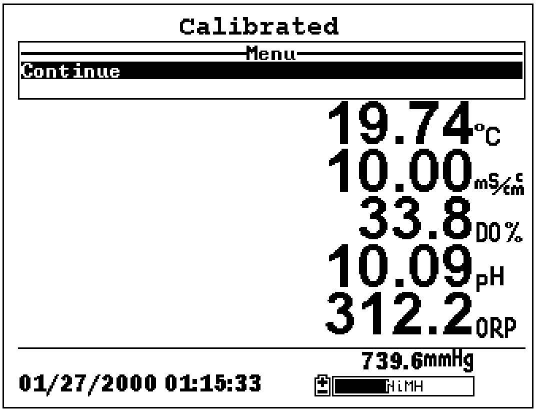
```
19.69°C
9.789mS/cm c
35.1DO%
10.08pH
315.3ORP
739.6mmHg
01/27/2000 01:14:19
```

Figure 6.5 Conductivity Calibration Screen

12. Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors

will appear on the screen and will change with time as they stabilize.

13. Observe the reading under Specific Conductance. When the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.



```
Calibrated
19.74°C
10.00mS/cm c
33.8DO%
10.09pH
312.2ORP
739.6mmHg
01/27/2000 01:15:33
NiMH
```

Figure 6.6 Calibrated

14. Press **Enter**. This returns you to the Conductivity Calibrate Selection Screen, See Figure 6.3 Conductivity Calibration Selection Screen.

15. Press **Escape** to return to the calibrate menu. See Figure 6.2 Calibrate Screen.

16. Rinse the probe module and sensors in tap or purified water and dry.

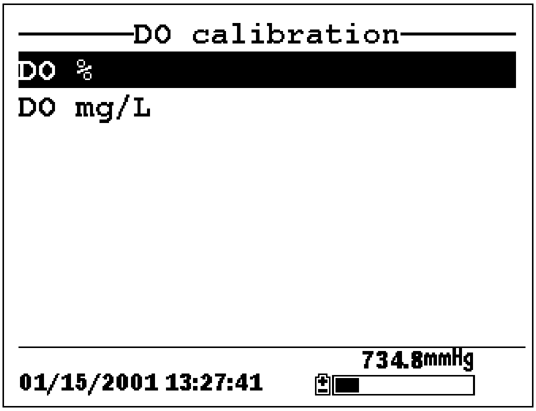
6.2.3 Dissolved Oxygen Calibration

This procedure calibrates dissolved oxygen. Calibrating any one option (% or mg/L) automatically calibrates the other.

1. Go to the calibrate screen as described in Section *6.2.1 Accessing the Calibrate Screen*.

NOTE: The instrument must be on for at least 20 minutes to polarize the DO sensor before calibrating.

2. Use the arrow keys to highlight the **Dissolved Oxygen** selection. See Figure 6.2 Calibrate Screen.
3. Press **Enter**. The dissolved oxygen calibration screen is displayed.



DO calibration

DO %

DO mg/L

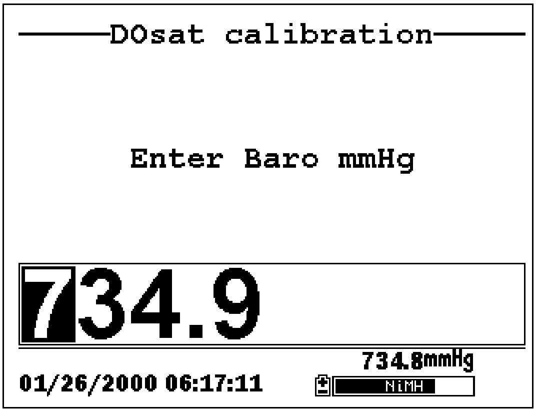
734.8mmHg

01/15/2001 13:27:41

Figure 6.7 DO Calibration Screen

DO Calibration in % Saturation

1. Use the arrow keys to highlight the DO% selection.
2. Press **Enter**. The DO Barometric Pressure Entry Screen is displayed.



DOsat calibration

Enter Baro mmHg

734.9

734.8mmHg

01/26/2000 06:17:11

Figure 6.8 DO Barometric Pressure Entry Screen

3. Place approximately 3 mm (1/8 inch) of water in the bottom of the transport/calibration cup.

4. Place the probe module into the transport/calibration cup.

   NOTE: Make sure that the DO and temperature sensors are **not** immersed in the water.

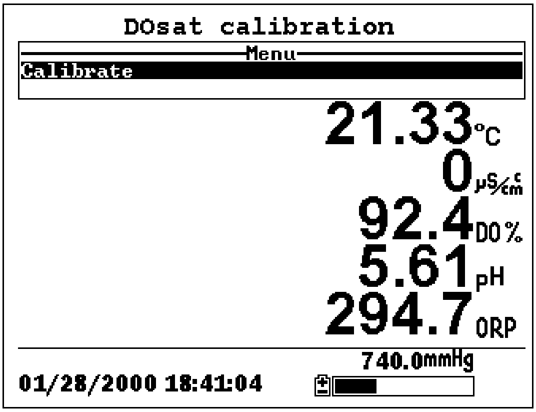
5. Engage only 1 or 2 threads of the transport/calibration cup to ensure the DO sensor is vented to the atmosphere.

6. Use the keypad to enter the current local barometric pressure.

   NOTE: If the unit has the optional barometer, no entry is required.

   NOTE: Barometer readings that appear in meteorological reports are generally corrected to sea level and must be uncorrected before use (refer to Section *10.10 Calibrate Barometer, Step 2*).

7. Press **Enter**. The DO% saturation calibration screen is displayed.



21.33°C
0 µS/cm c
92.4 DO%
5.61 pH
294.7 ORP
740.0mmHg
01/28/2000 18:41:04

Figure 6.9 DO Sat Calibration Screen

8. Allow approximately ten minutes for the air in the transport/calibration cup to become water saturated and for

the temperature to equilibrate before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.

9. Observe the reading under DO %. When the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue. See Figure 6.6 Calibrated.

10. Press **Enter**. This returns you to the DO calibration screen, See Figure 6.7 DO Calibration Screen.

11. Press **Escape** to return to the calibrate menu. See Figure 6.2 Calibrate Screen.

12. Rinse the probe module and sensors in tap or purified water and dry.

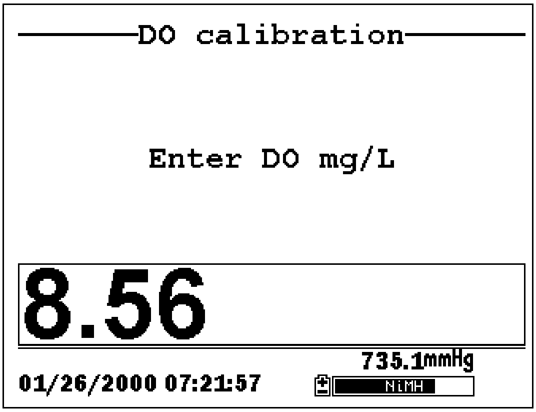
DO Calibration in mg/L

DO calibration in mg/L is carried out in a water sample which has a known concentration of dissolved oxygen (usually determined by a Winkler titration).

1. Go to the DO calibrate screen as described in Section *6.2.3 Dissolved Oxygen Calibration*, steps 1 through 3.

2. Use the arrow keys to highlight the **DO mg/L** selection.

3. Press **Enter**. The DO mg/L Entry Screen is displayed.



DO calibration

Enter DO mg/L

8.56

735.1mmHg

01/26/2000 07:21:57

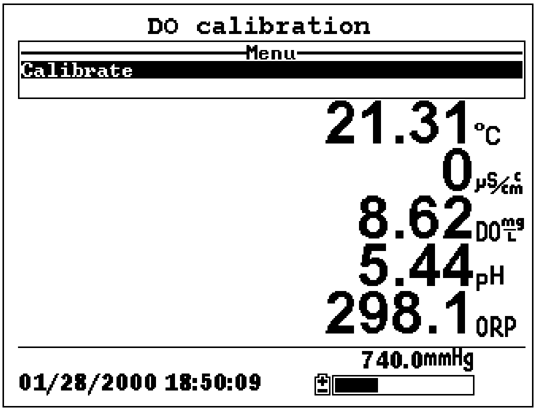
Figure 6.10 DO mg/L Entry Screen

4. Place the probe module in water with a known DO concentration.

   NOTE: Be sure to completely immerse all the sensors.

5. Use the keypad to enter the known DO concentration of the water.

6. Press **Enter**. The Dissolved Oxygen mg/L Calibration Screen is displayed.



DO calibration

21.31°C

0µS/cm c

8.62DO mg/L

5.44pH

298.1ORP

740.0mmHg

01/28/2000 18:50:09

Figure 6.11 DO mg/L Calibration Screen

7. Stir the water with a stir bar, or by rapidly moving the probe module, to provide fresh sample to the DO sensor.

8. Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.

9. Observe the DO mg/L reading, when the reading is stable (shows no significant change for approximately 30 seconds), press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.

10. Press **Enter**. This returns you to the DO calibration screen. See Figure 6.7 DO Calibration Screen.

11. Press **Escape** to return to the calibrate menu. See Figure 6.2 Calibrate Screen.

12. Rinse the probe module and sensors in tap or purified water and dry.

6.2.4 pH Calibration

1. Go to the calibrate screen as described in *Section 6.2.1 Accessing the Calibrate Screen*.

2. Use the arrow keys to highlight the **pH** selection. See Figure 6.2 Calibrate Screen.

3. Press **Enter**. The pH calibration screen is displayed.

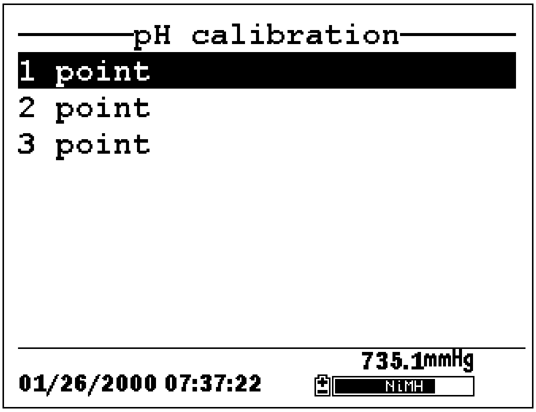


Figure 6.12 pH Calibration Screen

- Select the **1-point** option only if you are adjusting a previous calibration. If a 2-point or 3-point calibration has been performed previously, you can adjust the calibration by carrying out a one point calibration. The procedure for this calibration is the same as for a 2-point calibration, but the software will prompt you to select only one pH buffer.
- Select the **2-point** option to calibrate the pH sensor using only two calibration standards. Use this option if the media being monitored is known to be either basic or acidic. For example, if the pH of a pond is known to vary between 5.5 and 7, a two-point calibration with pH 7 and pH 4 buffers is sufficient. A three point calibration with an additional pH 10 buffer will not increase the accuracy of this measurement since the pH is not within this higher range.
- Select the **3-point** option to calibrate the pH sensor using three calibration solutions. In this procedure, the pH sensor is calibrated with a pH 7 buffer and two additional buffers. The 3-point calibration method assures maximum accuracy when the pH of the media to be monitored cannot be anticipated. The procedure for this calibration is the same as for a 2-point calibration, but the software will prompt you to select a third pH buffer.

4. Use the arrow keys to highlight the **2-point** selection.

5. Press **Enter**. The pH Entry Screen is displayed.

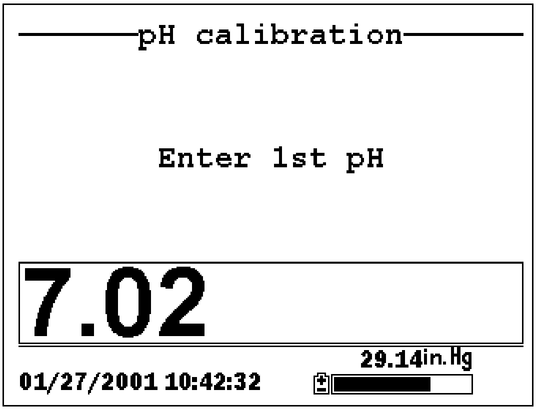


Figure 6.13 pH Entry Screen

6. Place the correct amount (see Table 6.1 Calibration Volumes) of pH buffer into a clean, dry or pre-rinsed transport/calibration cup.

⚠ **WARNING**: Calibration reagents may be hazardous to your health. See *Appendix D Health and Safety* for more information.

NOTE: For maximum accuracy, the pH buffers you choose should be within the same pH range as the water you are preparing to sample.

NOTE: Before proceeding, ensure that the sensor is as dry as possible. Ideally, rinse the pH sensor with a small amount of buffer that can be discarded. Be certain that you avoid cross-contamination of buffers with other solutions.

7. Carefully immerse the sensor end of the probe module into the solution.

8. Gently rotate and/or move the probe module up and down to remove any bubbles from the pH sensor.

NOTE: The sensor must be completely immersed. Using the recommended volumes from Table 6.1 Calibration Volumes, should ensure that the sensor is covered.

9. Screw the transport/calibration cup on the threaded end of the probe module and securely tighten.

   NOTE: Do not overtighten as this could cause damage to the threaded portions.

10. Use the keypad to enter the calibration value of the buffer you are using **at the current temperature**.

    NOTE: pH vs. temperature values are printed on the labels of all YSI pH buffers.

11. Press **Enter**. The pH calibration screen is displayed.

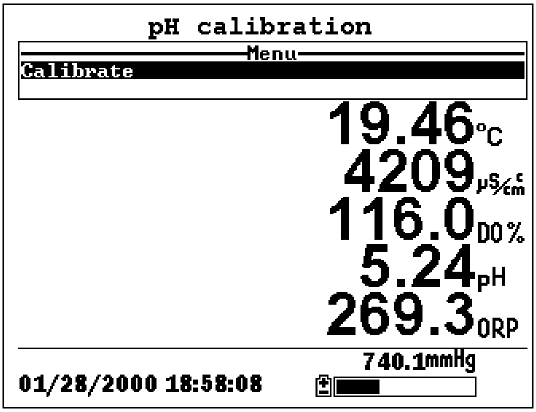


Figure 6.14 pH Calibration Screen

12. Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.

13. Observe the reading under pH, when the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.

14. Press **Enter**. This returns you to the Specified pH Calibration Screen, See Figure 6.13 pH Entry Screen.

15. Rinse the probe module, transport/calibration cup and sensors in tap or purified water and dry.

16. Repeat steps 6 through 13 above using a second pH buffer.

17. Press **Enter**. This returns you to the pH Calibration Screen, See Figure 6.12 pH Calibration Screen.

18. Press **Escape** to return to the calibrate menu. See Figure 6.2 Calibrate Screen.

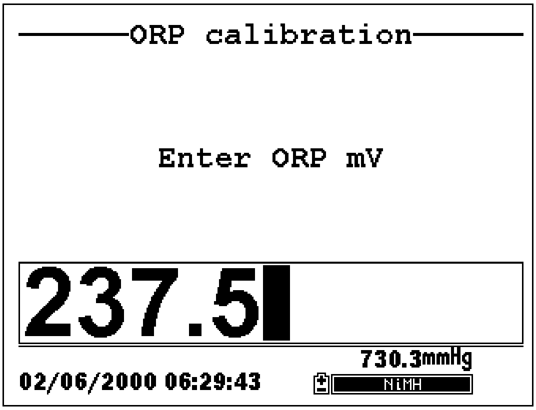
19. Rinse the probe module and sensors in tap or purified water and dry.

6.2.5 ORP Calibration

1. Go to the calibrate screen as described in Section *6.2.1 Accessing the Calibrate Screen*.

2. Use the arrow keys to highlight the **ORP** selection. See Figure 6.2 Calibrate Screen.

3. Press **Enter**. The ORP calibration screen is displayed.



ORP calibration

Enter ORP mV

237.5

730.3mmHg

02/06/2000 06:29:43

Figure 6.15 Specified ORP Calibration Screen

4. Place the correct amount (see Table 6.1 Calibration Volumes) of a known ORP solution (we recommend Zobell solution) into a clean, dry or pre-rinsed transport/calibration cup.

⚠ **WARNING**: Calibration reagents may be hazardous to your health. See *Appendix D Health and Safety* for more information.

NOTE: Before proceeding, ensure that the sensor is as dry as possible. Ideally, rinse the ORP sensor with a small amount of solution that can be discarded. Be certain that you avoid cross-contamination with other solutions.

5. Carefully immerse the sensor end of the probe module into the solution.

6. Gently rotate and/or move the probe module up and down to remove any bubbles from the ORP sensor.

   NOTE: The sensor must be completely immersed. Using the recommended volumes from Table 6.1 Calibration Volumes should ensure that the sensor is covered.

7. Screw the transport/calibration cup on the threaded end of the probe module and securely tighten.

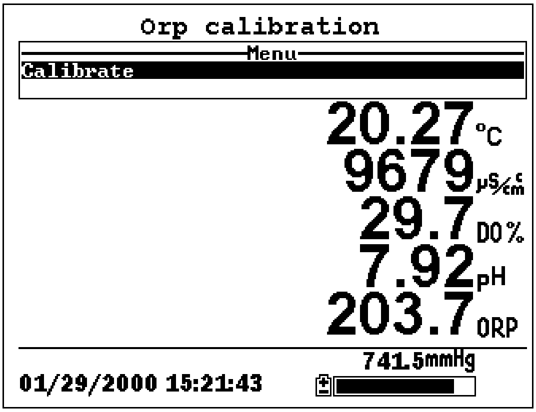
   NOTE: Do not overtighten as this could cause damage to the threaded portions.

8. Use the keypad to enter the correct value of the calibration solution you are using at the current temperature. Refer to Table 6.2 Zobel Solution Values.

Temperature °C	Zobell Solution Value, mV
-5	270.0
0	263.5
5	257.0
10	250.5
15	244.0
20	237.5
25	231.0
30	224.5
35	218.0
40	211.5
45	205.0
50	198.5

Table 6.2 Zobel Solution Values

9. Press **Enter**. The ORP calibration screen is displayed.



Orp calibration

Menu

Calibrate

20.27 °C

9679 µS/cm

29.7 DO%

7.92 pH

203.7 ORP

741.5mmHg

01/29/2000 15:21:43

Figure 6.16 ORP Calibration Screen

10. Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.

    NOTE: Verify that the temperature reading matches the value you used in Table 6.2 Zobel Solution Values.

11. Observe the reading under ORP, when the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.

12. Press **Enter**. This returns you to the Calibrate Screen. See Figure 6.2 Calibrate Screen.

13. Rinse the probe module and sensors in tap or purified water and dry.

6.3 Return to Factory Settings

1. Go to the calibrate screen as described in Section *6.2.1 Accessing the Calibrate Screen*.

2. Use the arrow keys to highlight the **Conductivity** selection. See Figure 6.2 Calibrate Screen.

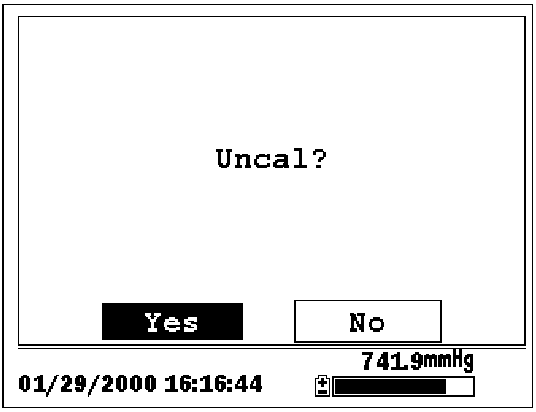
   NOTE: We will use the Conductivity sensor as an example; however, this process will work for any sensor.

3. Press **Enter.** The Conductivity Calibration Selection Screen is displayed. See Figure 6.3 Conductivity Calibration Selection Screen.

4. Use the arrow keys to highlight the **Specific Conductance** selection.

5. Press **Enter.** The Conductivity Calibration Entry Screen is displayed. See Figure 6.4 Conductivity Calibration Entry Screen.

6. Press and hold the **Enter** key down and press the **Escape** key.



Uncal?

Figure 6.17 ORP Calibration Screen

7. Use the arrow keys to highlight the **YES** selection.

CAUTION: This returns a sensor to the factory settings. For example, in selecting to return specific conductance to the factory setting, salinity and conductivity will automatically return to their factory settings.

8. Press **Enter**. This returns you to the Conductivity Calibrate Selection Screen, See Figure 6.3 Conductivity Calibration Selection Screen.

9. Press **Escape** to return to the calibrate menu. See Figure 6.2 Calibrate Screen.

7. Run

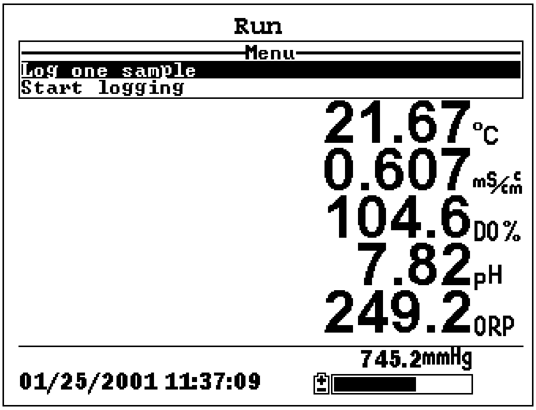
The Run screen displays data from the sensors in real-time and allows the user to log sample data to memory for later analysis. Refer to Section *9 Logging* for details on logging sample data.

7.1 Real-Time Data

NOTE: Before measuring samples you must prepare the probe module (refer to Section *3.4 Preparing the Probe Module*), attach the probe module to the instrument (refer to Section *3.6 Instrument/Cable Connection*) and calibrate the sensors (refer to Section *6 Calibrate*).

1. Press the **On/off** key.

OR select Run from the main menu to display the run screen.



21.67 °C
0.607 mS/cm c
104.6 DO %
7.82 pH
249.2 ORP
745.2 mmHg
01/25/2001 11:37:09

Figure 7.1 Run Screen

2. Make sure the probe sensor guard is installed.

3. Place the probe module in the sample. Be sure to completely immerse all the sensors.

4. Rapidly move the probe module through the sample to provide fresh sample to the DO sensor.

5. Watch the readings on the display until they are stable.

6. Refer to Section *9 Logging* for instructions on logging sample data.

8. File

The File menu allows the user to view, upload or delete sample data and calibration record files stored in the YSI 556 MPS.

8.1 Accessing the File Screen

1. Press the **On/off** key to display the run screen.
2. Press the **Escape** key to display the main menu screen.

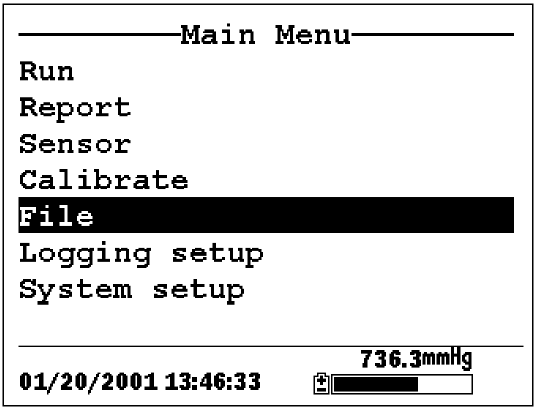


Figure 8.1 Main Menu Screen

3. Use the arrow keys to highlight the **File** selection.
4. Press the **Enter** key. The file screen is displayed.

Figure 8.2 File Screen

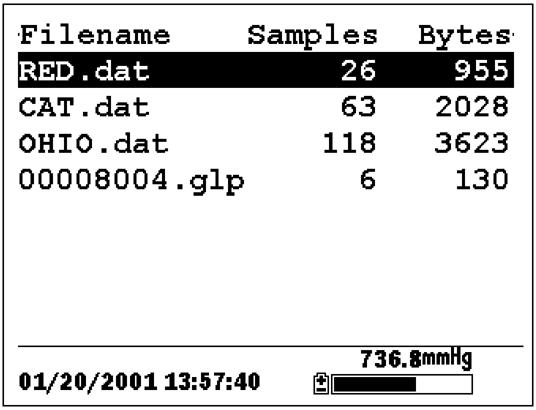
8.2 Directory

1. Go to the file screen as described in Section *8.1 Accessing the File Screen*.

2. Use the arrow keys to highlight the **Directory** selection. See Figure 8.2 File Screen.

3. Press the **Enter** key. The file list screen is displayed.

   NOTE: Files are listed in the order in which they are logged to memory. Sample Data files have the file extension **.dat**, while Calibration Record files have the file extension **.glp**.

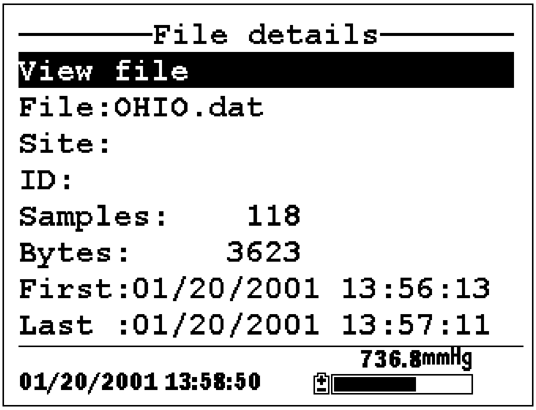


Filename	Samples	Bytes
RED.dat	26	955
CAT.dat	63	2028
OHIO.dat	118	3623
00008004.glp	6	130

Figure 8.3 File List Screen

4. Use the arrow keys to highlight a file.

5. Press the **Enter** key. The file details screen is displayed.



```
--------File details--------
View file
File:OHIO.dat
Site:
ID:
Samples:    118
Bytes:     3623
First:01/20/2001 13:56:13
Last :01/20/2001 13:57:11
                    736.8mmHg
01/20/2001 13:58:50
```

Figure 8.4 File Details Screen

6. Press the **Enter** key to view the file data. Refer to Section *8.3 View File* for details.

7. Press the **Escape** key repeatedly to return to the main menu screen.

8.3 View File

1. Go to the file screen as described in Section *8.1 Accessing the File Screen*. See Figure 8.2 File Screen.

2. Use the arrow keys to highlight the **View file** selection.

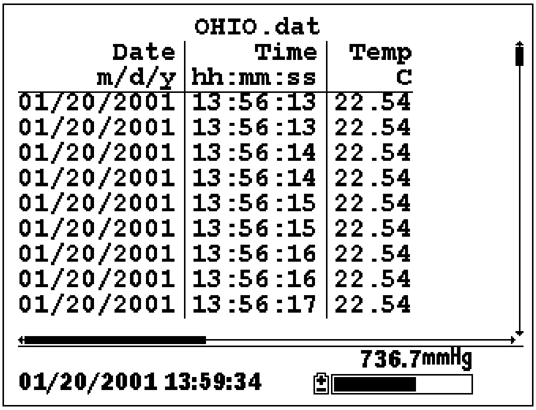
3. Press the **Enter** key. A list of files is displayed. See Figure 8.3 File List Screen.

4. Use the arrow keys to highlight an individual file.

   NOTE: You may have to scroll down to see all the files.

5. Press the **Enter** key. The file data is displayed with the file name at the top of the display.

   NOTE: If no file name was specified, the data is stored under the default name NONAME1.dat.



```
            OHIO.dat
      Date|      Time| Temp
     m/d/y|hh:mm:ss  |    C
01/20/2001|13:56:13  |22.54
01/20/2001|13:56:13  |22.54
01/20/2001|13:56:14  |22.54
01/20/2001|13:56:14  |22.54
01/20/2001|13:56:15  |22.54
01/20/2001|13:56:15  |22.54
01/20/2001|13:56:16  |22.54
01/20/2001|13:56:16  |22.54
01/20/2001|13:56:17  |22.54
                  736.7mmHg
01/20/2001 13:59:34
```

Figure 8.5 File Data Screen

6. Use the arrow keys to scroll horizontally and/or vertically to view all the data.

7. Press the **Escape** key repeatedly to return to the main menu screen.

8.4 Upload to PC

EcoWatch™ for Windows™ must be used as the PC software interface to the YSI 556 MPS. Refer to *Appendix G EcoWatch* for more information. EcoWatch for Windows is available at no cost via a download from the YSI Web Site (www.ysi.com) or by contacting YSI Customer Support. Refer to *Appendix E Customer Service.*

8.4.1 Upload Setup

1. Disconnect the YSI 5563 Probe Module from the YSI 556 MPS instrument.

2. Connect the YSI 556 MPS to a serial (Comm) port of your computer via the 655173 PC Interface cable as shown in the following diagram:

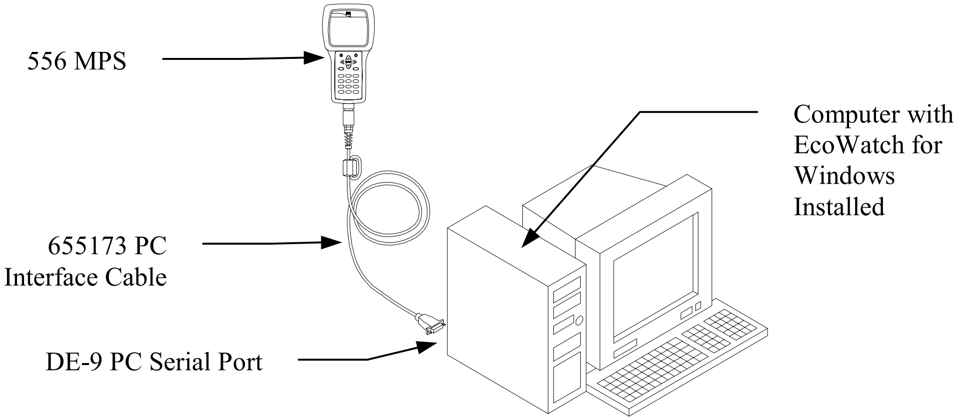


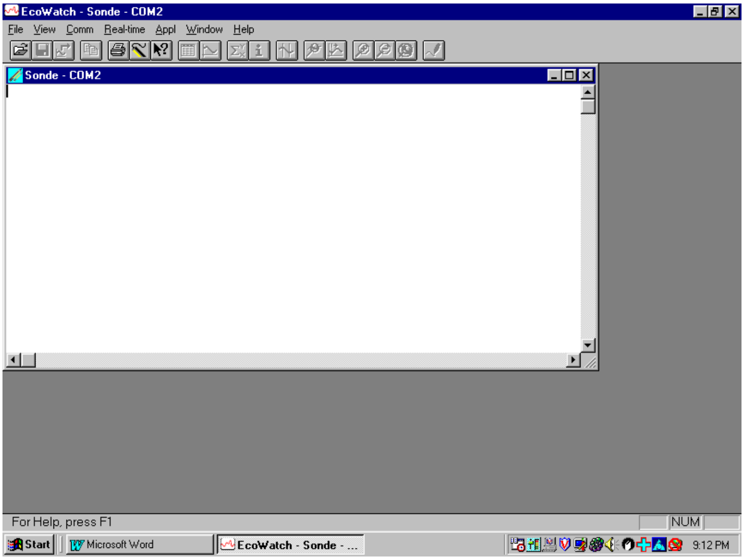
Figure 8.6 Computer/Instrument Interface

3. Open EcoWatch for Windows on your computer.

   NOTE: See *Appendix G EcoWatch* for installation instructions.

4. Click on the sonde/probe icon in the upper toolbar.

5. Set the Comm port number to match the port the YSI 556 MPS is connected to. After this setup procedure, the following screen will be present on your PC monitor:



8.4.2 Uploading a .DAT File

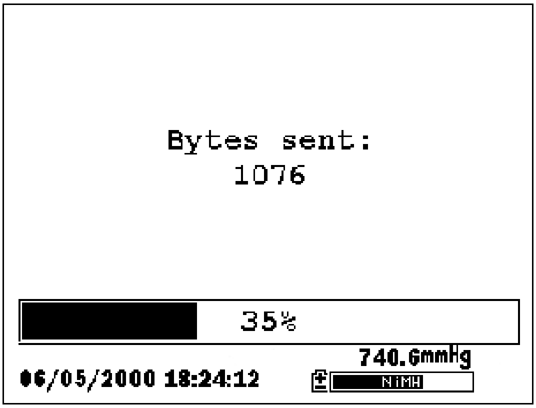
1. Setup the instrument as described in Section *8.4.1 Upload Setup*.

2. Go to the YSI 556 MPS file screen as described in Section *8.1 Accessing the File Screen.*

3. Use the arrow keys to highlight the **Upload to PC** selection. See Figure 8.2 File Screen.

4. Press the **Enter** key. The file list screen is displayed. See Figure 8.3 File List Screen.

5. Use the arrow keys to highlight the DAT file that you wish to transfer and press **Enter**, both the YSI 556 MPS and PC displays show the progress of the file transfer.



Bytes sent:
1076

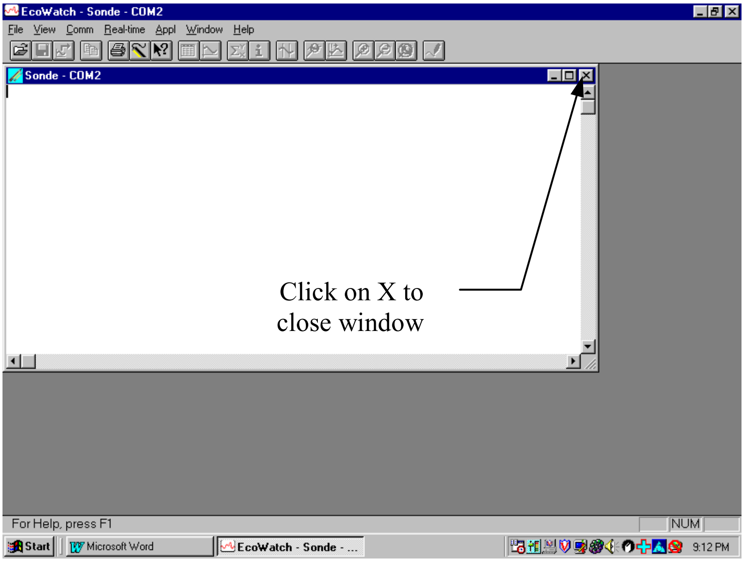
35%

740.6mmHg
06/05/2000 18:24:12
NiMH

Figure 8.7 File Transfer Progress Screen

NOTE: After transfer, the file will be located in the C:\ECOWWIN\DATA folder of your PC, designated with a .DAT extension.

6. After the file transfer is complete, close the terminal window (small window on the PC) by clicking on the "X" at its upper right corner.



Click on X to close window

7. Press the **Escape** key on the YSI 556 MPS repeatedly to return to the main menu screen.

8.4.3 Uploading a Calibration Record (.glp) File

For more information on the calibration record, Refer to *Appendix H Calibration Record Information*.

1. Setup up the instrument as described in Section *8.4.1 Upload Setup*.

2. Go to the YSI 556 MPS file screen as described in Section *8.1 Accessing the File Screen.*

3. Use the arrow keys to highlight the **Upload to PC** selection. See Figure 8.2 File Screen.

4. Press the **Enter** key. The file list screen is displayed. See Figure 8.3 File List Screen.

5. Use the arrow keys to highlight the calibration record file that you wish to transfer and press **Enter.**

6. You will then be given a choice of uploading the file in three formats; **Binary, Comma & “” Delimited, and ASCII Text**.

   NOTE: The binary format is reserved for future YSI software packages.

7. Choose an option and press **Enter,** both the YSI 556 and PC displays show the progress of the file transfer.

   NOTE: After transfer, the file will be located in the C:\ECOWWIN\DATA folder of your PC, designated with the appropriate file extension.

   NOTE: To view the Calibration Record data after upload, simply open the .txt file in a general text editor such as Wordpad or Notepad.

8. After the file transfer is complete, close the terminal window (small window on the PC) by clicking on the "X" at its upper right corner.

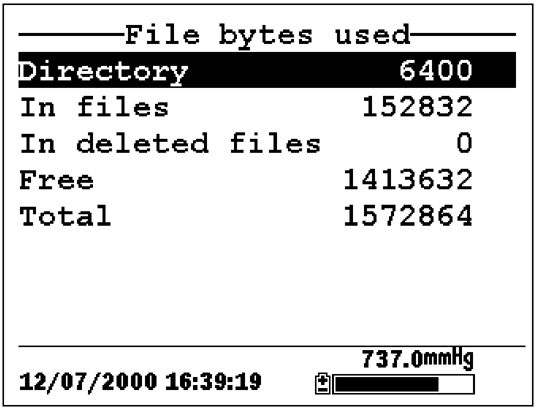
9. Press the **Escape** key repeatedly to return to the main menu screen.

8.5 File Memory

1. Go to the file screen as described in Section *8.1 Accessing the File Screen*.

2. Use the arrow keys to highlight the **File memory** selection. See Figure 8.2 File Screen.

3. Press the **Enter** key. The file bytes used screen is displayed.



```
-------File bytes used-------
Directory                6400
In files               152832
In deleted files            0
Free                  1413632
Total                 1572864

                    737.0mmHg
12/07/2000 16:39:19
```

Figure 8.8 File Bytes Used Screen

4. The amount of free memory is listed in line 4 of the file bytes used screen.

   NOTE: If the amount of free memory is low, it may be time to delete all files (after first uploading all data to a PC). Refer to Section *8.6 Delete All Files*.

5. Press the **Escape** key repeatedly to return to the main menu screen.

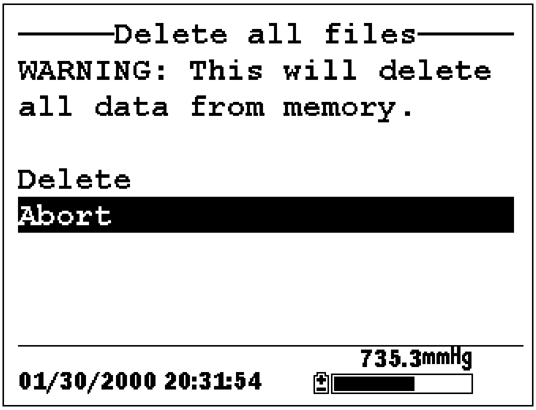
8.6 Delete All Files

NOTE: It is not possible to delete individual files in order to free up memory. The only way to free up memory is to delete ALL files present. Take care to transfer all files to your computer (refer to Section *8.4 Upload to PC*) *before* deleting them.

1. Go to the file screen as described in Section *8.1 Accessing the File Screen*.

2. Use the arrow keys to highlight the **Delete all files** selection. See Figure 8.2 File Screen.

3. Press the **Enter** key. The Delete all Files screen is displayed.

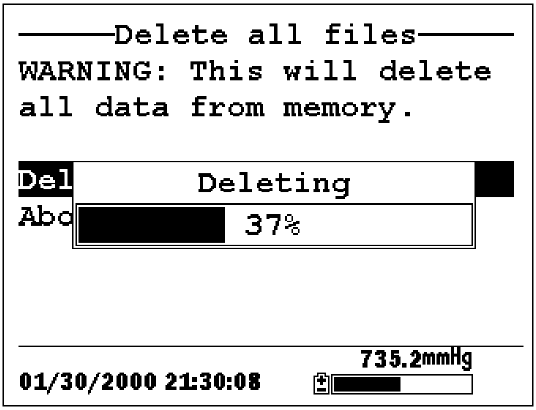


```
------Delete all files------
WARNING: This will delete
all data from memory.

Delete
Abort
```

Figure 8.9 Delete All Files Screen

4. Use the arrow keys to highlight the **Delete** selection.

5. Press the **Enter** key.



Delete all files

WARNING: This will delete all data from memory.

Figure 8.10 Deleting

The progress of file deletion is displayed in bar graph format.

NOTE: Deleting all files in the directory will not change any information in the site list.

6. Press the **Escape** key repeatedly to return to the main menu screen.

9. Logging

9.1 Accessing the Logging Setup Screen

1. Press the **On/off** key to display the run screen.

2. Press the **Escape** key to display the main menu screen.

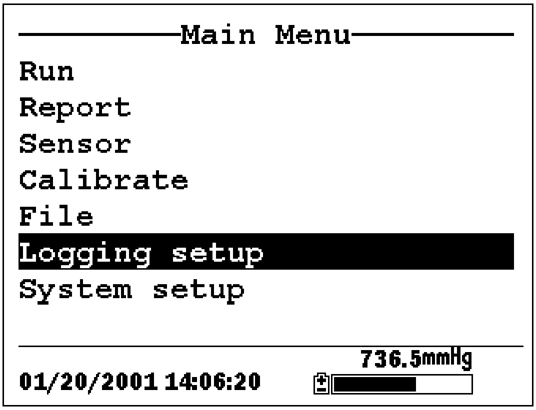
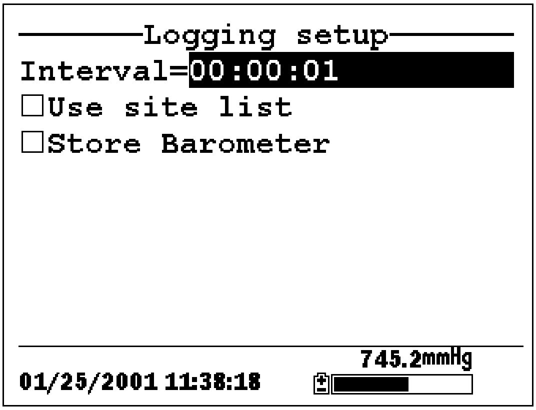


Figure 9.1 Main Menu

3. Use the arrow keys to highlight the **Logging setup** selection.

4. Press the **Enter** key. The logging setup screen is displayed.



Interval=00:00:01
☐Use site list
☐Store Barometer

Figure 9.2 Logging Setup Screen

9.2 Setting Logging Interval

Follow steps below to set the interval for logging a data stream.

NOTE: If you do not specify an interval, the instrument will use a default interval setting of 1 second.

NOTE: It is not necessary to set a logging interval when logging a single sample.

1. Go to the logging setup screen as described in Section *9.1 Accessing the Logging Setup Screen*.
2. Use the keypad to enter an interval between 1 second and 15 minutes. Refer to Section *2.9 Keypad Use*.

   NOTE: The interval field has hour, minute and second entry fields. Any entry over 15 minutes will change automatically to a 15-minute setting.
3. Press the **Enter** key. The data stream interval is set.
4. Press the **Escape** key repeatedly to return to the main menu screen.

9.3 Storing Barometer Readings

NOTE: The **Store barometer** option is only available on instruments that are equipped with the optional barometer.

1. Go to the logging setup screen as described in Section *9.1 Accessing the Logging Setup Screen*.
2. Use the arrow keys to highlight the **Store barometer** selection. See Figure 9.2 Logging Setup Screen.
3. Press the **Enter** key until a check mark is entered in the box next to the store barometer selection if you want to log barometric readings.

   OR press the **Enter** key until the box next to the barometer selection is empty if you do not want to log barometric readings.

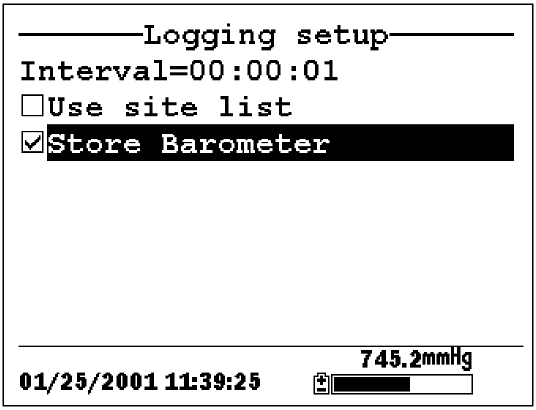


Figure 9.3 Store Barometer

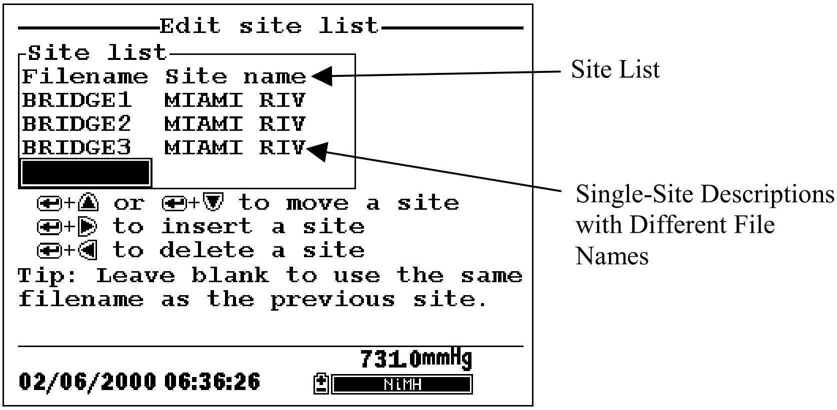
4. Press the **Escape** key repeatedly to return to the main menu screen.

9.4 Creating a Site List

The site list option allows you to define file and site descriptions in the office or laboratory before moving to field logging studies. This is usually more convenient than entering the information at the site and is particularly valuable if you are visiting certain sites on a regular basis. The following section describes how to set up site lists which contain entries designated "Site Descriptions" that will be instantly available to the user in the field to facilitate the logging of data with pre-established naming of files and sites. There are two kinds of **Site Descriptions** available for use in Site lists:

- **Site Descriptions** associated with applications where data from a single site is always logged to a single file. This type is referred to as a "Single-Site Description" and is characterized by two parameters – a file name and a site name. Files logged to YSI 556 MPS memory under a **Single-Site Description** will be characterized primarily by the file name, but will also have the Site name attached, so that it is viewable in either the YSI 556 MPS **File directory** or in EcoWatch for Windows after upload to a PC

- **Site Descriptions** associated with applications where data from <u>multiple sites</u> are logged to a <u>single file</u>. This type is referred to as a “Multi-site Description” and is characterized by three parameters – a file name, a site name, and a site number. Files logged to YSI 556 MPS memory under a **Multi-site Description** are characterized by a file name, but not a site name, since multiple sites are involved. However, each data point has a Site Number attached to it so that the user can easily determine the sampling site when viewing the data from the YSI 556 MPS **File** menu or processing the data in EcoWatch for Windows after upload to a PC.

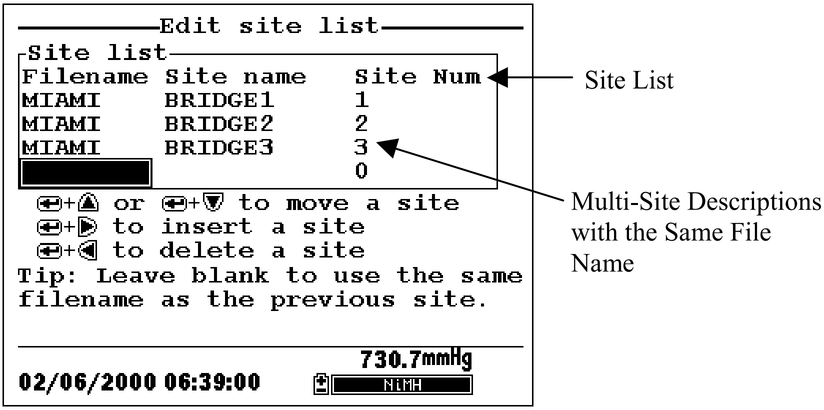


```
Edit site list
Site list
Filename Site name
BRIDGE1  MIAMI RIV
BRIDGE2  MIAMI RIV
BRIDGE3  MIAMI RIV

 ⏎+▲ or ⏎+▼ to move a site
 ⏎+▶ to insert a site
 ⏎+◀ to delete a site
Tip: Leave blank to use the same
filename as the previous site.

                          731.0mmHg
02/06/2000 06:36:26       NiMH
```

Site List

Single-Site Descriptions with Different File Names

Figure 9.4 Single-Site Descriptions



```
Edit site list
Site list
Filename Site name   Site Num
MIAMI    BRIDGE1     1
MIAMI    BRIDGE2     2
MIAMI    BRIDGE3     3
                     0
 ⏎+▲ or ⏎+▼ to move a site
 ⏎+▶ to insert a site
 ⏎+◀ to delete a site
Tip: Leave blank to use the same
filename as the previous site.

                          730.7mmHg
02/06/2000 06:39:00       NiMH
```

Site List

Multi-Site Descriptions with the Same File Name

Figure 9.5 Multiple-Site Descriptions

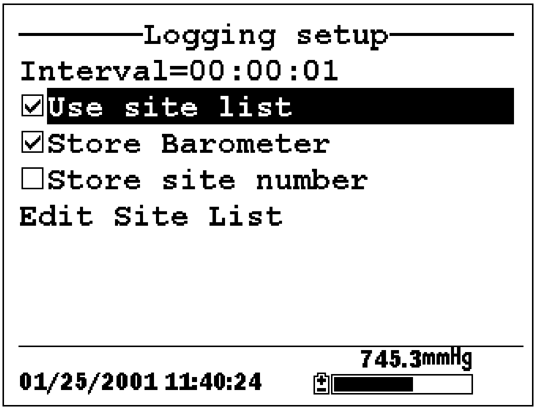
NOTE: Site lists containing Single Site Descriptions are usually input with the designation **Store Site Number** INACTIVE in the YSI 556 MPS **Logging setup** menu. Thus, no site numbers appear in the first **Site list** example. Conversely, **Site lists** containing **Multi-Site Descriptions** MUST be input with the **Store Site Number** selection ACTIVE as shown in the second example.

To create a site list:

1. Go to the logging setup screen as described in Section *9.1 Accessing the Logging Setup Screen*.

2. Use the arrow keys to highlight the **Use site list** selection.

3. Press the **Enter** key. A check mark is entered in the box next to the use site list selection *and* two new entries appear on the logging setup screen. See Figure 9.6 Logging Setup Screen.



```
———Logging setup———
Interval=00:00:01
☑Use site list
☑Store Barometer
☐Store site number
Edit Site List

                 745.3mmHg
01/25/2001 11:40:24
```

Figure 9.6 Logging Setup Screen

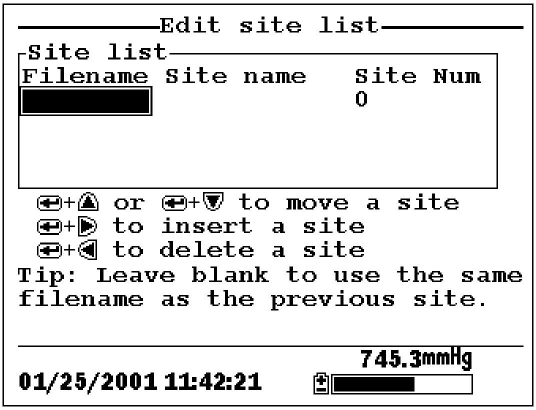
4. Use the arrow keys to highlight the **Store site number** selection.

5. If you are creating Multi-Site Descriptions (which require that the site **number** be stored in your data files), press the **Enter** key until a check mark appears in the box next to the store site number selection.

OR Press the **Enter** key until the box next to the store site number selection is empty, to create Single-Site Descriptions. The site **name** will be stored in the header of your data files.

6. Use the arrow keys to highlight the **Edit site list** selection.

7. Press the **Enter** key. The edit site list screen is displayed. See Figure 9.7 Edit Site List Screen. The **Filename** field is ready for input.



```
Edit site list
Site list
Filename Site name    Site Num
                      0

 ↵+▲ or ↵+▼ to move a site
 ↵+▶ to insert a site
 ↵+◀ to delete a site
Tip: Leave blank to use the same
filename as the previous site.

                     745.3mmHg
01/25/2001 11:42:21
```

Figure 9.7 Edit Site List Screen

8. Use the keypad to enter a filename up to 8 characters in length. Refer to Section *2.9 Keypad Use*.

9. Press the **Enter** key. The cursor moves to the right for the entry of a **Site name**.

10. Use the keypad to enter a site name up to 11 characters in length. Refer to Section *2.9 Keypad Use*.

    NOTE: If the store site number selection is *not* checked, skip to Step 13.

11. Press the **Enter** key. The cursor moves to the site number entry position.

12. Use the keypad to enter a site number up to 7 characters in length. Refer to Section *2.9 Keypad Use*.

13. Press **Enter**. The cursor moves to the next filename entry position.

14. Repeat Steps 8 to 13 until all filenames and sites have been entered.

15. Press **Escape** repeatedly to return to the main menu screen.

9.5 Editing a Site List

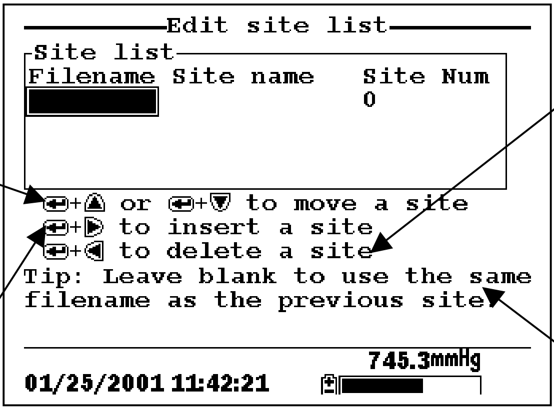
1. Go to the logging setup screen as described in Section *9.1 Accessing the Logging Setup Screen*.

2. Use the arrow keys to highlight the **Edit Site List** selection. See Figure 9.6 Logging Setup Screen.

3. Press the **Enter** key. The edit site list screen is displayed.

4. Edit the site list using the keystrokes described below.

   NOTE: Editing the site list will not have any effect on files stored in the instrument memory.



```
──────────Edit site list──────────
┌Site list──────────────────────┐
│Filename Site name    Site Num │
│████████              0        │
│                               │
└───────────────────────────────┘
 ⏎+▲ or ⏎+▼ to move a site
 ⏎+▶ to insert a site
 ⏎+◀ to delete a site
Tip: Leave blank to use the same
filename as the previous site
──────────────────────────────────
                    745.3mmHg
01/25/2001 11:42:21
```

Figure 9.8 Keystrokes for Editing Site List

<u>To MOVE a site:</u> **Use the arrow keys to highlight a site. Press the Up or Down arrow key while holding down the Enter key.**

<u>To INSERT a site above another site:</u> **Use the arrow keys to highlight the site. Press the** Right **arrow key while holding down the** Enter **key. Use keypad to input letters. Refer to Section *2.9 Keypad Use*.**

<u>To DELETE a site:</u> **Use the arrow keys to highlight a site. Press the Left arrow key while holding down the Enter key.**

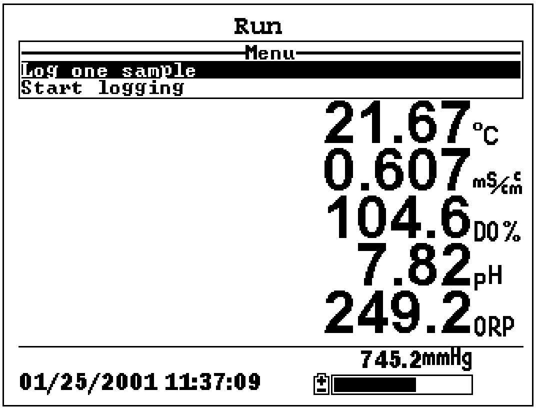
<u>To use the same file name as the previous site:</u> Leave the filename blank.

9.6 Logging Data Without a Site List

1. Follow Steps 1 through 5 in Section 7.1 Real-Time Data.

2. Use the arrow keys to highlight the **Log one sample** selection on the run screen if only a single sample is being logged.

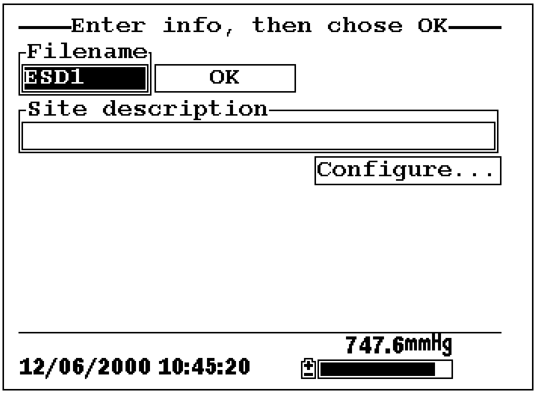
   OR Use the arrow keys to highlight the **Start logging** selection on the run screen if a data stream is being logged.



21.67°C
0.607mS/cm^c
104.6DO %
7.82pH
249.2ORP
745.2mmHg
01/25/2001 11:37:09

Figure 9.9 Run Screen

3. Press the **Enter** key. The Enter information screen is displayed.



Filename: ESD1
Site description:
747.6mmHg
12/06/2000 10:45:20

Figure 9.10 Enter Information Screen

NOTE: The last filename used will be displayed.

4. Use the keypad to enter a file name. Refer to Section *2.9 Keypad Use*.

   NOTE: The instrument will assign a default file name of NONAME if no file name is specified.

5. Press the **Enter** key to input the file name.

6. Use the arrow keys to highlight the **Site description** field in the enter information screen.

   NOTE: Entering a Site Description is optional. You may leave the Site Description blank and skip to Step 9.

7. Use the keypad to enter a site description name. Refer to Section *2.9 Keypad Use*.

8. Press the **Enter** key to input the site description.

   NOTE: If you want to change the logging setup, such as sampling interval or storing the barometer reading, use the arrow keys to highlight the **Configure** field, press the **Enter** key, then refer to Section *9.2 Setting Logging Interval* or *9.3 Storing Barometer Readings* for details.

9. Use the arrow keys to highlight the **OK** field in the center of the information screen.

10. Press the **Enter** key to start logging.

    NOTE: If the parameter mismatch screen is displayed, refer to Section *9.8 Adding Data to Existing Files*.

11. If a single point is being logged, the header on the run screen changes momentarily from **Menu** to **Sample logged** to confirm that the point was successfully logged. Skip to Step 13.

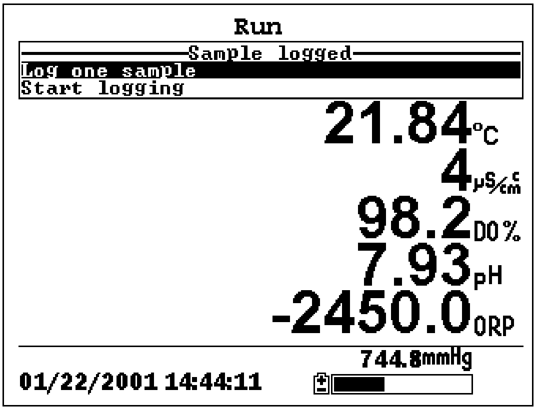

Run
Sample logged
Log one sample
Start logging
21.84°C
4µS/cm
98.2DO%
7.93pH
-2450.0ORP
744.8mmHg
01/22/2001 14:44:11

Figure 9.11 Sample Logged Screen

If a continuous stream of points is being logged, the start logging entry in the run screen changes from **Start logging** to **Stop logging**.

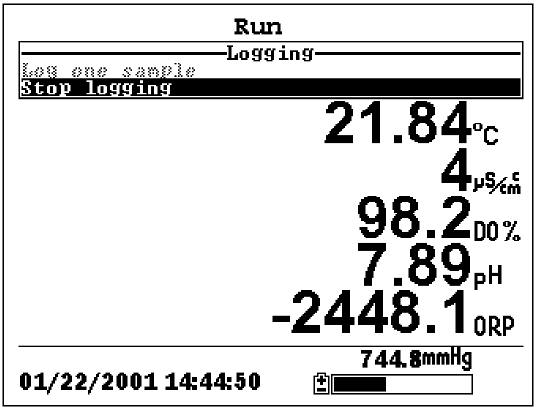

Run
Logging
Log one sample
Stop logging
21.84°C
4µS/cm
98.2DO%
7.89pH
-2448.1ORP
744.8mmHg
01/22/2001 14:44:50

Figure 9.12 Logging Screen

12. At the end of the logging interval, press **Enter** to stop logging.

13. Refer to Section *8.3 View File* to view the data on the instrument display.

9.7 Logging Data With a Site List

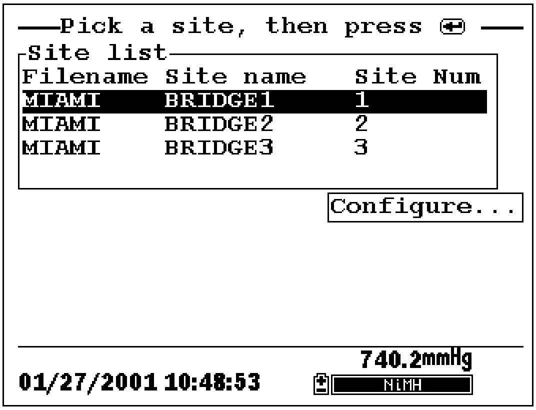
1. If you have not already created a site list, refer to Section *9.4 Creating a Site List*.

2. Follow Steps 1 through 5 in Section 7.1 Real-Time Data.

3. Use the arrow keys to highlight the **Log one sample** selection on the run screen if only a single sample is being logged.

   OR Use the arrow keys to highlight the **Start logging** selection on the run screen if a data stream is being logged. See Figure 9.9 Run Screen.

4. Press the **Enter** key. The Pick a site screen is displayed.



Pick a site, then press ⏎

Site list

Filename	Site name	Site Num
MIAMI	BRIDGE1	1
MIAMI	BRIDGE2	2
MIAMI	BRIDGE3	3

Figure 9.13 Pick a Site Screen

5. Use the arrow keys to highlight the **site** of your choice.

   NOTE: If the site of your choice is grayed out in the site list, refer to Section *9.8 Adding Data to Existing Files*.

   NOTE: Refer to Section *9.5 Editing a Site List* if you want to edit the site list.

6. Press the **Enter** key to start logging.

NOTE: If the parameter mismatch screen is displayed, refer to Section *9.8 Adding Data to Existing Files*.

7. If a single point is being logged, the header on the run screen changes momentarily from **Menu** to **Sample logged** to confirm that the point was successfully logged. See Figure 9.11 Sample Logged Screen. Skip to Step 9.

   If a continuous stream of points is being logged, the start logging entry in the run screen changes from **Start logging** to **Stop logging**. See Figure 9.12 Logging Screen.

8. At the end of the logging interval, press **Enter** to stop logging.

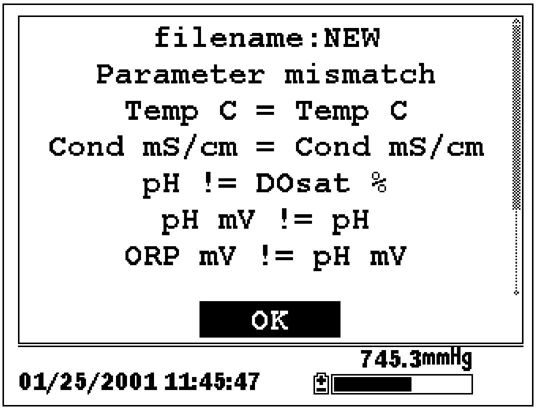
9. Refer to Section *8.3 View File* to view the data on the instrument display.

9.8 Adding Data to Existing Files

In order to add new data to an existing file, the current logging and sensor setup must be *exactly* the same as when the file was created. The following settings must be the same:

- **Sensors enabled** (refer to Section *4 Sensors*)
- **Store Barometer** (refer to Section *9.3 Storing Barometer Readings*)
- **Store Site Number** (refer to Section *9.4 Creating a Site List*)

If the current logging setup is not exactly the same as when the file was created, a parameter mismatch screen is displayed.



```
filename:NEW
Parameter mismatch
Temp C = Temp C
Cond mS/cm = Cond mS/cm
pH != DOsat %
pH mV != pH
ORP mV != pH mV
```

Figure 9.14 Parameter Mismatch Screen

NOTE: The right column shows parameters used when the file was created. The left column shows current parameters.

1. Press the **Down Arrow** key to scroll down and find the mismatch(es).

2. Use the following chart to resolve the mismatch(es).

Mismatch	**Action**	**Reference**
Sensor(s) missing from left column	Enable the missing sensor(s)	Section *4 Sensors*
Extra sensor(s) listed in left column	Disable the extra sensor(s)	Section *4 Sensors*
Barometer missing from left column, but present in right column	Enable the Store Barometer setting	Section *9.3 Storing Barometer Readings*
Barometer present in left column, but missing from right column	Disable the Store Barometer setting	Section *9.3 Storing Barometer Readings*
Store Site Number missing from left column, but present in right column	Enable the Store Site Number setting	Section *9.4 Creating a Site List*
Store Site Number present in left column, but missing from right column	Disable the Store Site Number setting	Section *9.4 Creating a Site List*

3. Return to Section *9.6 Logging Data Without a Site List* or *9.7 Logging Data With a Site List*.

10. System Setup

The YSI 556 MPS has a number of features that are user-selectable or can be configured to meet the user's preferences. Most of these choices are found in the **System setup** menu.

10.1 Accessing the System Setup Screen

1. Press the **On/off** key to display the run screen. See Figure 2.1 Front View of YSI 556 MPS.
2. Press the **Escape** key to display the main menu screen.
3. Use the arrow keys to highlight the **System setup** selection.

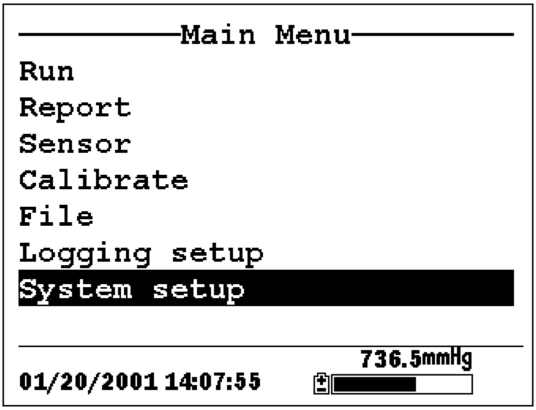
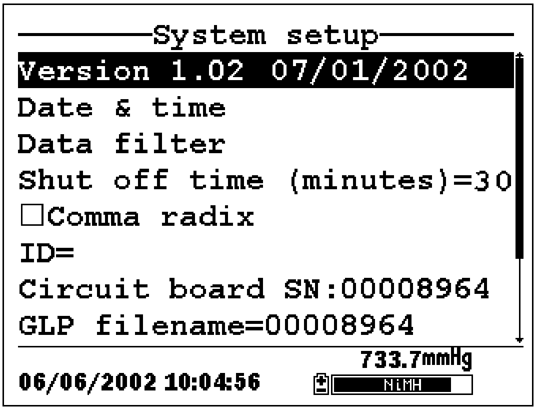


Figure 10.1 Main Menu

4. Press the **Enter** key. The system setup screen is displayed.



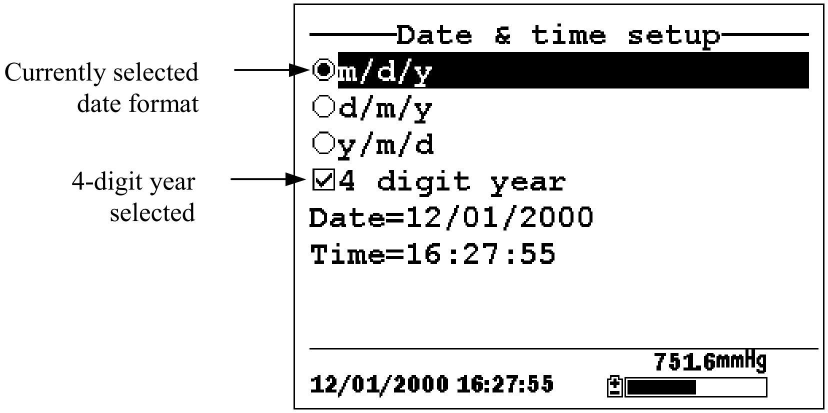
```
System setup
Version 1.02 07/01/2002
Date & time
Data filter
Shut off time (minutes)=30
☐Comma radix
ID=
Circuit board SN:00008964
GLP filename=00008964
733.7mmHg
06/06/2002 10:04:56
```

Figure 10.2 System Setup Screen

NOTE: The first line of the **System setup** menu shows the current software version of your YSI 556 MPS. As software enhancements are introduced, you will be able to upgrade your YSI 556 MPS from the YSI Web site. Refer to Section *11.2 Upgrading YSI 556 MPS* Software for details.

10.2 Date and Time Setup

1. Go to the system setup screen as described in Section *10.1 Accessing the System Setup Screen*.
2. Use the arrow keys to highlight the **Date & time** selection on the system setup screen. See Figure 10.2 System Setup Screen.
3. Press **Enter**. The date and time setup screen is displayed.



Date & time setup
●m/d/y
○d/m/y
○y/m/d
☑4 digit year
Date=12/01/2000
Time=16:27:55

751.6mmHg
12/01/2000 16:27:55

Figure 10.3 Date Setup Screen

NOTE: A black dot to the left of a date format indicates that format is selected.

4. Use the arrow keys to highlight your desired date format.
5. Press **Enter**.
6. Use the arrow keys to highlight the 4-digit year selection.
7. Press **Enter**. A check mark appears in the check box next to the 4-digit year selection.

   NOTE: If unchecked, a 2-digit year is used.

8. Use the arrow keys to highlight the **Date** selection.
9. Press **Enter**. A cursor appears over the first number in the date.
10. Enter the proper number from the keypad for the highlighted date digit. The cursor moves automatically to the next date digit. Refer to Section *2.9 Keypad Use* for more keypad information.
11. Repeat Step 10 until all date digits are correct.

12. Press **Enter** to input the specified date.

13. Use the arrow keys to highlight the **Time** selection.

14. Press **Enter**. A cursor appears over the first number in the time selection.

15. Enter the proper number from the keypad for the highlighted time digit. The cursor moves automatically to the next time digit.

    NOTE: Use military format when entering time. For example, 2:00 PM is entered as 14:00.

16. Repeat Step 15 until all time digits are correct.

17. Press **Enter** to input the correct time.

18. Press the **Escape** key repeatedly to return to the Main menu screen.

10.3 Data Filter

The Data Filter is a software filter that eliminates sensor noise and provides more stable readings.

NOTE: YSI recommends using the default values for the data filter for most field applications.

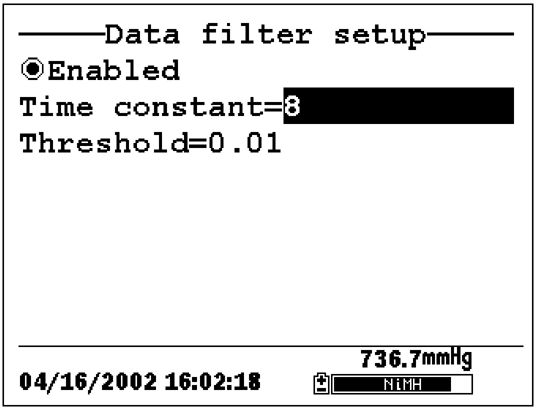
However, users who are primarily interested in a fast response from their dissolved oxygen sensor should consider a change of the default time constant setting of 8 seconds to one of 2 seconds. This change can be made according to the instructions in Section *10.3.1 Changing the Data Filter Settings* below. The disadvantage of lowering the time constant is that field pH readings may appear somewhat noisy if the cable is in motion.

10.3.1 Changing the Data Filter Settings

1. Go to the system setup screen as described in Section *10.1 Accessing the System Setup Screen*.

2. Use the arrow keys to highlight the **Data filter** selection. See Figure 10.1 Main Menu.

3. Press the **Enter** key. The Data filter setup screen is displayed.



Data filter setup

● Enabled

Time constant=8

Threshold=0.01

736.7mmHg

04/16/2002 16:02:18

Figure 10.4 Data Filter Screen

4. With Enabled highlighted, press the **Enter** key to Enable or Disable the data filter. A black dot to the left of the selection indicates the data filter is enabled.

5. Use the arrow keys to highlight the **Time constant** field.

   NOTE: This value is the time constant in seconds for the software data filter. Increasing the time constant will result in greater filtering of the data, but will also slow down the apparent response of the sensors.

6. Use the keypad to enter a value. The default value is 8 and this value is ideal for most 556 field applications. As described in Section *10.3 Data Filter* above, users who wish to decrease the response time of the DO readings at the expense of some noise for the pH readings determined concurrently, should change the Time Constant to a value of 2.

7. Press the **Enter** key to enter the time constant.

8. Use the arrow keys to highlight the **Threshold** field.

   NOTE: This value determines when the software data filter will engage/disengage, speeding the response to large changes in a reading. When the difference between two consecutive readings is larger than the threshold, then the reading is displayed unfiltered. When the difference between two consecutive readings drops below the threshold, readings will be filtered again.

9. Use the keypad to enter a value. The default value is 0.01.

10. Press the **Enter** key to enter the threshold.

11. Press the **Escape** key repeatedly to return to the Main menu screen.

10.4 Shutoff Time

The YSI 556 MPS shuts off automatically after 30 minutes of inactivity. The shut off time may be changed as described below.

1. Go to the system setup screen as described in Section *10.1 Accessing the System Setup Screen*.

2. Use the arrow keys to highlight the **Shutoff time** selection on the system setup screen. See Figure 10.2 System Setup Screen.

3. Use the keypad to enter a value from 0 to 60 minutes. The default value is 30.

   NOTE: To disable the automatic shutoff feature, enter a zero (0).

4. Press the **Enter** key to enter the correct shutoff time.

5. Press the **Escape** key repeatedly to return to the main menu screen.

10.5 Comma Radix

The user can toggle between a period (default) and comma for the radix mark by selecting this item and pressing the **Enter** key as follows:

1. Go to the system setup screen as described in Section *10.1 Accessing the System Setup Screen*.

2. Use the arrow keys to highlight the **Comma radix** selection on the system setup screen. See Figure 10.2 System Setup Screen.

3. Press the **Enter** key. A check mark appears in the check box next to the comma radix selection indicating that the radix mark is a comma.

10.6 ID

This selection allows you to enter an identification name/number for your YSI 556 MPS. This ID name/number is logged in the header of each file.

1. Go to the system setup screen as described in Section *10.1 Accessing the System Setup Screen*.

2. Use the arrow keys to highlight the **ID** selection. See Figure 10.1 Main Menu.

3. Use the keypad to enter an alphanumeric ID up to 15 characters in length. Refer to Section *2.9 Keypad Use*.

4. Press the **Enter** key to enter the ID.

5. Press the **Escape** key repeatedly to return to the main menu screen.

10.7 GLP Filename

This selection allows you to enter a different filename for the YSI 556 MPS Calibration Record file.

NOTE: The default filename is the "556 PC board Serial Number.glp."

6. Go to the system setup screen as described in Section *10.1 Accessing the System Setup Screen*.

7. Use the arrow keys to highlight the **GLP Filename** selection. See Figure 10.1 Main Menu.

8. Use the keypad to enter a filename up to 8 characters in length. Refer to Section *2.9 Keypad Use*.

9. Press the **Enter** key to enter the new filename.

Press the **Escape** key repeatedly to return to the main menu screen.

10.8 TDS Constant

This selection allows you to set the constant used to calculate Total Dissolved Solids (TDS). TDS in g/L is calculated by multiplying this constant times the specific conductance in mS/cm.

10.8.1 Changing the TDS Constant

1. Go to the system setup screen as described in Section *10.1 Accessing the System Setup Screen*.

2. Use the arrow keys to highlight the **TDS Constant** selection. See Figure 10.1 Main Menu.

3. Use the keypad to enter a value. Refer to Section *2.9 Keypad Use*. The default value is 0.65.

4. Press the **Enter** key to enter the correct TDS constant.

5. Press the **Escape** key repeatedly to return to the main menu screen.

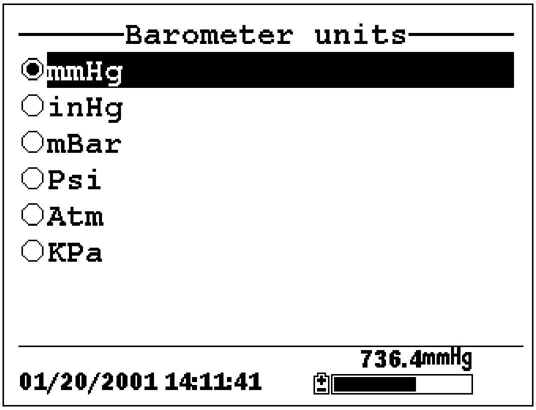
10.9 Barometer Units

The following information is only for instruments with the barometer option.

1. Go to the system setup screen as described in Section *10.1 Accessing the System Setup Screen*.

2. Use the arrow keys to highlight the **Barometer units** selection on the system setup screen. See Figure 10.2 System Setup Screen.

3. Press the **Enter** key. The Barometer units screen will appear.



Barometer units

● mmHg

○ inHg

○ mBar

○ Psi

○ Atm

○ KPa

736.4mmHg

01/20/2001 14:11:41

Figure 10.5 Barometer Units Screen

A black dot indicates the currently selected units.

4. Use the arrow keys to highlight your desired barometric unit.

5. Press the **Enter** key to select your choice. A black dot will appear in the circle next to your selected units.

6. Press the **Escape** key repeatedly to return to the main menu screen.

10.10 Calibrate Barometer

The optional barometer has been factory calibrated to provide accurate readings. However, some sensor drift may occur over time, requiring occasional calibration by the user, as follows:

1. Determine your local barometric pressure from an independent laboratory barometer or from your local weather service.

2. If the barometric pressure (BP) reading is from your local weather station, reverse the equation that corrects it to sea level.

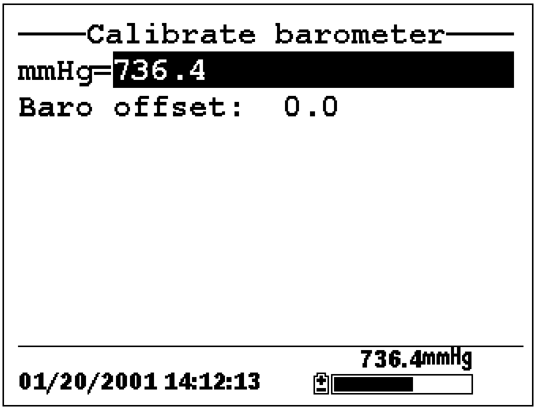
   NOTE: For this equation to be accurate, the barometric pressure units must be in mm Hg.

   True BP = (Corrected BP) – [2.5 * (Local Altitude/100)]

3. Go to the system setup screen as described in Section *10.1 Accessing the System Setup Screen*.

4. Use the arrow keys to highlight the **Calibrate barometer** selection on the system setup screen. See Figure 10.2 System Setup Screen.

5. Press the **Enter** key. The Calibrate Barometer screen is displayed.



```
———Calibrate barometer———
mmHg=736.4
Baro offset:  0.0
```

6. Use the keypad to input the known barometric pressure value as determined in Step 2.

7. Press the **Enter** key. The new barometer reading is displayed as well as the approximate offset from the factory reading.

   NOTE: To return the sensor to the factory setting, subtract the offset amount from the current setting and repeat Steps 5 to 7.

8. Press the **Escape** key repeatedly to return to the main menu screen.

11. Maintenance

11.1 Sensor Care and Maintenance

Once the sensors have been properly installed, remember that periodic cleaning and DO membrane changes are required.

11.1.1 DO Sensor

For best results, we recommend that the KCl solution and the membrane cap be changed at least once every 30 days.

1. It is important to recognize that oxygen dissolved in the sample is consumed during sensor operation. It is therefore essential that the sample be continuously stirred at the sensor tip. If stagnation occurs, your readings will be artificially low. Stirring may be accomplished by mechanically moving the sample around the sensor tip, or by rapidly moving the sensor through the sample. The rate of stirring should be at least 1 foot per second.

2. Membrane life depends on usage. Membranes will last a long time if installed properly and treated with care. Erratic readings are a result of loose, wrinkled, damaged, or fouled membranes, or from large (more than 1/8" diameter) bubbles in the electrolyte reservoir. If erratic readings or evidence of membrane damage occurs, you should replace the membrane and the electrolyte solution. The average replacement interval is two to four weeks.

3. If the membrane is coated with oxygen consuming (e.g. bacteria) or oxygen producing organisms (e.g. algae), erroneous readings may occur.

4. Chlorine, sulfur dioxide, nitric oxide, and nitrous oxide can affect readings by behaving like oxygen at the sensor. If you suspect erroneous readings, it may be necessary to determine if these gases are the cause.

5. Avoid any environment that contains substances that may attack the probe module and sensor materials. Some of these substances are concentrated acids, caustics, and strong

solvents. The sensor materials that come in contact with the sample include FEP Teflon, acrylic plastic, EPR rubber, stainless steel, epoxy, polyetherimide and the PVC cable covering.

6. It is possible for the silver anode, which is the entire silver body of the sensor, to become contaminated. This will prevent successful calibration. To restore the anode, refer to Section *11.1.1 DO Sensor, Silver Anode Cleaning.*

7. For correct sensor operation, the gold cathode must always be bright. If it is tarnished (which can result from contact with certain gases), or plated with silver (which can result from extended use with a loose or wrinkled membrane), the gold surface must be restored. To restore the cathode, refer to Section *11.1.1 DO Sensor, Gold Cathode Cleaning.*

8. To keep the electrolyte from drying out, store the sensor in the transport/calibration cup with at least 1/8″ of water.

Silver Anode Cleaning

After extended use, a thick layer of AgCl builds up on the silver anode reducing the sensitivity of the sensor. The anode must be cleaned to remove this layer and restore proper performance. The cleaning can be chemical or mechanical:

Chemical Cleaning: Remove the membrane cap and soak the entire anode section in a 14% ammonium hydroxide solution for 2 to 3 minutes, followed by a thorough rinsing with distilled or deionized water. The anode should then be thoroughly wiped with a wet paper towel to remove the residual layer from the anode.

Mechanical Cleaning: Sand off the dark layer from the silver anode with 400 grit wet/dry sandpaper. Wrap the sandpaper around the anode and twist the sensor. Rinse the anode with clean water after sanding, followed by wiping thoroughly with a wet paper towel.

NOTE: After cleaning, a new membrane cap must be installed. Refer to Section *3.4.3 Membrane Cap Installation***.**

Turn the instrument on and allow the system to stabilize for at least 30 minutes. If, after several hours, you are still unable to calibrate, contact your dealer or YSI Customer Service. Refer to *Appendix E Customer Service*.

Gold Cathode Cleaning

For correct sensor operation, the gold cathode must be textured properly. It can become tarnished or plated with silver after extended use. The gold cathode can be cleaned by using the adhesive backed sanding disc and tool provided in the YSI 5238 Probe Reconditioning Kit.

Using the sanding paper provided in the YSI 5238 Probe Reconditioning Kit, wet sand the gold with a twisting motion about 3 times or until all silver deposits are removed and the gold appears to have a matte finish. Rinse the cathode with clean water after sanding, followed by wiping thoroughly with a wet paper towel. If the cathode remains tarnished, contact your dealer or YSI Customer Service. Refer to *Appendix E Customer Service*.

NOTE: After cleaning, a new membrane cap must be installed. Refer to Section *3.4.3 Membrane Cap Installation***.**

11.1.2 DO Sensor Replacement

1. Remove the probe sensor guard.

⚠ **CAUTION:** Thoroughly dry the sensor so that no water enters the probe module sensor port when the sensor is removed.

2. Insert the long end of the hex key wrench into the small hole in the side of the probe module bulkhead. Turn the wrench counterclockwise and remove the screw. (You do not have to remove the screw all the way to release the sensor.)

3. Pull the old DO sensor module straight out of the probe module body.

   NOTE: The DO sensor is not threaded, it is keyed, so it cannot be removed by twisting.

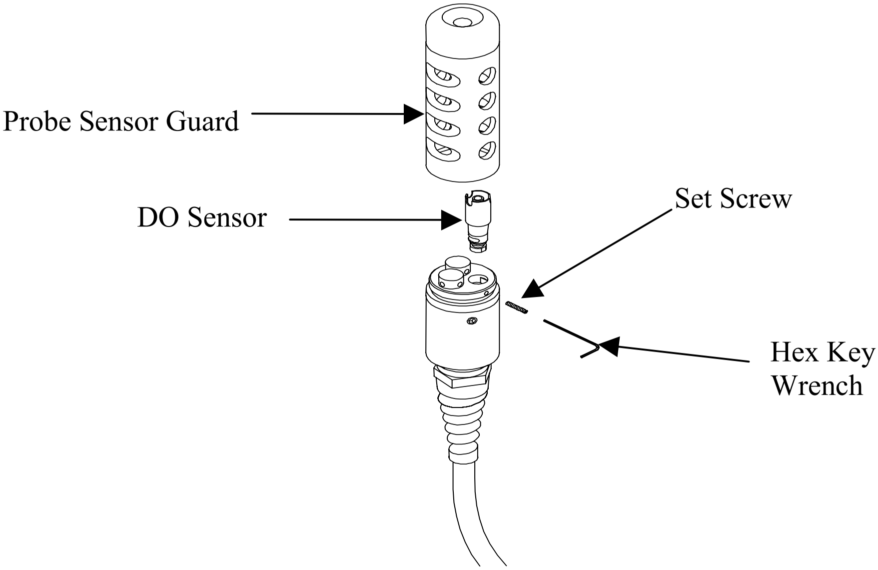


Figure 11.1 DO Sensor Replacement

4. Insert the new DO sensor module. Make sure that the inside of the probe module sensor port and the o-ring on the sensor are clean, with no contaminants, such as grease, dirt, or hair. The DO sensor is keyed, or has a flat side, so that it cannot be aligned improperly.

   NOTE: Make sure the DO sensor bottoms out before the set screw is inserted.

5. Insert the set screw into the small hole in the side of the probe module bulkhead, and turn clockwise to rethread.

⚠ **CAUTION:** Make sure that you do not cross-thread the set screw. Use the hex key wrench to tighten the screw in properly, making sure that the screw does not stick out of the side of the probe module bulkhead. The probe sensor guard will not thread on properly and damage may result if the screw is allowed to stick out.

NOTE: The YSI 5563 DO sensor is shipped dry. A shipping membrane was installed to protect the electrode. A new membrane cap must be installed before the first use. Refer to Section *3.4.1 Sensor Installation.*

11.1.3 YSI 5564 pH and 5565 Combination pH/ORP Sensor Cleaning

Cleaning is required whenever deposits or contaminants appear on the glass and/or platinum surfaces of these sensors or when the response of the sensor becomes slow.

1. Remove the sensor from the probe module.

2. Initially, simply use clean water and a soft clean cloth, lens cleaning tissue, or cotton swab to remove all foreign material from the glass bulb (YSI 5564 and YSI 5565) and platinum button (YSI 5565). Then use a moistened cotton swab to carefully remove any material that may be blocking the reference electrode junction of the sensor.

⚠ **CAUTION:** When using a cotton swab with the YSI 5564 or YSI 5565, be careful NOT to wedge the swab tip between the guard and the glass sensor. If necessary, remove cotton from the swab tip, so that the cotton can reach all parts of the sensor tip without stress.

NOTE: If good pH and/or ORP response is not restored by the above procedure, perform the following additional procedure:

1. Soak the sensor for 10-15 minutes in clean water containing a few drops of commercial dishwashing liquid.

2. GENTLY clean the glass bulb and platinum button by rubbing with a cotton swab soaked in the cleaning solution.

3. Rinse the sensor in clean water, wipe with a cotton swab saturated with clean water, and then re-rinse with clean water.

NOTE: If good pH and/or ORP response is still not restored by the above procedure, perform the following additional procedure:

1. Soak the sensor for 30-60 minutes in one molar (1 M) hydrochloric acid (HCl). This reagent can be purchased from most distributors. Be sure to follow the safety instructions included with the acid.

2. GENTLY clean the glass bulb and platinum button by rubbing with a cotton swab soaked in the acid.

3. Rinse the sensor in clean water, wipe with a cotton swab saturated with clean water, and then re-rinse with clean water. To be certain that all traces of the acid are removed from the sensor crevices, soak the sensor in clean water for about an hour with occasional stirring.

NOTE: If biological contamination of the reference junction is suspected or if good response is not restored by the above procedures, perform the following additional cleaning step:

1. Soak the sensor for approximately 1 hour in a 1 to 1 dilution of commercially available chlorine bleach.

2. Rinse the sensor with clean water and then soak for at least 1 hour in clean water with occasional stirring to remove residual bleach from the junction. (If possible, soak the sensor for period of time longer than 1 hour in order to be certain that all traces of chlorine bleach are removed.) Then re-rinse the sensor with clean water and retest.`

11.1.4 Temperature/Conductivity Sensor Cleaning

The single most important requirement for accurate and reproducible results in conductivity measurement is a clean cell. A dirty cell will change the conductivity of a solution by contaminating it. The small cleaning brush included in the YSI 5511 Maintenance Kit is ideal for this purpose.

To clean the conductivity cell:

1. Dip the brush in clean water and insert it into each hole 15-20 times.

2. Rinse the cell thoroughly in deionized or clean tap water.

NOTE: In the event that deposits have formed on the electrodes, perform the following additional procedure:

1. Use a mild detergent solution in combination with the brush. Dip the brush in the solution and insert it into each hole 15-20 times.

2. Rinse the cell thoroughly in deionized or clean tap water.

   NOTE: After cleaning, check the response and accuracy of the conductivity cell with a calibration standard.

   NOTE: If this procedure is unsuccessful, or if sensor performance is impaired, it may be necessary to return the sensor to a YSI authorized service center for service, Refer to *Appendix E Customer Service*.

   The temperature portion of the sensor requires no maintenance.

11.2 Upgrading YSI 556 MPS Software

1. Access the YSI Environmental Software Downloads page as described in *Appendix G EcoWatch* Step 1 through 3.

2. Click on the **YSI Instruments Software Updates** link (or scroll down until you see YSI 556 MPS).

3. Click on the file icon to the right of the **YSI 556 MPS** listing and save the file to a temporary directory on your computer.

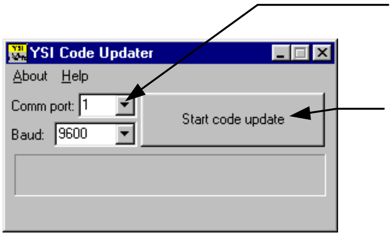
4. After the download is complete, run the file (that you just downloaded) and follow the on screen instructions to install the YSI Code Updater on your computer. If you encounter difficulties, contact YSI customer service for advice. Refer to *Appendix E Customer Service*.

5. If necessary, disconnect the YSI 5563 Probe Module from the YSI 556 MPS instrument.

6. Connect the YSI 556 MPS to a serial port of your computer via the 655173 PC interface cable. See Figure 8.6 Computer/Instrument Interface.

7. Press the **On/off** key on the YSI 556 MPS to display the run screen.

8. Run the YSI Code Updater software that you just installed on your computer. The following window will be displayed:



Comm port: 1

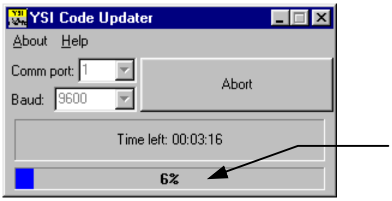
Baud: 9600

Select Comm port

Click on Start code update

9. Set the Comm port number to match the port that you connected the 655173 PC Interface Cable to, then click on the **Start Code Update button**.

The YSI 556 MPS screen will blank out and a progress indicator will be displayed on the PC.



Comm port: 1

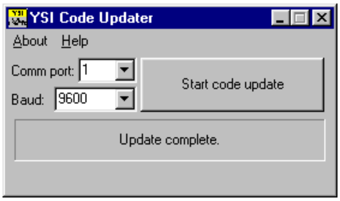
Baud: 9600

Time left: 00:03:16

6%

Progress Indicator

When the update is finished (indicated on the PC screen), the YSI 556 MPS will return to the Run screen. See Figure 7.1 Run Screen.



Comm port: 1

Baud: 9600

Update complete.

10. Close the YSI Code Updater window (on the PC) by clicking on the "X" in the upper right corner of the window.

11. Disconnect the YSI 556 MPS from the 655173 PC interface cable and reconnect it to the YSI 5563 Probe Module. Refer to Section *3.6 Instrument/Cable Connection*.

12. Storage

Proper storage between periods of usage will not only extend the life of the sensors, but will also ensure that the unit will be ready to use as quickly as possible in your next application.

12.1 General Recommendations for Short Term Storage

No matter what sensors are installed in the instrument, it is important to keep them moist without actually immersing them in liquid. Immersing them could cause some of them to drift or result in a shorter lifetime.

YSI recommends that short term storage of all multi-parameter instruments be done by placing approximately 1/2 inch of tap water in the transport/calibration cup that was supplied with the instrument, and by placing the probe module with all of the sensors installed into the cup. The use of a moist sponge instead of a 1/2 inch of tap water is also acceptable, as long as its presence does not compromise the attachment of the cup to the probe module. The transport/calibration cup should be sealed to prevent evaporation.

NOTE: Ensure that an o-ring is installed in the o-ring groove on the threaded end of the probe module body. See Figure 3.7 Transport/Calibration Cup Installation.

⚠ **CAUTION:** The water level has to be low enough so that none of the sensors are actually under water. Check the transport/calibration cup periodically to make certain that the water is still present or the sponge is still moist.

NOTE: If the storage water (tap water) is accidentally lost during field use, environmental water can be used.

12.2 General Recommendations for Long Term Storage

12.2.1 Probe Module Storage

1. Remove the pH or pH/ORP sensor from the probe module and store according to the individual sensor storage instructions found in Section *12.2.2 Sensor Storage*.

2. Seal the empty port with the provided port plug.

NOTE: Leave the conductivity/temperature sensor and dissolved oxygen sensor, with membrane cap still on, in the probe module.

3. Place 1/2″ of water, deionized, distilled or tap, in the transport/calibration cup.

⚠ **CAUTION:** The water level has to be low enough so that none of the sensors are actually under water. Check the transport/calibration cup periodically to make certain that the water is still present or the sponge is still moist.

4. Insert the probe module into the cup.

NOTE: Ensure that an o-ring is installed in the o-ring groove on the threaded end of the probe module body. See Figure 3.7 Transport/Calibration Cup Installation.

12.2.2 Sensor Storage

Temperature/Conductivity Sensor

No special precautions are required. Sensor can be stored dry or wet, as long as solutions in contact with the thermistor and conductivity electrodes are not corrosive (for example, chlorine bleach). However, it is recommended that the sensor be cleaned with the provided brush prior to long term storage. Refer to Section *11.1.4 Temperature/Conductivity Sensor Cleaning.*

pH and Combination pH/ORP Sensor

The key to sensor storage is to make certain that the reference electrode junction does not dry out. Junctions which have been allowed to dry out due to improper storage procedures can usually be rehydrated by soaking the sensor for several hours (overnight is recommended) in a solution which is 2 molar in potassium chloride. If potassium chloride solution is not available, soaking the sensor in tap water or commercial pH buffers may restore sensor function. However in some cases the sensor may have been irreparably damaged by the dehydration and will require replacement.

⚠ **CAUTION:** Do not store the sensor in distilled or deionized water as the glass sensor may be damaged by exposure to this medium.

1. Remove the pH or pH/ORP sensor from the probe module.

2. Seal the empty port with the provided port plug.

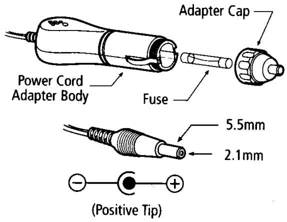
3. Place the sensor in the storage vessel (plastic boot or bottle) which was on the sensor at delivery. The vessel should contain a solution which is 2 molar in potassium chloride.

   NOTE: Make certain that the vessel is sealed to prevent evaporation of the storage solution.

13. Troubleshooting

The following sections describe problems you may encounter when using the YSI 556 MPS and provides suggestions to overcome the symptom.

PROBLEM	POSSIBLE SOLUTION
Display Problems	
No display is visible after pressing the on/off key.	If C cells are used, make certain that they are installed properly with regard to polarity and that good batteries are used. If a rechargeable battery pack is used, place the pack in the instrument and charge for 30 minutes.
Instrument software appears to be locked up as evidenced by no response to keypad entries or display not changing.	First, attempt to reset the instrument by simply turning off and then on again. If this fails, remove battery power from the instrument for 30 seconds and then reapply power. When using C cells, remove the battery lid and one of the batteries; when using the rechargeable battery pack, remove the pack completely from the instrument. After 30 seconds replace the battery or battery pack and check for instrument function.
The 556 display flashes and the instrument speaker makes a continuous clicking sound.	The battery voltage is low. Change to new C cells or recharge the 6117 battery pack.
Water Damage to Instrument	
Leakage detected in battery compartment when using C cells	Dispose of batteries properly. Dry the battery compartment using compressed air if possible. If corrosion is present on battery terminals, contact YSI Customer Service.
Water has contacted rechargeable battery pack	Remove battery pack immediately. Send battery pack to YSI Product Service for evaluation. **CAUTION**: DO NOT REUSE BATTERY PACK UNTIL YSI PRODUCT SERVICE HAS EVALUATED IT.
Leakage suspected into the main cavity of the instrument case	Remove the batteries immediately. Return the instrument to YSI Product Service.

PROBLEM	POSSIBLE SOLUTION
Optional Cigarette Lighter Charger	
Power cord fuse blown 	1. Unscrew adapter's cap, remove tip and pull out fuse. 2. Replace fuse with a new 2-amp fast-blow fuse from an electronics store such as Radio Shack. 3. Reassemble the adapter and securely screw the cap back onto the adapter body.
File Problems	
Upload of files from YSI 556 MPS to PC fails	1. Make sure that cable is connected properly to both 556 and PC. 2. Make certain that the proper Comm port is selected in EcoWatch for Windows.
Barometer data is not stored with sensor data file.	Make sure **Store barometer** is active in the 556 **Logging setup** menu.
Site Descriptions in the **Site List** are "grayed-out" and not available for appending files with additional data.	There is a parameter mismatch between the current 556 setup and that initially used. Change the current logging and sensor setup to match the setup that was initially used to create the file.
Sensor Problems	
Dissolved Oxygen reading unstable or inaccurate. Out of Range message appears during calibration.	Sensor not properly calibrated. Follow DO cal procedures.
	Membrane not properly installed or may be punctured. Replace membrane cap.
	DO sensor electrodes require cleaning. Follow DO cleaning procedure. Use 5511 Maintenance kit.
	Water in sensor connector. Dry connector; reinstall sensor.
	Algae or other contaminant clinging to DO sensor. Rinse DO sensor with clean water.
	Barometric pressure entry is incorrect. Repeat DO cal procedure.
	Calibrated at extreme temperature. Recalibrate at (or near) sample temperature.
	DO sensor has been damaged. Replace sensor.
	Internal failure. Return probe module for service.

PROBLEM	POSSIBLE SOLUTION
Sensor Problems	
pH or ORP readings are unstable or inaccurate. Out of Range message appears during calibration.	Sensor requires cleaning. Follow sensor cleaning procedure.
	Sensor requires calibration. Follow cal procedures.
	pH sensor reference junction has dried out from improper storage. Soak sensor in tap water or buffer until readings become stable.
	Water in sensor connector. Dry connector; reinstall sensor.
	Sensor has been damaged. Replace sensor.
	Calibration solutions out of spec or contaminated with other solution. Use new calibration solutions.
	ORP fails Zobell check. Take into account temperature dependence of Zobell solution readings.
	Internal failure. Return probe module for service.
Conductivity unstable or inaccurate. Out of Range message appears during calibration.	Conductivity improperly calibrated. Follow calibration procedure.
	Conductivity sensor requires cleaning. Follow cleaning procedure.
	Conductivity sensor damaged. Replace sensor.
	Calibration solution out of spec or contaminated. Use new calibration solution.
	Internal failure. Return probe module for service.
	Calibration solution or sample does not cover entire sensor. Immerse sensor fully.
Temperature, unstable or inaccurate	Water in connector. Dry connector; reinstall sensor.
	Sensor has been damaged. Replace the 5560 sensor.
Installed sensor has no reading	The sensor has been disabled. Enable sensor.
	Water in sensor connector. Dry connector; reinstall sensor.
	Sensor has been damaged. Replace the sensor.
	Report output improperly set up. Set up report output.
	Internal failure. Return probe module for service.

If these guidelines and tips fail to correct your problem or if any other symptoms occur, contact YSI Customer Service for Advice. Refer to *Appendix E Customer Service*.

14. Appendix A YSI 556 MPS Specifications

14.1 Sensor Specifications

Dissolved Oxygen	
Sensor Type	Steady state polarographic
Range: *% air sat'n*	▪ 0 to 500% air saturation
mg/L	▪ 0 to 50 mg/L
Accuracy: *% air sat'n*	▪ 0 to 200% air saturation: ±2% of the reading or 2% air saturation; whichever is greater ▪ 200 to 500% air saturation: ±6% of the reading
mg/L	▪ 0 to 20 mg/L: ±2% of the reading or 0.2 mg/L; whichever is greater ▪ 20 to 50 mg/L: ±6% of the reading
Resolution: *% air sat'n*	▪ 0.1% air saturation
mg/L	▪ 0.01 mg/L
Temperature	
Sensor Type:	YSI Precision™ thermistor
Range:	-5 to 45°C
Accuracy:	±0.15°C
Resolution:	0.01°C
Conductivity	
Sensor Type:	4-electrode cell with auto-ranging
Range:	0 to 200 mS/cm
Accuracy:	±0.5% of reading or ±0.001 mS/cm; whichever is greater–4 meter cable ±1.0% of reading or ±0.001 mS/cm; whichever is greater–20 meter cable
Resolution:	0.001 mS/cm to 0.1 mS/cm (range-dependent)
Salinity	
Sensor Type:	Calculated from conductivity and temperature
Range:	0 to 70 ppt
Accuracy:	±1.0% of reading or 0.1 ppt; whichever is greater
Resolution:	0.01 ppt

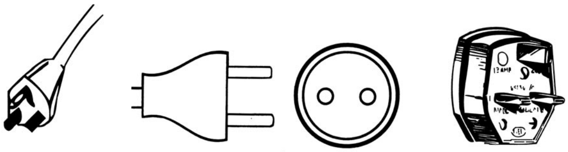
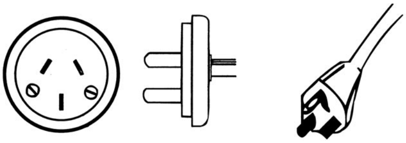
pH (optional)	
Sensor Type:	Glass combination electrode
Range:	0 to 14 units
Accuracy:	±0.2 units
Resolution:	0.01 units
ORP (optional)	
ORP Sensor Type:	Platinum button
Range:	-999 to +999 mV
Accuracy:	±20 mV
Resolution:	0.1 mV

Barometer (optional)	
Range:	500 to 800 mm Hg
Accuracy:	±3 mm Hg within ±15°C temperature range from calibration point
Resolution:	0.1 mm Hg

14.2 Instrument Specifications

Memory Size:	1.5 MB Flash Memory 49,000 data sets (@ 6 parameters per set plus time stamp) 100 Sites
Size:	11.9 cm width x 22.9 cm length (4.7 in. x 9 in.)
Weight with batteries:	0.92 kg (2.1 lbs)
Power:	4 alkaline C-cells; optional rechargeable pack
Cables:	4, 10, and 20 m (13.1, 32.8, 65.6 ft.) lengths
Warranty:	3-Years for the instrument; 1-Year for the probe modules and cable

15. Appendix B Instrument Accessories

ITEM #	ACCESSORY
5563-4	4m Cable with DO/temp/conductivity
5563-10	10m Cable with DO/temp/conductivity
5563-20	20m Cable with DO/temp/conductivity
5564	pH Kit
5565	pH/ORP Kit
6118	Rechargeable Battery Pack Kit for use in US
5094	Rechargeable Battery Pack Kit with universal charger and three adapter cables for use in international applications 
5095	Rechargeable Battery Pack Kit with universal charger and two adapter cables for use in international applications 
5083	Flow Cell – probe module is secured in the flow cell and groundwater is pumped through it
616	Charger, Cigarette Lighter – used to power up the instrument from a car's cigarette lighter
4654	Tripod
614	Ultra Clamp, C Clamp –used to clamp the instrument to a table top or car dashboard
6081	Large Carrying Case, Hard-sided
5085	Hands-free Harness
5065	Carrying Case, Form-fitted, for use in the field – has a clear vinyl window, shoulder strap, belt loop strap and hand strap

16. Appendix C Required Federal Communications Notice

The Federal Communications Commission defines this product as a computing device and requires the following notice.

This equipment generates and uses radio frequency energy and if not installed and used properly, may cause interference to radio and television reception. It has been type tested and found to comply with the limits for a Class A or Class B computing device in accordance with the specification in Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient the receiving antenna
- Relocate the computer with respect to the receiver
- Move the computer away from the receiver
- Plug the computer into a different outlet so that the computer and receiver are on different branch circuits.

If necessary, the user should consult the dealer or an experienced radio/television technician for additional suggestions. The user may find the following booklet, prepared by the Federal Communications Commission, helpful: "How to Identify and Resolve Radio-TV Interference Problems". This booklet is available from the U.S. Government Printing Office, Washington, D.C. 20402, Stock No.0004-000-00345-4.

17. Appendix D Health and Safety

YSI Conductivity solutions: 3161, 3163, 3165, 3167, 3168, 3169

INGREDIENTS:

- ☐ Iodine
- ☐ Potassium Chloride
- ☐ Water

WARNING: INHALATION MAY BE FATAL.

⚠ ***CAUTION*: AVOID INHALATION, SKIN CONTACT, EYE CONTACT OR INGESTION. MAY EVOLVE TOXIC FUMES IN FIRE.**

Harmful if ingested or inhaled. Skin or eye contact may cause irritation. Has a corrosive effect on the gastro-intestinal tract, causing abdominal pain, vomiting, and diarrhea. Hyper-sensitivity may cause conjunctivitis, bronchitis, skin rashes etc. Evidence of reproductive effects.

FIRST AID:
INHALATION: Remove victim from exposure area. Keep victim warm and at rest. In severe cases seek medical attention.
SKIN CONTACT: Remove contaminated clothing immediately. Wash affected area thoroughly with large amounts of water. In severe cases seek medical attention.
EYE CONTACT: Wash eyes immediately with large amounts of water, (approx. 10 minutes). Seek medical attention immediately.
INGESTION: Wash out mouth thoroughly with large amounts of water and give plenty of water to drink. Seek medical attention immediately.

YSI pH 4.00, 7.00, and 10.00 Buffer Solutions: 3821, 3822, 3823

pH 4 INGREDIENTS:

☐ Potassium Hydrogen Phthalate
☐ Formaldehyde
☐ Water

pH 7 INGREDIENTS:

☐ Sodium Phosphate, Dibasic
☐ Potassium Phosphate, Monobasic
☐ Water

pH 10 INGREDIENTS:

☐ Potassium Borate, Tetra
☐ Potassium Carbonate
☐ Potassium Hydroxide
☐ Sodium (di) Ethylenediamine Tetraacetate
☐ Water

⚠ ***CAUTION*** **- AVOID INHALATION, SKIN CONTACT, EYE CONTACT OR INGESTION. MAY AFFECT MUCOUS MEMBRANES.**

Inhalation may cause severe irritation and be harmful. Skin contact may cause irritation; prolonged or repeated exposure may cause Dermatitis. Eye contact may cause irritation or conjunctivitis. Ingestion may cause nausea, vomiting and diarrhea.

FIRST AID:

INHALATION - Remove victim from exposure area to fresh air immediately. If breathing has stopped, give artificial respiration. Keep victim warm and at rest. Seek medical attention immediately.

SKIN CONTACT - Remove contaminated clothing immediately. Wash affected area with soap or mild detergent and large amounts of water (approx. 15-20 minutes). Seek medical attention immediately.

EYE CONTACT - Wash eyes immediately with large amounts of water (approx. 15-20 minutes), occasionally lifting upper and lower lids. Seek medical attention immediately.

INGESTION - If victim is conscious, immediately give 2 to 4 glasses of water and induce vomiting by touching finger to back of throat. Seek medical attention immediately.

YSI Zobell Solution: 3682

INGREDIENTS:

- ☐ Potassium Chloride
- ☐ Potassium Ferrocyanide Trihydrate
- ☐ Potassium Ferricyanide

⚠ ***CAUTION* - AVOID INHALATION, SKIN CONTACT, EYE CONTACT OR INGESTION. MAY AFFECT MUCOUS MEMBRANES.**

May be harmful by inhalation, ingestion, or skin absorption. Causes eye and skin irritation. Material is irritating to mucous membranes and upper respiratory tract. The chemical, physical, and toxicological properties have not been thoroughly investigated.

Ingestion of large quantities can cause weakness, gastrointestinal irritation and circulatory disturbances.

FIRST AID:

INHALATION - Remove victim from exposure area to fresh air immediately. If breathing has stopped, give artificial respiration. Keep victim warm and at rest. Seek medical attention immediately.

SKIN CONTACT - Remove contaminated clothing immediately. Wash affected area with soap or mild detergent and large amounts of water (approx. 15-20 minutes). Seek medical attention immediately.

EYE CONTACT - Wash eyes immediately with large amounts of water (approx. 15-20 minutes), occasionally lifting upper and lower lids. Seek medical attention immediately.

INGESTION - If victim is conscious, immediately give 2 to 4 glasses of water and induce vomiting by touching finger to back of throat. Seek medical attention immediately.

18. Appendix E Customer Service

For information on Authorized Service Centers, refer to *Authorized Service Centers* in this appendix.

Equipment exposed to biological, radioactive, or toxic materials must be cleaned and disinfected before being returned or presented for service. A cleaning certificate must accompany the equipment. Refer to *18.2 Cleaning Instructions* in this appendix.

18.1 YSI Environmental Authorized Service Centers

For information on the nearest authorized service center, please contact:

YSI Technical Support • 1725 Brannum Lane
Yellow Springs, Ohio • 45387 • Phone: +1 (937) 767-7241
Phone: 800-897-4151 (US) • Email: environmental@ysi.com

or visit our website for the most current information:

www.ysi.com

18.2 Cleaning Instructions

Equipment exposed to biological, radioactive, or toxic materials must be cleaned and disinfected before being serviced. Biological contamination is presumed for any instrument, probe, or other device that has been used with body fluids or tissues, or with wastewater. Radioactive contamination is presumed for any instrument, probe or other device that has been used near any radioactive source.

If an instrument, probe, or other part is returned or presented for service without a Cleaning Certificate, and if in our opinion it represents a potential biological or radioactive hazard, our service personnel reserve the right to withhold service until appropriate cleaning, decontamination, and certification has been completed. We will contact the sender for instructions as to the disposition of the equipment. Disposition costs will be the responsibility of the sender.

When service is required, either at the user's facility or at a YSI Service Center, the following steps must be taken to ensure the safety of service personnel.

- In a manner appropriate to each device, decontaminate all exposed surfaces, including any containers. 70% isopropyl alcohol or a solution of 1/4-cup bleach to 1-gallon tap water is suitable for most disinfecting. Instruments used with wastewater may be disinfected with .5% Lysol if this is more convenient to the user.
- The user shall take normal precautions to prevent radioactive contamination and must use appropriate decontamination procedures should exposure occur.
- If exposure has occurred, the customer must certify that decontamination has been accomplished and that no radioactivity is detectable by survey equipment.
- Any product being returned to the YSI Repair Center should be packed securely to prevent damage.
- Cleaning must be completed and certified on any product before returning it to YSI.

18.3 Packing Procedure

- Clean and decontaminate items to ensure the safety of the handler.
- Complete and include the Cleaning Certificate.
- Place the product in a plastic bag to keep out dirt and packing material.
- Use a large carton, preferably the original, and surround the product completely with packing material.
- Insure for the replacement value of the product.

18.4 Cleaning Certificate

Organization ____

Department ____

Address ____

City _________________ State __ Zip _________________

Country _____________________ Phone _______________

Model No. of Device __ Lot Number ________________

Contaminant (if known) ______________________________

Cleaning Agent(s) used ______________________________

Radioactive Decontamination Certified?

(Answer only if there has been radioactive exposure)

_______ Yes _______ No

Cleaning Certified By ________________________________

Name Date

18.5 Warranty

The instrument is warranted for three years against defects in workmanship and materials when used for its intended purposes and maintained according to instructions. The probe module and cables are warranted for one year. The dissolved oxygen, temperature/conductivity, pH, and pH/ORP combination sensors are warranted for one year. Damage due to accidents, misuse, tampering, or failure to perform prescribed maintenance is not covered. The warranty period for chemicals and reagents is determined by the expiration date printed on their labels. Within the warranty period, YSI will repair or replace, at its sole discretion, free of charge, any product that YSI determines to be covered by this warranty.

To exercise this warranty, write or call your local YSI representative, or contact YSI Customer Service in Yellow Springs, Ohio. Send the product and proof of purchase, transportation prepaid, to the Authorized Service Center selected by YSI. Repair or replacement will be made and the product returned transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period, or at least 90 days from date of repair or replacement.

Limitation of Warranty

This Warranty does not apply to any YSI product damage or failure caused by (i) failure to install, operate or use the product in accordance with YSI’s written instructions, (ii) abuse or misuse of the product, (iii) failure to maintain the product in accordance with YSI’s written instructions or standard industry procedure, (iv) any improper repairs to the product, (v) use by you of defective or improper components or parts in servicing or repairing the product, or (vi) modification of the product in any way not expressly authorized by YSI.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. YSI'S LIABILITY UNDER THIS WARRANTY IS LIMITED TO REPAIR OR REPLACEMENT OF THE PRODUCT, AND THIS SHALL BE YOUR SOLE AND EXCLUSIVE REMEDY FOR ANY DEFECTIVE PRODUCT COVERED BY THIS WARRANTY. IN NO EVENT SHALL YSI BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING FROM ANY DEFECTIVE PRODUCT COVERED BY THIS WARRANTY.

19. Appendix F Ferrite Bead Installation

⚠ **WARNING:** If you are using your YSI 556 in a European Community (CE) country or in Australia or New Zealand, you must attach a ferrite bead to the 655173 PC Interface Cable and the YSI 6117 Charger Adapter Cable in order to comply with the Residential, Commercial and Light Industrial Class B Limits for radio-frequency emissions specified in EN55011 (CISPR11) for Industrial, Scientific and Medical laboratory equipment. These ferrite assemblies are supplied as part of cable kits.

1. Make a small loop (approximately 5 cm in diameter) in the cable near the YSI 556 MS-19 connector.
2. Lay the open ferrite bead assembly under the loop with the cable cross-over position within the cylinder of the ferrite bead.

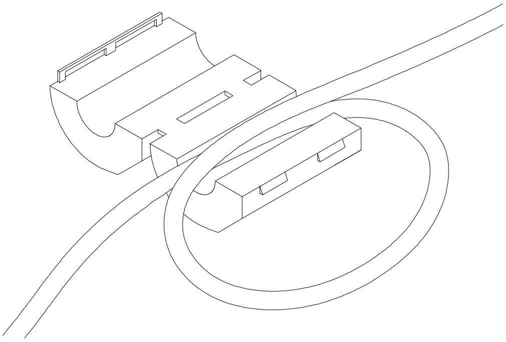


Figure 19.1 Ferrite Bead Installation

3. Snap the two pieces of the bead together making certain that the tabs lock securely.
4. When the installation is complete, the 655173 and YSI 6117 cables should resemble the following drawings.

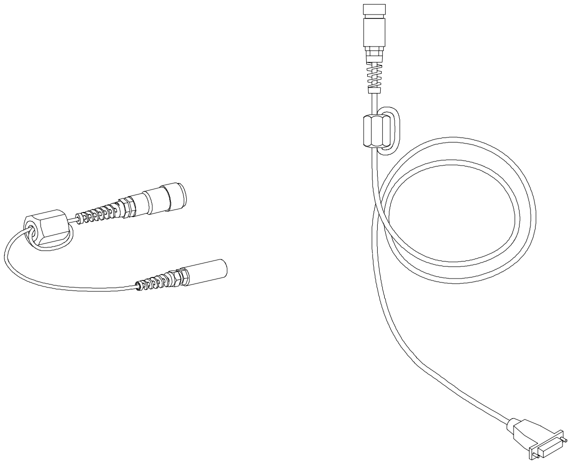


Figure 19.2 Cables with Ferrite Beads

20. Appendix G EcoWatch

EcoWatch™ for Windows™ must be used as the PC software interface to the YSI 556 MPS. EcoWatch is a powerful tool that can also be used with YSI 6-series sondes. Many features of the software will only be utilized by advanced users or are not relevant to the 556 MPS at all. This section is designed in tutorial format to familiarize you with the commonly used features of EcoWatch so that it will be possible to:

- Upload data from a 556 MPS to a PC
- Assemble plots and reports of your data
- Zoom in on certain segments of the plots of your data to facilitate analysis
- Show statistical data for your studies
- Export data in spreadsheet-compatible formats
- Print plots and reports

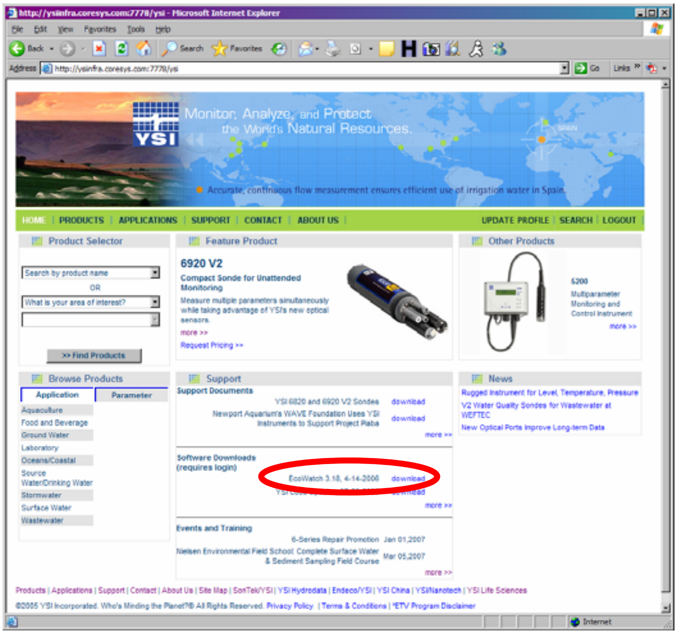
The advanced features of EcoWatch can be explored by downloading a 6-series manual from the YSI Web Site (www.ysi.com), purchasing a hard copy of the manual through YSI Customer Service (Item # 069300), or utilizing the on-line help feature of the software.

20.1 Installing EcoWatch for Windows

EcoWatch for Windows is available at no cost via a download from the YSI Web Site.

1. Access the YSI Web Site at www.ysi.com.

2. Click on the **Login** link and login (or register if you have not previously registered).



3. Click on the EcoWatch link and save the file to a directory on your computer.

4. After the download is complete, run the EcoWatch file (that you just downloaded) and follow the on screen instructions to install the software on your computer.

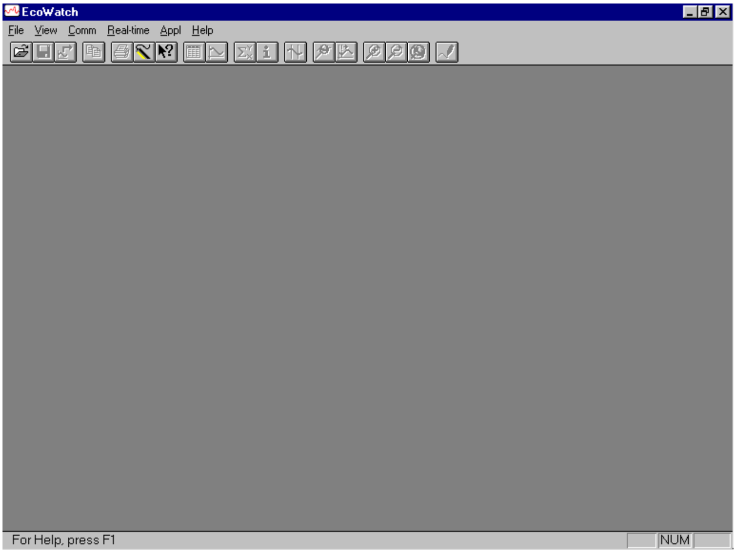
If you encounter difficulties in the download procedure, contact YSI Customer Service. Refer to ***Appendix E Customer Service***. Alternatively, you may purchase the software on CD ROM (Item #006075) by contacting YSI Customer Service.

20.2 EcoWatch Tutorial

This EcoWatch tutorial is designed to teach you the commonly used operations associated with the software when used with your 556 MPS.

After you have uploaded a file, Refer to Section 8.4 Upload to PC, you will see two files in the C:\ECOWWIN\DATA directory; the file you transferred and a file supplied by YSI designated SAMPLE.DAT. This SAMPLE.DAT file is referred to in the remainder of this tutorial section. After following the instructions below for the analysis of SAMPLE.DAT, you apply the same analysis to the data file which was uploaded from your 556 MPS to assure that you are familiar with the basic features and capabilities of EcoWatch for Windows.

To start the analysis of the SAMPLE.DAT file, note that a shortened menu bar is visible and many of the tools in the toolbar appear dimmed or "grayed out" before any file is opened (see below).



Full activation of EcoWatch features will be realized after a file is opened.

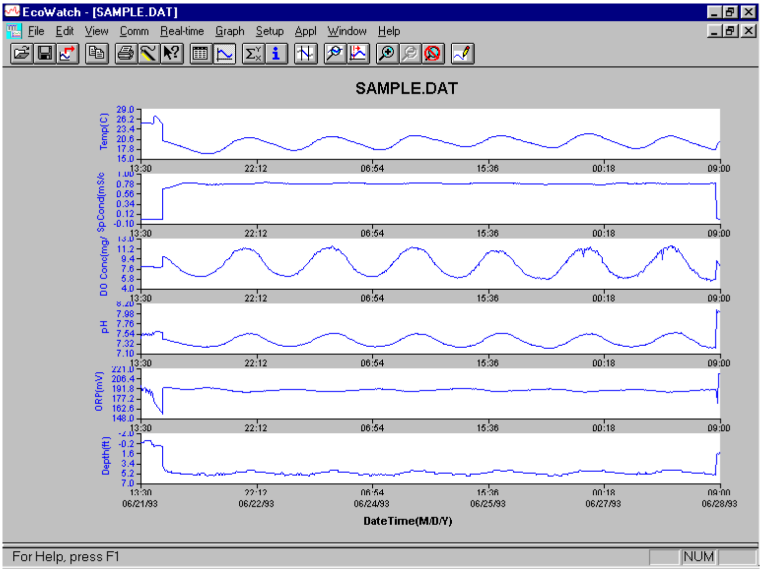
To open the sample data file:

5. 1. Click the **File** menu button in the toolbar.

6. 2. Select the **SAMPLE.DAT** file.

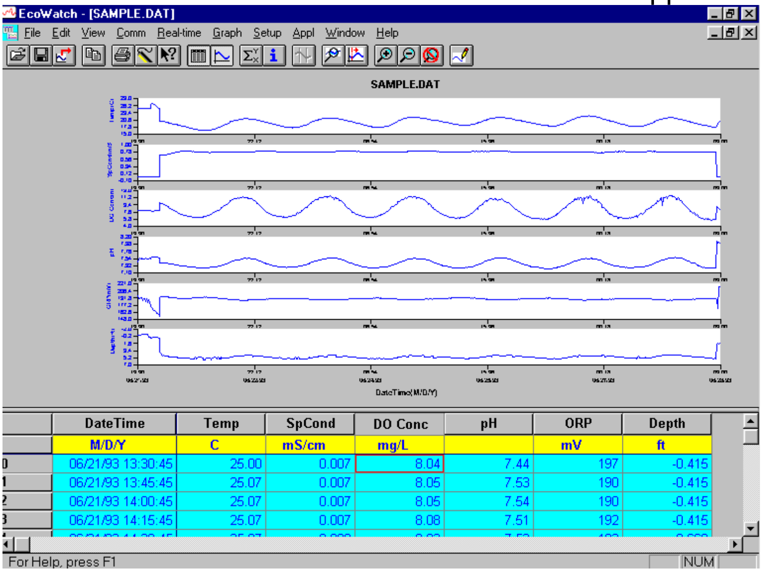
7. 3. Click **OK** to open the file.

The following display will appear:



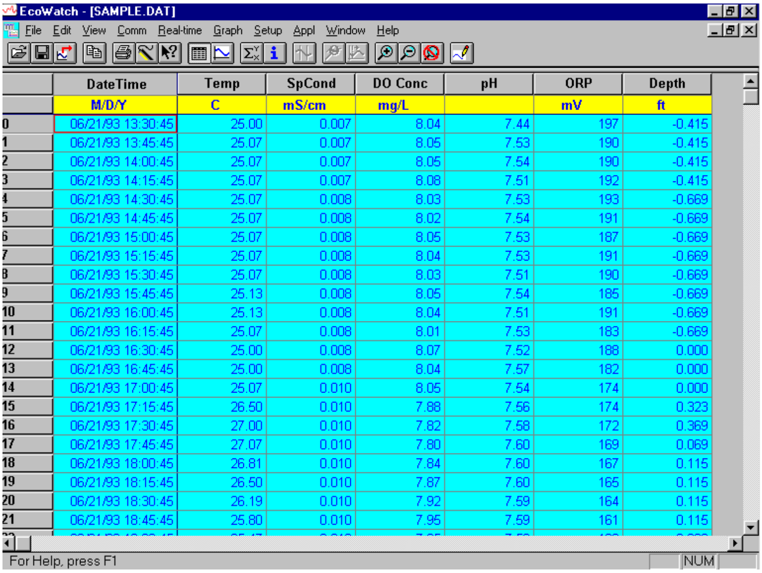
Note that the data in this file appears as a graph of temperature, specific conductance, dissolved oxygen, pH, ORP, and depth, all versus time. The graphs are scaled automatically so that all data fits comfortably on the computer screen. Note also that this data file was obtained with a 6-series sonde for which a depth sensor is available. Depth is NOT a current parameter for the 556 MPS.

The **Table** and **Graph** buttons on the toolbar are on/off switches that are used to display or hide the graph and table pages respectively. When displaying a graph and a table at the same time, you can control the relative size of the two pages by placing the cursor over the small bar that separates them and then dragging it to the desired location. Click the **Table** button to generate the following dual display of data.



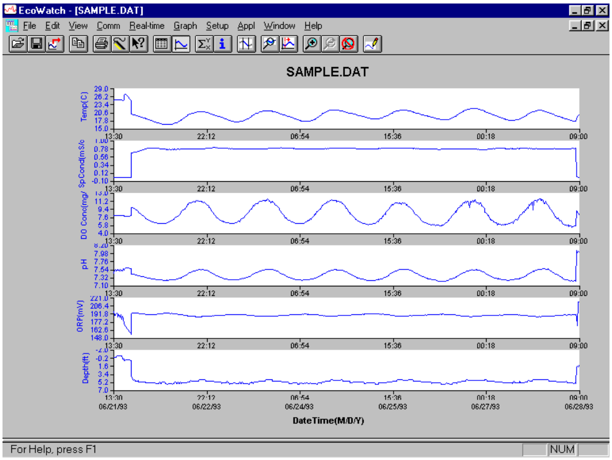
	DateTime	Temp	SpCond	DO Conc	pH	ORP	Depth
	M/D/Y	C	mS/cm	mg/L		mV	ft
0	06/21/93 13:30:45	25.00	0.007	8.04	7.44	197	-0.415
1	06/21/93 13:45:45	25.07	0.007	8.05	7.53	190	-0.415
2	06/21/93 14:00:45	25.07	0.007	8.05	7.54	190	-0.415
3	06/21/93 14:15:45	25.07	0.007	8.08	7.51	192	-0.415

Now click the **Graph** button (turn it off) to display only a report of your data as shown below. Note that the size of the report can be varied by clicking on the and buttons in the Toolbar.

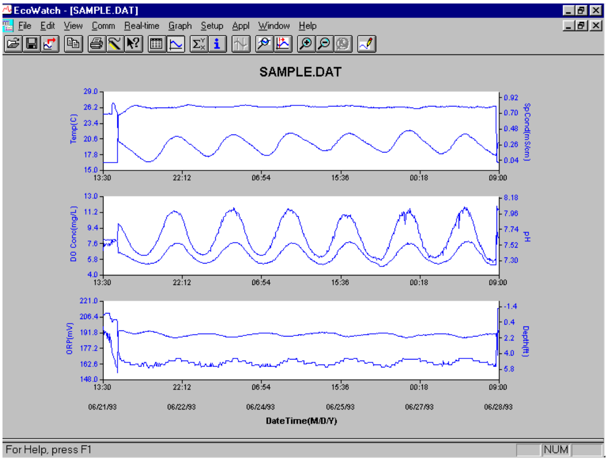


	DateTime	Temp	SpCond	DO Conc	pH	ORP	Depth
	M/D/Y	C	mS/cm	mg/L		mV	ft
0	06/21/93 13:30:45	25.00	0.007	8.04	7.44	197	-0.415
1	06/21/93 13:45:45	25.07	0.007	8.05	7.53	190	-0.415
2	06/21/93 14:00:45	25.07	0.007	8.05	7.54	190	-0.415
3	06/21/93 14:15:45	25.07	0.007	8.08	7.51	192	-0.415
4	06/21/93 14:30:45	25.07	0.008	8.03	7.53	193	-0.669
5	06/21/93 14:45:45	25.07	0.008	8.02	7.54	191	-0.669
6	06/21/93 15:00:45	25.07	0.008	8.05	7.53	187	-0.669
7	06/21/93 15:15:45	25.07	0.008	8.04	7.53	191	-0.669
8	06/21/93 15:30:45	25.07	0.008	8.03	7.51	190	-0.669
9	06/21/93 15:45:45	25.13	0.008	8.05	7.54	185	-0.669
10	06/21/93 16:00:45	25.13	0.008	8.04	7.51	191	-0.669
11	06/21/93 16:15:45	25.07	0.008	8.01	7.53	183	-0.669
12	06/21/93 16:30:45	25.00	0.008	8.07	7.52	188	0.000
13	06/21/93 16:45:45	25.00	0.008	8.04	7.57	182	0.000
14	06/21/93 17:00:45	25.07	0.010	8.05	7.54	174	0.000
15	06/21/93 17:15:45	26.50	0.010	7.88	7.56	174	0.323
16	06/21/93 17:30:45	27.00	0.010	7.82	7.58	172	0.369
17	06/21/93 17:45:45	27.07	0.010	7.80	7.60	169	0.069
18	06/21/93 18:00:45	26.81	0.010	7.84	7.60	167	0.115
19	06/21/93 18:15:45	26.50	0.010	7.87	7.60	165	0.115
20	06/21/93 18:30:45	26.19	0.010	7.92	7.59	164	0.115
21	06/21/93 18:45:45	25.80	0.010	7.95	7.59	161	0.115

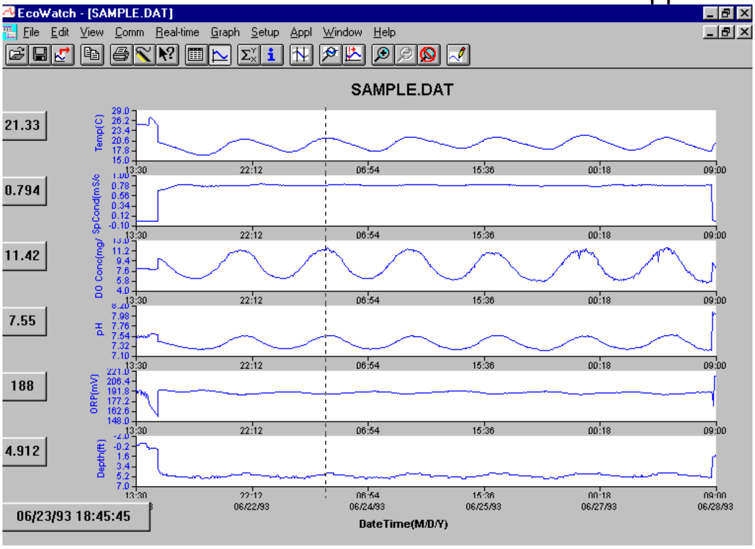
Now return to the original graphic display by toggling the **Table** button “off” and **Graph** button “on”.



From the **Setup** menu, click **Graph**. Click **2 Traces per Graph** and notice that the parameters are now graphed in pairs for easy comparison of parameters.

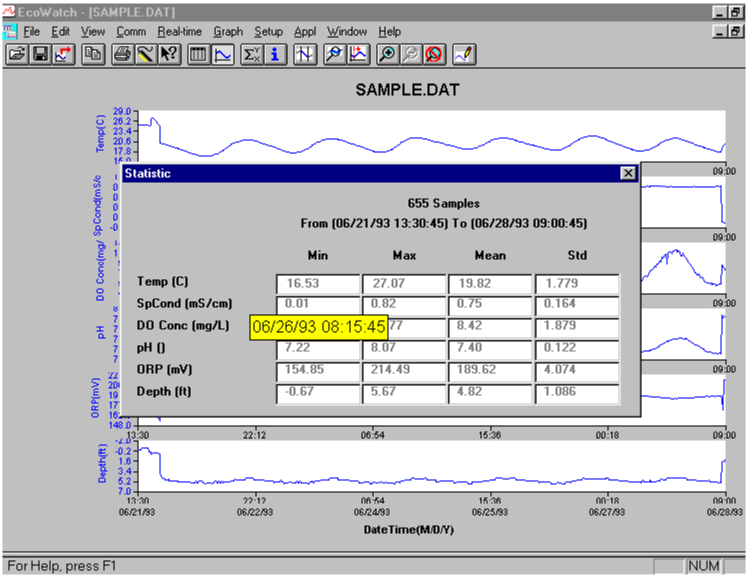


Click **1 Trace per Graph** to return the display to the original setting. Move the cursor to any position in the graph, then click and hold the right mouse button.



Note that the exact measurements for this point in time are displayed to the left of the graph. While holding down the right mouse button, move to another area on the graph. Notice how the measurements change as you move. When you release the mouse button, the display returns to normal.

To view statistical information for the study, click the **Statistics** Σ button on the toolbar. On the statistics window, click on any min or max value to display the time when it occurred.



Statistic

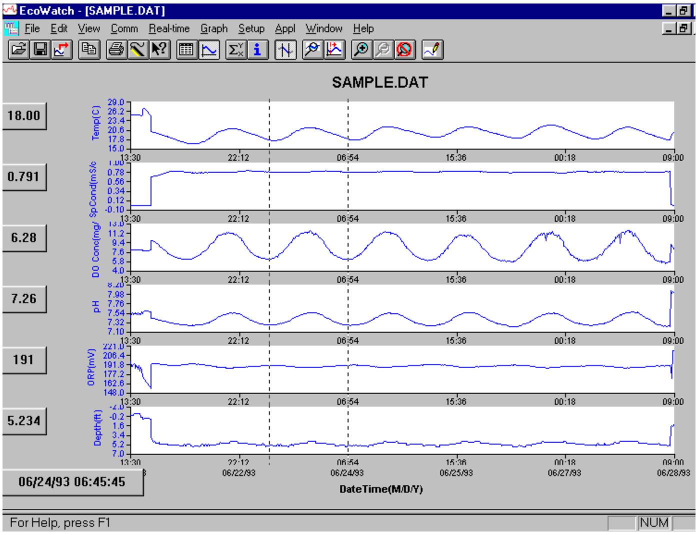
655 Samples

From (06/21/93 13:30:45) To (06/28/93 09:00:45)

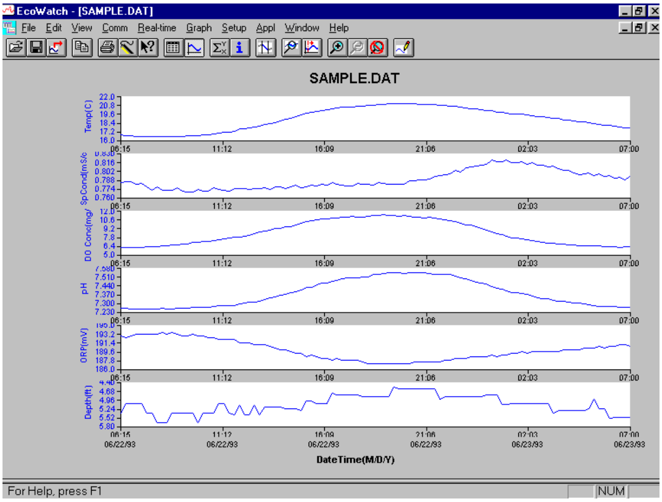
	Min	Max	Mean	Std
Temp (C)	16.53	27.07	19.82	1.779
SpCond (mS/cm)	0.01	0.82	0.75	0.164
DO Conc (mg/L)	06/26/93 08:15:45	77	8.42	1.879
pH ()	7.22	8.07	7.40	0.122
ORP (mV)	154.85	214.49	189.62	4.074
Depth (ft)	-0.67	5.67	4.82	1.086

After viewing statistics, click the “x” at the upper right to close the window and return to the normal display.

Now click on the delimiter icon in the toolbar and then move the displayed icon to the graph. Click at the two points shown by dotted lines in the display below, being sure that the first click is to the left of the second.

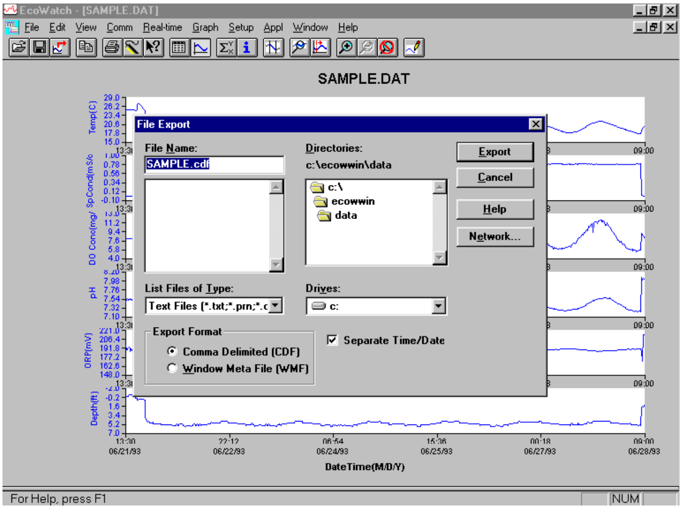


The data between the two selected points will then be graphed in higher resolution as shown below.



To return to the complete data set, select **Graph** from the toolbar and then click **Cancel Limits**.

Now select the icon from the Toolbar to create a new data file which will allow your data to be imported into spreadsheets. Select the default export settings for a Comma Delimited File (.CDF) and click OK. A new spreadsheet-importable file (SAMPLE.CDF) is now present in the same folder as the SAMPLE.DAT file.



File Name: SAMPLE.cdf

Directories: c:\ecowwin\data

c:\
ecowwin
data

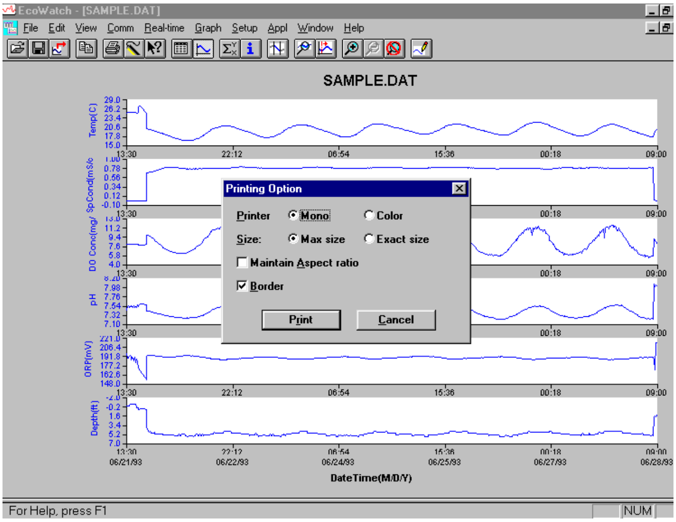
List Files of Type: Text Files (*.txt;*.prn;*.c

Drives: c:

Export Format
● Comma Delimited (CDF)
○ Window Meta File (WMF)

☑ Separate Time/Date

Now select the icon from the toolbar to print the plot. Accept the default settings and click OK to complete the printing operation.



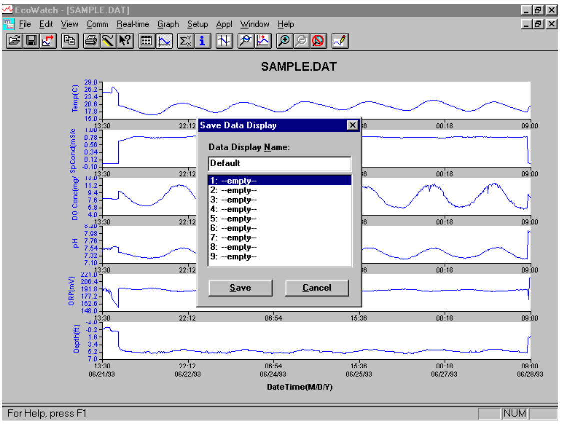
Printer: ● Mono ○ Color

Size: ● Max size ○ Exact size

☐ Maintain Aspect ratio

☑ Border

Finally, end the tutorial by saving the **Data Display** in the format shown. From the **File** menu, click **Save Data Display**.



Save Data Display

Data Display Name:

Default

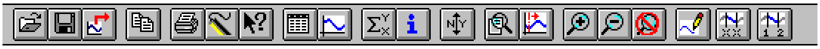
1: --empty--
2: --empty--
3: --empty--
4: --empty--
5: --empty--
6: --empty--
7: --empty--
8: --empty--
9: --empty--

Then type “Default” for the file name and click **Save**. The parameters, colors, format, and x-axis time interval associated with the current display are now saved and can be accessed any time in the future. Nine different data displays may be saved for any data file. You can easily switch between various displays of the data. The data files can be accessed by clicking **Load Data Display** from the file menu and then selecting the desired presentation.

20.2.1 Summary of Toolbar Capability

The EcoWatch toolbar includes buttons for some of the most common commands in EcoWatch, such as **File Open**. To display or hide the toolbar, open the **View** menu and click on the **Toolbar** command. A check mark appears next to the menu item when the toolbar is displayed.

The toolbar is displayed across the top of the application window, below the menu bar.



Click To:

Open an existing data file (.DAT). EcoWatch displays the **Open** dialog box, in which you can locate and open the desired file.

Save the working Data Display of the active data file. EcoWatch displays the **Save Data Display** dialog box in which you can overwrite existing Data Display or save to a new one.

Export data as a graph in Window Meta File (.WMF) format or as data in Comma Delimited (.CDF) format.

Copy the whole graph page or data from the selection on the table to the clipboard.

Print the active graph page or table page depending on which one is currently active.

Open a new terminal window to communicate with the sonde.

Access context sensitive help (Shift+F1).

Toggle table window during file processing.

Toggle graph window during file processing.

Display study statistics.

Display study info.

Limit the data to be processed in a study.

Enlarge a selective portion of graph.

Center the graph under the cursor.

Enlarge graph or table 20%.

Reduce graph or table 20%.

Return graph or table to its normal state (unzoom)

Redraw the graph.

20.2.2 Other Capabilities

The above tutorial and function list for the toolbar provide basic information to allow you to view and analyze the field data which was stored in your 556 MPS. Some of the other commonly used capabilities of EcoWatch which the user may want to explore are listed below:

- Customize the units for each parameter, e.g., report uS/cm instead of mS/cm for conductivity.
- Customize the order of parameters in each plot or report.
- Customize the colors and fonts of each data display.
- Manually scale the y-axis sensitivity for each parameter.
- Merging of two or more data files with compatible parameter formats
- View information about the study such as number of points, instrument serial number, etc. which was stored in the 556 with the data.
- Print data reports in different statistical formats.
- Create plots of parameter vs. parameter rather than parameter vs. time.

These additional features of EcoWatch for Windows are explained in detail in the YSI 6-series manual (which can be downloaded at no cost from the YSI Web Site as described above) and the Help selection in the EcoWatch menubar. To purchase a hard copy of the 6-series manual, contact YSI Customer Service using the contact information in *Appendix E Customer Service*.

21. Appendix H Calibration Record Information

When your YSI 556 MPS sensors are initially calibrated, relevant information about the sensors will be stored in a separate file in the YSI 556 MPS memory.

NOTE: This file, by default, will have the name "556 Circuit Board Serial Number.glp." The circuit board serial number is assigned at the factory and has a hexadecimal format such as 000080A4. Thus the default calibration record file would be designated 00080A4.glp. Refer to Section *10.7 GLP Filename* to change the filename.

The information in the calibration record will track the sensor performance of your instrument and should be particularly useful for programs operating under Good Laboratory Practices (GLP) protocols.

21.1 Viewing the Calibration Record (.glp) File

NOTE: Make certain that you have performed a calibration on at least one of the sensors associated with your YSI 556 MPS.

1. Follow the procedures outlined in Section *8.3 View File*.

21.2 Uploading the Calibration Record (.glp) File

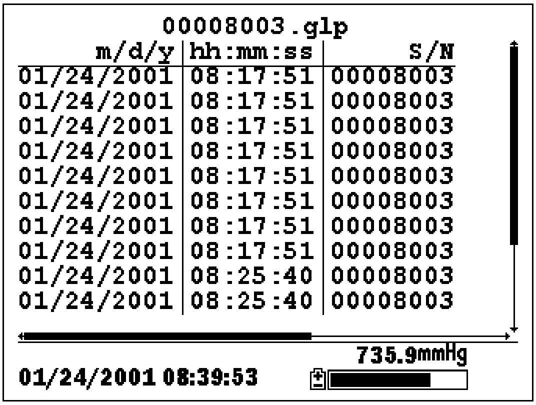
NOTE: Make certain that you have performed a calibration on at least one of the sensors associated with your YSI 556 MPS.

1. Follow the procedures outlined in Section *8.4 Upload to PC*.

21.3 Understanding the Calibration Record (.glp) File

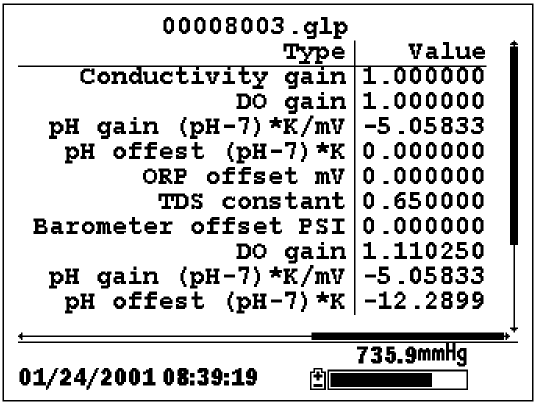
1. Open a calibration record file. Refer to Section *8.3 View File*.

2. Use the arrow keys to scroll horizontally and/or vertically to view all the data.



```
            00008003.glp
      m/d/y|hh:mm:ss|      S/N
01/24/2001|08:17:51|00008003
01/24/2001|08:17:51|00008003
01/24/2001|08:17:51|00008003
01/24/2001|08:17:51|00008003
01/24/2001|08:17:51|00008003
01/24/2001|08:17:51|00008003
01/24/2001|08:17:51|00008003
01/24/2001|08:17:51|00008003
01/24/2001|08:25:40|00008003
01/24/2001|08:25:40|00008003
                         735.9mmHg
01/24/2001 08:39:53
```

Figure 21.1 Calibration Record Screen 1



```
            00008003.glp
                    Type|   Value
    Conductivity gain|1.000000
              DO gain|1.000000
  pH gain (pH-7)*K/mV|-5.05833
   pH offest (pH-7)*K|0.000000
       ORP offset mV|0.000000
        TDS constant|0.650000
 Barometer offset PSI|0.000000
              DO gain|1.110250
  pH gain (pH-7)*K/mV|-5.05833
   pH offest (pH-7)*K|-12.2899
                         735.9mmHg
01/24/2001 08:39:19
```

Figure 21.2 Calibration Record Screen 2

NOTE: Each sensor (not parameter) is characterized by either 1 line (Conductivity, Dissolved Oxygen, ORP, TDS, or Barometer (Optional)) or 2 lines (pH) of calibration documentation.

The left hand portion of each calibration entry shows the date and time that a calibration of a particular sensor was performed. In addition, each calibration entry is characterized by the instrument serial number, as defined by YSI. See Figure 21.1 Calibration Record Screen 1. The right hand portion shows the YSI designation of the calibration constants and their values after their calibration has been performed. A more detailed description of the calibration constants is provided below:

- **Conductivity Gain** – A relative number which describes the sensitivity of the sensor. Basically, the value represents the calculated cell constant divided by the typical value of the cell constant (5 cm^{-1}).

- **DO Gain** – A relative number which describes the sensitivity of the sensor. Basically, the value represents the sensor current at the time of calibration divided by the typical value of the sensor current (15 uA).

- **pH Gain** – A number which basically represents the sensitivity of the pH sensor. To remove the effect of temperature on the slope of the relationship of probe output in mv versus pH, the value of pH/mv is multiplied by the temperature in degrees Kelvin (K).

- **pH Offset** – A number which basically represents the offset (or intercept) of the relationship of probe output in mv versus pH, the value of pH is multiplied by the temperature in degrees Kelvin (K).

Anytime you perform a calibration, information concerning the calibration constants will be logged to the Calibration Record file (.glp file). However, if the **Delete All Files** command is used, Refer to Section *8.6 Delete All Files*, the Calibration Record file will also be lost. It is critical that this file should be uploaded to your PC prior to issuing a **Delete All Files** command. Refer to Section *8.4 Upload to PC*.

YSI incorporated

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STANDARD OPERATING PROCEDURE

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.

II. Equipment and Materials

- Adjustable-rate positive-displacement pump, submersible pump, or peristaltic pump
- Horiba® U-22 or equivalent water quality meter to monitor pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature
- Air monitoring equipment
- Personal protective equipment
- Flow-through cell with inlet/outlet ports 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
- Purged water containers
- Sample containers
- Waste container labels
- In-line disposable 0.45µm filters (QED® FF8100 or equivalent)
- Shipping supplies (labels, coolers, and ice)
- Aluminum foil
- 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. Record well number, site, date, and condition in the field logbook.

4. Place plastic sheeting on the ground surrounding well head. All decontaminated equipment to be used in sampling will be placed only on the plastic sheeting until after the sampling has been completed. Do not let any downhole equipment touch the ground.

5. Open the well and begin screening breathing zone with air monitoring device until sampling is complete, in accordance with the HASP.

6. All sampling equipment and any other equipment to be placed in the well must cleaned and decontaminated before sampling in accordance with SOP *Decontamination of Personnel and Equipment*.

7. 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 pump. Lower the pump slowly into the well and set it at approximately the middle of the screen, or wetted screen interval, and at least two feet above the bottom of the well to avoid disturbance of sediment. Submersible pumps should be lowered by the suspension cable rather than the discharge tubing.

8. Insert the water quality measurement probes into the flow-through cell and place in a shaded area. The purged groundwater must enter the flow through the cell by the lower port and exit via the upper port. Wrap exposed tubing and the flow through cell in aluminum foil to minimize heat loss/gain due to environmental conditions.

9. Generators and fuel, if used, must be located at least 30 feet downwind from the well to avoid exhaust fumes contaminating the samples.

10. Begin 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. Contain purged water for placement in labeled 55-gallon drum or tank, as appropriate.

12. The water level should be monitored frequently 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 minimize water level drawdown.

13. During purging, the field parameters must be 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 pump should be allowed to operate at the same rate as the purge cycle until sampling begins, whereupon the discharge should be reduced to 0.1 L/m.

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.

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 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.
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. VOC vials should be capped slowly to prevent introduction of air bubbles in the sample. Once capped, the VOC vial should be inverted and tapped to detect the presence of air bubbles.

5. Immediately upon collection, all samples for chemical analysis are to be labeled and placed on ice.

6. Re-usable equipment must be cleaned and decontaminated in accordance with the *Decontamination of Personnel and Equipment* SOP.

The following information, at a minimum, must 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, field screening, field chemistry, sampling method), volume of water purged prior to sampling, 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)

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. Submersible pumps used in large diameter wells

should be equipped with a shroud to force water flow across the pump motor to dissipate heat build-up.

- 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.

STANDARD OPERATING PROCEDURE

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.

FIELD SAMPLING PROTOCOLS TO AVOID CROSS-CONTAMINATION DURING WATER SAMPLING FOR PERFLUORINATED COMPOUNDS (PFCs)

1.0 PURPOSE

While EPA method 537 provides basic guidance on sampling for PFC's in drinking water, due to the potential for cross contamination this Standard Operating Procedure (SOP) addendum describes additional precautionary procedures/considerations when collecting groundwater or drinking water samples. Sampling specific SOPs should also be reviewed prior to conducting field sampling activities at PFC sites.

2.0 SCOPE

This procedure applies to all qualified personnel and subcontractors who collect or otherwise handle water samples for analysis of PFCs. This SOP should be reviewed by all on-site personnel prior to implementation of field activities.

3.0 GENERAL

Given the low detection limits associated with PFC analysis and the many potential sources of trace levels of PFCs, field personnel are advised to act on the side of caution by strictly following these protocols, frequently replacing nitrile gloves, and rinsing field equipment to help mitigate the potential for background contamination detections of PFCs. Specific items related to field sampling are discussed below.

4.0 PROCEDURES/CONSIDERATIONS

The following are procedures/considerations to be made during field activities at potential PFC release sites.

Field Equipment

- **Do not use Teflon®-containing materials** (e.g., Teflon® tubing, bailers, tape, plumbing paste, or other Teflon® materials) since Teflon® contains fluorinated compounds.
- High-density polyethylene (HDPE), low-density polyethylene (LDPE), and silicon materials are acceptable for sampling. Samples should not be stored in containers made of LDPE materials.
- To avoid plastic coating or glue materials, **do not use waterproof field books**. Field reports should be documented on loose paper on masonite or aluminum clipboards (i.e. plastic clipboards, binders, or spiral hard cover notebooks are not acceptable). Sharpies®/markers should be avoided.
- **Post-It Notes are not allowed** on project sites.

- **Do not use markers.** Pens should be used when documenting field activities in the field log and on field forms as well as labeling sample containers and preparing the Chain of Custody.
- **Do not use chemical (blue) ice packs** during the sampling program. This includes the use of ice packs for the storage of food and/or samples.

Field Clothing and Personal Protective Equipment

- **Do not wear water resistant, waterproof, or stain-treated clothing** during the field program. Field clothing made of synthetic and natural fibers (preferably cotton) are acceptable. Field clothing should be laundered avoiding the use of fabric softener. Preferably, field gear should be cotton construction and well laundered (a minimum of 6 times from time of purchase). New clothing may contain PFC related treatments. **Do not use new clothing** while sampling or sample handling.
- **Do not wear clothing or boots containing Gore-Tex™** during the sampling program as it consists of a PFC membrane.
- All safety footwear will consist of steel-toed boots made with polyurethane and polyvinyl chloride (PVC).
- **Do not wear Tyvek® clothing** on-site since it contains fluorinated compounds.
- Disposable nitrile gloves must be worn at all times. Further, a new pair of nitrile gloves should be donned prior to the following activities at each sample location:
  - Decontamination of re-usable sampling equipment;
  - Prior to contact with sample bottles or water containers;
  - Insertion of anything into the well (e.g. HDPE tubing, HydraSleeve bailer, etc.);
  - Insertion of silicon tubing into the peristaltic pump;
  - Completion of monitor well purging, prior to sample collection;
  - Handling of any quality assurance/quality control samples including field blanks and equipment blanks; and,
  - After the handling of any non-dedicated sampling equipment, contact with non-decontaminated surfaces, or when judged necessary by field personnel.

Sample Containers

- Samples should be collected in polypropylene or HDPE bottles fitted with an unlined (no Teflon®), polypropylene HDPE screw cap. This is an especially important point as many laboratories utilize Teflon-lined bottles.
- Container labels will be completed using pen (**NO MARKERS**) after the caps have been placed back on each bottle.

- Glass containers should also be avoided due to potential loss of analyte through adsorption.

Wet Weather

- Field sampling occurring during wet weather (e.g., rainfall and snowfall) should be conducted while wearing appropriate clothing that will not pose a risk for cross-contamination. Teams should avoid synthetic gear that has been treated with water-repellant finishes containing PFCs. Use rain gear made from polyurethane and wax-coated materials.

Equipment Decontamination

For GW sampling, it is highly recommended that disposable equipment be utilized. However, if equipment re-use is performed, field sampling equipment, including oil/water interface meters and water level indicators, that are utilized at each sample location will require cleaning between uses. Alconox® and Liquinox® soap is acceptable for use since the Material Safety Data Sheets do not list fluoro-surfactants as an ingredient. However, **Decon 90 must not be used** during decontamination activities. Water used for the decontamination of sampling equipment will be laboratory certified "PFC-free" water.

Personnel Hygiene

- Field personnel should not use cosmetics, moisturizers, hand cream, or other related products as part of their personal cleaning/showering routine on the morning of a sampling event, as these products may contain surfactants and represent a potential source of PFCs.
- Many manufactured sunblock and insect repellants contain PFCs and should not be brought or used on-site. Sunblock and insect repellants that are used on-site should consist of 100% natural ingredients.

Food Considerations

- No food or drink shall be brought on-site, with the exception of bottled water and hydration drinks (i.e., Gatorade® and Powerade®).

Blanks

- Utilization of blanks is a good quality check to monitor and control the effects of contamination. Trip blanks and field blanks are recommended.

REFERENCES

- Transport Canada, 2013. *Perfluorochemical (PFC) Field Sampling Protocol*. May.

- Delta Consultants, 2010. *Report of Investigation Activities at Select Firefighting Foam Training Areas and Foam Discharge Sites in Minnesota*. February.
- MPCA, 2008. *Closed Landfill Program Sampling Protocol for Monitoring Wells.* October.
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- *EPA, 2009. EPA Document #: EPA/600/R-08/092, METHOD 537. DETERMINATION OF SELECTED PERFLUORINATED ALKYL ACIDS IN DRINKING WATER BY SOLID PHASE EXTRACTION AND LIQUID CHROMATOGRAPHY/TANDEM MASS SPECTROMETRY (LC/MS/MS). Version 1.1. September*

STANDARD OPERATING PROCEDURE

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.

Screen Size Opening (Inches)	Screen Size Slot Number	Typical Sand Pack Mesh Size (U.S. Standard Sieve Number)
0.005	5	100
0.010	10	20 to 40
0.020	20	10 to 20
0.030	30	10 to 20

- 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. A grout density scale is recommended for determining the correct density. See attached grout volume and weights chart for calculation of grout volume.
- 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

Grout Volume and Weights Chart

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.

STANDARD OPERATING PROCEDURE

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)

STANDARD OPERATING PROCEDURE

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

- 6-inch to 12-inch ID steel or Schedule 80 polyvinyl chloride (PVC) surface casing, depending upon application.
- Temporary bottom plug or grout shoe.
- 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 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, bentonite pellets or chips.

- Bentonite for grout: Pure, powdered bentonite.
- Cement-Bentonite Grout: Proportion 6 to 8 gallons of water per 94-pound bag of Portland cement; 3 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 measure pH, temperature, specific conductance, and turbidity 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 or greater 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*.

Permanent surface casing will be placed in the bottom of the borehole and the surface casing will be pressed into a low permeability layer, if present. The surface casing will be grouted in place by installing the grout through a tremie pipe connected to the grout shoe, or placed at the bottom of the annulus.

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 inside the surface casing once the grout has been allowed to cure 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 a low permeability layer, if present. However, it will not be grouted into place.

C. Monitoring-Well Installation

Typically, the well is completed within the surface casing using mud rotary techniques. 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 completed, 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 correct depth for well installation.

The appropriate lengths of well screen, nominally 10 feet (with bottom cap), and casing will be 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 0.010-inch slotted screen and Morie No. 01 (or DSI No.2) silica sand for 0.020-inch slotted screen 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 tape measure. The primary sand pack will extend from the bottom of the borehole to a minimum 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 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 side-discharge tremie pipe plugged at the bottom. The openings in the tremie pipe will allow the grout to discharge laterally into the borehole and 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 2 inches above the ground surface.

Four steel guard posts will be installed around the locking casing. Guard posts shall be concrete-filled, at least 2 inches in diameter, and 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 8 to 12-inch dia. manhole cover with a rubber gasket 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 6 inches below the ground surface.

Inside the manhole, a locking cap will be placed on the inner well 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 may not allow low turbidity results to be achieved.

The surging apparatus will include a tight-fitting 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, turbidity, 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 one hour 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 (MWDoubleDiag.xls)

STANDARD OPERATING PROCEDURE

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. Alternatively, the datalogger can be started manually just prior to injection of air. 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.

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

OPERATING PROCEDURE

Title: **Potable Water Supply Sampling**

Effective Date: May 30, 2013

Number: SESDPROC-305-R3

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Revision History

The top row of this table shows the most recent changes to this controlled document. For previous revision history information, archived versions of this document are maintained by the SESD Document Control Coordinator on the SESD local area network (LAN).

History	Effective Date
SESDPROC-305-R3, *Potable Water Sampling*, replaces SESDPROC-305-R2 **General:** Corrected any typographical, grammatical and/or editorial errors. **Title Page:** Changed author from Maria Labrador to Mike Neill. **Revision History:** Changes were made to reflect the current practice of only including the most recent changes in the revision history. Section 1.4: Omitted references that were no longer applicable. **Section 2.3**: Reorganized section by adding four subsections: Sample Handling, Sample Preservation, Sample Dechlorination and Other Sample Preservation/Stabilization. Section 2.3.1: Omitted “procedures” and “used” and added “used” in the first sentence. Omitted “labeled” from first sentence of Item 3. Item 4 was added to address samples requiring reduced temperature storage. Section 2.3.2: This section was revised to reflect current preservation practices. Section 2.3.3: The following language was added to create Section 2.3.3: “Potable water samples that have been treated with chlorine require the addition of sodium thiosulfate to dechlorinate the sample.” Section 2.3.4: The following language was added to create Section 2.3.4: “If other preservation or stabilization requirements are needed, refer to the USEPA Region 4 Analytical Support Branch Laboratory Operations and Quality Assurance Manual (ASBLOQAM), Most Recent Version.” Section 3.1: The requirements for obtaining the resident’s information were moved to the top of this section. In the first sentence of the next to last paragraph the following language was added: “or the container is pre-preserved.” Section 4: Section was renamed from “Potable Water Supply Sampling Methods – Purging” to “Potable Water Supply Purging.” Section 4.1 and Section 4.1.1: Section 4.1.1 was moved to Section 4.1. Section was renamed from “Purging and Purge Adequacy” to “Potable Wells – Purging and Purge Adequacy.” Language from former Section 4.2 concerning potable water purging from residential wells was relocated to the	May 30, 2013

first and last paragraph of this section. Section 4.2: Previous language was omitted and replaced with language concerning water supply plants and large industrial supplies. Section was renamed to reflect the new subject. Section 4.2: Section was omitted. Section 5.2: Section was renamed from "Collecting Samples from Wells with In Place Plumbing" to "Collecting Samples from Residential Wells." Section 5.3: Section was renamed from "Sample Preservation" to "Collecting Samples from Water Supply Plants." The entire section was revised to reflect current practices. Section 5.4: Content from Section 5.4.1 was incorporated into Section 5.4. Sections 5.4.1 and 5.4.2 were omitted. Section 5.5: This section was omitted. Section 5.6: This section was omitted.	
SESDPROC-305-R2, *Potable Water Sampling*, replaces SESDPROC-305-R1	January 29, 2013
SESDPROC-305-R1, *Potable Water Sampling*, replaces SESDPROC-305-R0	November 1, 2007
SESDPROC-305-R0, Potable Water Supply Sampling, Original Issue	February 05, 2007

TABLE OF CONTENTS

1 General Information

1.1 Purpose

This document describes general and specific procedures, methods and considerations to be used and observed when collecting potable water supply samples for field screening or laboratory analysis.

1.2 Scope/Application

The procedures contained in this document are to be used by field personnel when collecting and handling potable water supply samples in the field. On the occasion that SESD field personnel determine that any of the procedures described in this section are inappropriate, inadequate or impractical and that another procedure must be used to obtain a potable water supply sample, the variant procedure will be documented in the field logbook, along with a description of the circumstances requiring its use. Mention of trade names or commercial products in this operating procedure does not constitute endorsement or recommendation for use.

1.3 Documentation/Verification

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

1.4 References

International Air Transport Authority (IATA). Dangerous Goods Regulations, Most Recent Version

Puls, Robert W., and Michael J. Barcelona. Filtration of Ground Water Samples for Metals Analysis. *Hazardous Waste and Hazardous Materials* 6(4): 385-393 (1989).

Puls, Robert W., Don A. Clark, and Bert Bledsoe. Metals in Ground Water: Sampling Artifacts and Reproducibility. *Hazardous Waste and Hazardous Materials* 9(2): 149-162 (1992).

SESD Operating Procedure for Control of Records, SESDPROC-002, Most Recent Version

SESD Operating Procedure for Equipment Inventory and Management, SESDPROC-108, Most Recent Version

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

SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC, SESDPROC-206, Most Recent Version

SESD Operating Procedure for Field pH Measurement, SESDPROC-100, Most Recent Version

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

SESD Operating Procedure for Field Specific Conductance Measurement, SESDPROC-101, Most Recent Version

SESD Operating Procedure for Field Temperature Measurement, SESDPROC-102, Most Recent Version

SESD Operating Procedure for Field Turbidity Measurement, SESDPROC-103, Most Recent Version

SESD Operating Procedure for Logbooks, SESDPROC-010, Most Recent Version

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

SESD Operating Procedure for Packaging, Marking, Labeling and Shipping of Environmental and Waste Samples, SESDPROC-209, Most Recent Version

SESD Operating Procedure for Sample and Evidence Management, SESDPROC-005, Most Recent Version

Title 49 Code of Federal Regulations, Pts. 171 to 179, Most Recent Version.

US EPA. April 13, 1981. Final Regulation Package for Compliance with DOT Regulations in the Shipment of Environmental Laboratory Samples. Memo from David Weitzman, Work Group Chairman, Office of Occupational Health and Safety (PM-273)

US EPA. 1995. Ground Water Sampling - A Workshop Summary. Proceedings from the Dallas, Texas November 30 - December 2, 1993 Workshop. Office of Research and Development Robert S. Kerr Environmental Research Laboratory. EPA/600/R-94/205.

US EPA. 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Region 4 Science and Ecosystem Support Division (SESD), Athens, GA

US EPA. Analytical Support Branch Laboratory Operations and Quality Assurance Manual. Region 4 SESD, Athens, GA, Most Recent Version

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4, SESD, Athens, GA, Most Recent Version

1.5 General Precautions

1.5.1 Safety

Proper safety precautions must be observed when collecting potable water supply samples. Refer to the SESD Safety, Health and Environmental Management Program (SHEMP) Procedures and Policy Manual and any pertinent site-specific Health and Safety Plans (HASP) for guidelines on safety precautions. These guidelines should be used to complement the judgment of an experienced professional. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate.

1.5.2 Procedural Precautions

The following precautions should be considered when collecting potable water supply samples.

- Special care must be taken not to contaminate samples. This includes storing samples in a secure location to preclude conditions which could alter the properties of the sample. Samples shall be custody sealed during long-term storage or shipment.
- Always sample from the anticipated cleanest, i.e., least contaminated location, to the most contaminated location. This minimizes the opportunity for cross-contamination to occur during sampling.
- Collected samples must remain in the custody of the sampler or sample custodian until the samples are relinquished to another party.
- If samples are transported by the sampler, they will remain under his/her custody or be secured until they are relinquished.
- Shipped samples shall conform to all U.S. Department of Transportation (DOT) rules of shipment found in Title 49 of the Code of Federal

Regulations (49 CFR Parts 171 to 179), and/or International Air Transportation Association (IATA) hazardous materials shipping requirements found in the current edition of IATA's Dangerous Goods Regulations.

- Documentation of field sampling is done in a bound logbook.
- Chain-of-custody documents shall be filled out and remain with the samples until custody is relinquished.
- All shipping documents, such as air bills, bills of lading, etc., shall be retained by the project leader and stored in a secure place.

2 Special Sampling Considerations

2.1 Volatile Organic Compounds (VOC) Analysis

Potable water supply samples for VOC analysis must be collected in 40 ml glass vials with Teflon® septa. The vials may be either preserved with concentrated hydrochloric acid or they may be unpreserved. Preserved samples have a two-week holding time, whereas unpreserved samples have only a seven-day holding time. In the great majority of cases, the preserved vials are used to take advantage of the extended holding time. In some situations, however, it may be necessary to use the unpreserved vials. For example, if the potable water supply has a high amount of dissolved limestone, i.e., is highly calcareous, there will most likely be an effervescent reaction between the hydrochloric acid and the water, producing large numbers of fine bubbles. This will render the sample unacceptable. In this case, unpreserved vials should be used and arrangements must be confirmed with the laboratory to ensure that they can accept the unpreserved vials and meet the shorter sample holding times.

The samples should be collected with as little agitation or disturbance as possible. The vial should be filled so that there is a meniscus at the top of the vial and absolutely no bubbles or headspace should be present in the vial after it is capped. After the cap is securely tightened, the vial should be inverted and tapped on the palm of one hand to see if any undetected bubbles are dislodged. If a bubble or bubbles are present, the vial should be topped off using a minimal amount of sample to re-establish the meniscus. Care should be taken not to flush any preservative out of the vial during topping off. If, after topping off and capping the vial, bubbles are still present, a new vial should be obtained and the sample re-collected.

2.2 Special Precautions for Potable Water Supply Sampling

- A clean pair of new, non-powdered, disposable gloves will be worn each time a different location is sampled and the gloves should be donned immediately prior to sampling. The gloves should not come in contact with the media being sampled and should be changed any time during sample collection when their cleanliness is compromised.
- Sample containers for samples suspected of containing high concentrations of contaminants shall be stored separately.
- Sample collection activities shall proceed progressively from the least suspected contaminated area to the most suspected contaminated area if sampling devices are to be reused. Samples of waste or highly contaminated media must not be placed in the same ice chest as environmental (i.e., containing low contaminant levels) or background samples.
- If possible, one member of the field sampling team should take all the notes and photographs, etc., while the other members collect the samples.

- Samplers must use new, verified and certified-clean disposable or non-disposable equipment cleaned according to procedures contained in the SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205), or the SESD Operating Procedure for Field Cleaning and Decontamination at the FEC (SESDPROC-206) for collection of samples for trace metals or organic compound analyses.

2.3 Sample Handling and Preservation Requirements

2.3.1 Sample Handling

The following should be used when collecting samples from potable water supplies:

- Potable water supply samples will typically be collected from a tap or spigot located at or near the well head or pump house and before the water supply is introduced into any storage tanks or treatment units. Efforts should be made to reduce the flow from either the tap or spigot during sample collection to minimize sample agitation.
- During sample collection, make sure that the tap or spigot does not contact the sample container.
- Place the sample into appropriate containers. Samples collected for VOC analysis must not have any headspace (see Section 2.1, Volatile Organic Compounds Analysis). All other sample containers must be filled with an allowance for ullage.
- Samples requiring reduced temperature storage should be placed on ice immediately.

2.3.2 Sample Preservation

All samples requiring preservation must be preserved as soon as practically possible, ideally immediately at the time of sample collection. If preserved VOC vials are used, these will be preserved with concentrated hydrochloric acid by Analytical Support Branch (ASB) personnel prior to departure for the field investigation. ASB personnel will also provide sodium hydroxide tablets to preserve water samples that are being analyzed for cyanide. For all other chemical preservatives, SESD will use the appropriate chemical preservative generally stored in an individual single-use vial as described in the SESD Operating Procedure for Field Sampling Quality Control (SESDPROC-011). The adequacy of sample preservation will be checked after the addition of the preservative for all samples except for the samples collected for VOC analysis. Additional preservative should be added to achieve adequate preservation.

2.3.3 Sample Dechlorination

Potable water samples that have been treated with chlorine require the addition of sodium thiosulfate to dechlorinate the sample.

2.3.4 Other Sample Preservation/Stabilization

If other preservation or stabilization requirements are needed, refer to the USEPA Region 4 Analytical Support Branch Laboratory Operations and Quality Assurance Manual (ASBLOQAM), Most Recent Version.

2.4 Quality Control

Equipment rinsate blanks should be collected if equipment is field cleaned and re-used on-site or if necessary to document that low-level contaminants were not introduced by any sampling equipment.

2.5 Records

Information generated or obtained by SESD personnel will be organized and accounted for in accordance with SESD records management procedures found in the SESD Operating Procedure for Control of Records (SESDPROC-002). Field notes, recorded in a bound field logbook, will be generated, as well as chain-of-custody documentation in accordance with the SESD Operating Procedure for Sample and Evidence Management (SESDPROC-005) and the SESD Operating Procedure for Logbooks (SESDPROC-010).

3 Potable Water Supply Sampling – Sample Site Selection

3.1 General

Obtain or confirm the following information:

- the name(s) of the resident(s) or water supply owner/operator
- the exact physical address
- the exact mailing address (if different from the physical address)
- the resident's/operator's home, work and mobile telephone numbers (when available)

The information is required so that the residents or water supply owner/operators can be informed of the results of the sampling program.

The following should be considered when choosing the location to collect a potable water sample:

- Taps selected for sample collection should be supplied with water from a service pipe connected directly to a water main in the segment of interest.

- Whenever possible, choose the tap closest to the water source, and prior to the water lines entering the residence, office, building, etc., and also prior to any holding or pressurization tanks.

- The sampling tap must be protected from exterior contamination associated with being too close to a sink bottom or to the ground. Contaminated water or soil from the faucet exterior may enter the bottle during the collection procedure since it is difficult to place a bottle under a low tap without grazing the neck interior against the outside faucet surface. If the tap is too close to the ground for direct collection into the appropriate container, it is acceptable to use a smaller container to transfer sample to a larger container. The smaller container should be made of glass or stainless steel, and should be decontaminated to the same standards as the larger container.

- Leaking taps that allow water to discharge from around the valve stem handle and down the outside of the faucet, or taps in which water tends to run up on the outside of the lip, are to be avoided as sampling locations.

- Disconnect any hoses, filters, or aerators attached to the tap before sampling. These devices can harbor a bacterial population if they are not routinely cleaned or replaced when worn or cracked.

- Taps where the water flow is not constant should be avoided because temporary fluctuation in line pressure may cause clumps of microbial growth that are lodged in a pipe section or faucet connection to break loose. A smooth flowing water stream at moderate pressure without splashing should be used. The sample should be collected without changing the water flow. It may be appropriate to reduce the flow for the volatile organic compounds aliquot to minimize sample agitation.

Occasionally, samples are collected to determine the contribution of system-related variables (e.g., transmission pipes, water coolers, water heaters, holding tanks, pressurization tanks, etc.) to the quality of potable water supplies. In these cases, it may be necessary to ensure that the water source has not been used for a specific time interval (e.g., over a weekend or a three- or four-day holiday period). Sample collection may consist of collecting a sample of the initial flush, collecting a sample after several minutes, and collecting another sample after the system being investigated has been completely purged.

When sampling for bacterial content or the container is pre-preserved, the sample container should not be rinsed before use due to possible contamination of the sample container or removal of the thiosulfate dechlorinating agent (if used). When filling any sample container, care should be taken that splashing drops of water from the ground or sink do not enter into either the bottle or cap.

When sampling at a water treatment plant, samples are often collected from the raw water supply and the treated water after chlorination.

4 Potable Water Supply– Purging

4.1 Potable Wells - Purging and Purge Adequacy

Wells with in-place plumbing are commonly found at residences. The objective of purging wells with in-place pumps is the same as with monitoring wells without in-place pumps, i.e., to ultimately collect a water sample representative of aquifer conditions.

Purging is the process of removing stagnant water immediately prior to sampling. In order to determine when an adequate purge has occurred, field investigators should monitor the pH, specific conductance and turbidity of the water removed during purging. For potable water supply sampling, it is recommended to purge the system for at least 15 minutes when possible.

An adequate purge is achieved when the pH and specific conductance of the potable water have stabilized and the turbidity has either stabilized or is below 10 Nephelometric Turbidity Units (NTUs). Although 10 NTUs is normally considered the minimum goal for most water sampling objectives, lower turbidity has been shown to be easily achievable in most situations and reasonable attempts should be made to achieve these lower levels. Stabilization occurs when, for at least three consecutive measurements, the pH remains constant within 0.1 Standard Unit (SU) and the specific conductance varies no more than approximately 10 percent. There are no set criteria establishing how many total sets of measurements are adequate to document stability of parameters.

If, after 15 minutes, the in situ chemical parameters have not stabilized according to the above criteria, additional water can be removed. If the parameters have not stabilized after 15 minutes, it is at the discretion of the project leader whether or not to collect a sample or to continue purging.

A well with an intermittently run pump should, in all respects, be treated like a well without a pump. In these cases, parameters are measured and the well is sampled from the pump discharge after parameter conditions have been met. Generally, under these conditions, 15 to 30 minutes will be adequate.

4.2 Water Supply Plants

Municipality water supply plants and large industrial supplies that operate continuously, require no purge other than opening a valve and allowing it to flush for a few minutes. If a storage tank is present, a spigot, valve or other sampling point should be located between the pump and the storage tank. If not, locate the valve closest to the tank. Measurements of pH, specific conductance and turbidity are recorded at the time of sampling when water quality parameters are required.

4.3 Investigation Derived Waste

Purging generates quantities of purge water or investigation derived waste (IDW), the disposition of which must be considered. See the SESD Operating Procedure for Management of Investigation Derived Waste (SESDPROC-202) for guidance on management or disposal of this waste.

5 Potable Water Supply Sampling Methods – Sampling

5.1 General

Sampling is the process of obtaining, containerizing, and preserving (if required) a potable water supply water sample after the purging process is complete. It is recognized that there are situations, such as industrial or municipal supply wells or private residential wells, where a well may be equipped with a dedicated pump from which a sample would not normally be collected. Discretion should always be used in obtaining a sample.

5.2 Collecting Samples from Residential Wells

Samples should be collected following purging from a valve or cold water tap as near to the well as possible, preferably prior to any storage/pressure tanks or physical/chemical treatment system that might be present. Remove any hose that may be present before sample collection and reduce the flow to a low level to minimize sample disturbance, particularly with respect to volatile organic constituents. Samples should be collected directly into the appropriate containers (see the ASBLOQAM for a list of containers). It may be necessary to use a secondary container, such as a clean 8 oz. or similar size sample jar or a stainless steel scoop, to obtain and transfer samples from spigots with low ground clearance. All measurements for pH, specific conductance and turbidity should be recorded at the time of sample collection.

1. Ideally, the sample should be collected from a tap or spigot located at or near the well head or pump house and before the water supply is introduced into any storage tanks or treatment units. If the sample must be collected at a point in the water line beyond pressurization or holding tank, a sufficient volume of water should be purged to provide a complete exchange of fresh water into the tank and at the location where the sample is collected. If the sample is collected from a tap or spigot located just before a storage tank, spigots located inside the building or structure should be turned on to prevent any backflow from the storage tank to the sample tap or spigot. It is generally advisable to open several taps during the purge to ensure a rapid and complete exchange of water in the tanks.

2. Purge the system for at least 15 minutes when possible. During the purge period, obtain at least three sets of readings as follows: after purging for several minutes, measure the pH, specific conductivity and turbidity of the water. Continue to measure these parameters to assess for stabilization.

3. After three sets of readings have been obtained, samples may be collected. If stabilization has not occurred after the 15-minute purge period, it is at the discretion of the project leader to collect the sample or continue purging and

monitoring the parameters. This would depend on the condition of the system and the specific objectives of the investigation.

5.3 Collecting Samples from Water Supply Plants

Municipality water supply plants and wells that continuously operate, require no purge other than opening a valve and allowing it to flush for a few minutes. If a storage tank is present, a spigot, valve or other sampling point should be located between the pump and the storage tank. If not, locate the valve closest to the tank. Measurements of pH, specific conductance and turbidity are recorded at the time of sampling when water quality parameters are required.

5.4 Special Sample Collection Procedures

Special sample handling procedures should be instituted when trace contaminant samples are being collected. All sampling equipment which comes into contact with the water must be cleaned in accordance with the cleaning procedures described in the SESD Operating Procedure for Field Equipment Cleaning and Decontamination, (SESDPROC-205) or the SESD Operating Procedure for Field Cleaning and Decontamination at the FEC (SESDPROC-206), as applicable.

Appendix B
DoD ELAP Letter

ilac-MRA

The American Association for Laboratory Accreditation

World Class Accreditation

Accredited DoD ELAP Laboratory

A2LA has accredited

TESTAMERICA LABORATORIES SACRAMENTO

West Sacramento, CA

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 2009 TNI Standard, and the requirements of the Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 5.0 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 14th day of May 2014.

President & CEO
For the Accreditation Council
Certificate Number 2928.01
Valid to January 31, 2016

For the tests to which this accreditation applies, please refer to the laboratory's Environmental Scope of Accreditation.

American Association for Laboratory Accreditation

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

TESTAMERICA LABORATORIES SACRAMENTO

880 Riverside Parkway
West Sacramento, CA 95605
Lisa Stafford Phone: 916 374 4308

ENVIRONMENTAL

Valid To: January 31, 2016 Certificate Number: 2928.01

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 2009 TNI Standard, and the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 5.0 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

Inductively Coupled Plasma (ICP), ICP-Mass Spectroscopy, Atomic Absorption Spectroscopy (flame), Gas Chromatography(GC), GC- Mass Spectroscopy, High Resolution Gas Chromatography/High Resolution Mass Spectroscopy, Liquid Chromatography(LC),LC- Mass Spectroscopy, Ion Chromatography, Spectrophotometry, Misc.-Electronic Probes

Parameter/Analyte	**Program: Solid/Hazardous Waste Matrix: Non-Potable Water**	**Program: Solid/Hazardous Waste Matrix: Solid/Chemical Materials**	**Air**
Metals			
Aluminum	EPA 6010B/6010C/6020//6020A	EPA 6010B/6010C/6020//6020A	EPA 6020/6020A
Antimony	EPA 6010B/6010C/6020//6020A	EPA 6010B/6010C/6020//6020A	EPA 6020/6020A
Arsenic	EPA 6010B/6010C/6020//6020A	EPA 6010B/6010C/6020//6020A	EPA 6020/6020A
Barium	EPA 6010B/6010C/6020//6020A	EPA 6010B/6010C/6020//6020A	EPA 6020/6020A
Beryllium	EPA 6010B/6010C/6020//6020A	EPA 6010B/6010C/6020//6020A	EPA 6020/6020A
Boron	EPA 6010B/6020/6010C/6020A	EPA 6010B/6020/6010C/6020A	-------
Cadmium	EPA 6010B/6010C/6020//6020A	EPA 6010B/6010C/6020//6020A	EPA 6020/6020A
Calcium	EPA 6010B/6010C/6020//6020A	EPA 6010B/6010C/6020//6020A	EPA 6020/6020A
Chromium (Total)	EPA 6010B/6010C/6020//6020A	EPA 6010B/6010C/6020//6020A	EPA 6020/6020A
Chromium (Hexavalent)	EPA 7196A	EPA 7196A	-------
Cobalt	EPA 6010B/6010C/6020//6020A	EPA 6010B/6010C/6020//6020A	EPA 6020/6020A
Copper	EPA 6010B/6010C/6020//6020A	EPA 6010B/6010C/6020//6020A	EPA 6020/6020A
Iron	EPA 6010B/6010C/6020//6020A	EPA 6010B/6010C/6020//6020A	EPA 6020/6020A

Parameter/Analyte	**Program: Solid/Hazardous Waste Matrix: Non-Potable Water**	**Program: Solid/Hazardous Waste Matrix: Solid/Chemical Materials**	**Air**
Lead	EPA 6010B/6010C/6020//6020A	EPA 6010B/6010C/6020//6020A	EPA 6020/6020A
Magnesium	EPA 6010B/6010C/6020//6020A	EPA 6010B/6010C/6020//6020A	EPA 6020/6020A
Manganese	EPA 6010B/6010C/6020//6020A	EPA 6010B/6010C/6020//6020A	EPA 6020/6020A
Mercury	EPA 7470A	EPA 7471A	-------
Molybdenum	EPA 6010B/6010C/6020//6020A	EPA 6010B/6010C/6020//6020A	EPA 6020/6020A
Nickel	EPA 6010B/6010C/6020//6020A	EPA 6010B/6010C/6020//6020A	EPA 6020/6020A
Phosphorus	EPA 6020/6020A	EPA 6020/6020A	-------
Potassium	EPA 6010B/6010C/6020//6020A	EPA 6010B/6010C/6020//6020A	EPA 6020/6020A
Selenium	EPA 6010B/6010C/6020//6020A	EPA 6010B/6010C/6020//6020A	EPA 6020/6020A
Silica	EPA 6010B/6010C	-------	-------
Silicon	EPA 6010B/6010C	-------	-------
Silver	EPA 6010B/6010C/6020//6020A	EPA 6010B/6010C/6020//6020A	EPA 6020/6020A
Sodium	EPA 6010B/6010C/6020//6020A	EPA 6010B/6010C/6020//6020A	EPA 6020/6020A
Strontium	EPA 6020/6020A	EPA 6020/6020A	-------
Thallium	EPA 6010B/6020 6010C/6020A	EPA 6010B/6020 6010C/6020A	EPA 6020/6020A
Thallium	EPA 6010B/6020	EPA 6010B/6020	EPA 6020/6020A
Tin	EPA 6010B/6020/6010C/6020A	EPA 6010B/6020/6010C/6020A	-------
Titanium	EPA 6010B/6020/6010C/6020A	EPA 6010B/6020/6010C/6020A	-------
Uranium	EPA 6020/6020A	EPA 6020/6020A	-------
Vanadium	EPA 6010B/6010C/6020//6020A	EPA 6010B/6010C/6020//6020A	EPA 6020/6020A
Zinc	EPA 6010B/6010C/6020//6020A	EPA 6010B/6010C/6020//6020A	EPA 6020/6020A
<u>Nutrients</u>			
Nitrate	EPA 353.2/9056A/300.0	EPA 353.2/ 9056A/300.0	-------
Nitrate-nitrite	EPA 353.2	EPA 353.2	-------
Nitrite	EPA 353.2/9056A/300.0	EPA 353.2/9056A/300.0	-------
Orthophosphate	EPA 9056A/300.0	EPA 9056A/300.0	-------
<u>Wet Chemistry</u>			
Alkalinity	SM 2320B (1997)	-------	-------
Chemical Oxygen Demand	EPA 410.4	-------	-------
Oil and Grease	EPA 1664A/9070	EPA 1664A/9071	-------
Nitrocellulose	WS-WC-0050	WS-WC-0050	-------
Perchlorate	EPA 6850	EPA 6850	-------
pH	EPA 9040B/9040C	EPA 9045C/9045D	-------
Bromide	EPA 9056A/300.0	EPA 9056A/300.0	-------
Chloride	EPA 9056A/300.0	EPA 9056A/300.0	-------
Fluoride	EPA 9056A/300.0	EPA 9056A/300.0	-------
Sulfate	EPA 9056A/300.0	EPA 9056A/300.0	-------

Peter Unger

Parameter/Analyte	**Program: Solid/Hazardous Waste Matrix: Non-Potable Water**	**Program: Solid/Hazardous Waste Matrix: Solid/Chemical Materials**	**Air**
Solids, Total	SM2540B (1997)	-------	-------
Solids, Total Suspended	SM2540D (1997)	-------	-------
Solids, Total Dissolved	SM2540C (1997)	-------	-------
%Moisture	-------	ASTM D2216	
TSP (Total Suspended Particulate)	-------	-------	40CFR Part 50 App B
PM10	-------	-------	40CFR Part 50 App J
<u>Hazardous Waste Characteristics</u>			
TCLP Extractables	-------	EPA 1311	-------
TCLP Inorganics	-------	EPA 1311	-------
<u>Purgeable Organics</u>			
(volatiles)			
1,1,1,2-Tetrachloroethane	EPA 8260B/8260C	EPA 8260B/8260C	-------
1,1,1-Trichloroethane	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15/ TO15 SIM
1,1,2,2-Tetrachloroethane	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15/ TO15 SIM
1,1,2-Trichloroethane	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15/ TO15 SIM
1,1-2-Trichloro-1,2-2-trifluorethane	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
1,1-Dichloroethane	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15/ TO15 SIM
1,1-Dichloroethene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15/ TO15 SIM
1,1-Dichloroethane	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
1,1-Dichloroethene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
1,1-Dichloropropene	EPA 8260B/8260C	EPA 8260B/8260C	-------
1,2,3-Trichlorobenzene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
1,2,3-Trichloropropane	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15/ TO15 SIM
1,2,4-Trichlorobenzene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15/ TO15 SIM
1,2,4-Trimethylbenzene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
1,2-Dibromo-3-chloropropane	EPA 8260B/8260C	EPA 8260B/8260C	-------
1,2-Dibromoethane	EPA 8260B/8260C	EPA 8260B/8260C	-------
1,2-Dichlorobenzene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
1,2-Dichloroethane	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15/ TO15 SIM

Parameter/Analyte	**Program: Solid/Hazardous Waste Matrix: Non-Potable Water**	**Program: Solid/Hazardous Waste Matrix: Solid/Chemical Materials**	**Air**
1,2-Dichloropropane	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15/ TO15 SIM
1,3,5-Trimethylbenzene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
1,3-Dichlorobenzene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
1,3-Dichloropropane	EPA 8260B/8260C	EPA 8260B/8260C	-------
1,4-Dichlorobenzene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15/ TO15 SIM
1,4-Dioxane	-------	-------	TO14A/TO15/ TO15 SIM
1-Chlorocyclohexane	EPA 8260B/8260C	EPA 8260B/8260C	-------
2,2-Dichloropropane	EPA 8260B/8260C	EPA 8260B/8260C	-------
2-Butanone (MEK)	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
2-Chlorotoluene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
2-Hexanone (MBK)	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
2-Methyl-2-propanol (tert-Butyl Alcohol, TBA)	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
4-Chlorotoluene	EPA 8260B/8260C	EPA 8260B/8260C	-------
4-Ethyltoluene	-------	-------	TO14A/TO15
4-Isopropyltoluene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
4-Methyl-2-pentanone (MIBK)	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
Acetone	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
Acrolein	-------	-------	TO14A/TO15
Allyl Chloride	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
Alpha Methyl Styrene	-------	-------	TO14A/TO15
Benzene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15; TO3/ TO15 SIM
Benzyl chloride	-------	-------	TO14A/TO15
Bromobenzene	EPA 8260B/8260C	EPA 8260B/8260C	-------
Bromochloromethane	EPA 8260B/8260C	EPA 8260B/8260C	-------
Bromodichloromethane	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15/ TO15 SIM
Bromoform	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
Bromomethane	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
Butadiene (1,3-Butadiene)	-------	-------	TO14A/TO15/ TO15 SIM
Butane	-------	-------	TO14A/TO15
Carbon disulfide	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15; EPA 15/16
Carbon tetrachloride	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15/ TO15 SIM
Chlorobenzene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
Chlorodifluoromethane	-------	-------	TO14A/TO15
Chloroethane	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15

Parameter/Analyte	Program: Solid/Hazardous Waste Matrix: Non-Potable Water	Program: Solid/Hazardous Waste Matrix: Solid/Chemical Materials	Air
Chloroform	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15/ TO15 SIM
Chloromethane	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
cis-1,2-Dichloroethene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15/ TO15 SIM
cis-1,3-Dichloropropene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
Cyclohexane	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
Dibromochloromethane	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15/ TO15 SIM
Dibromomethane	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
Dichlorodifluoromethane	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
Diisopropyl ether (DIPE)	EPA 8260B/8260C	EPA 8260B/8260C	------------
Dimethyl Disulfide	WS-MS-0003	WS-MS-0003	EPA 15/16
Ethyl acetate	-------	-------	TO14A/TO15
Ethylbenzene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15; TO3
Ethylene Dibromide (EDB)	-------	-------	TO14A/TO15/ TO15 SIM
Ethylmethacrylate	EPA 8260B/8260C	EPA 8260B/8260C	-------
Ethyl tert-butyl ether (ETBE)	EPA 8260B/8260C	EPA 8260B/8260C	-------
Hexachlorobutadiene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15/ TO15 SIM
Hexane	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
Iodomethane	EPA 8260B/8260C	EPA 8260B/8260C	-------
Isobutanol (2-Methyl-1-propanol)	EPA 8260B/8260C	EPA 8260B/8260C	-------
Isooctane (2,2,4-Trimethylpentane)	-------	-------	TO14A/TO15
Isopropyl alcohol	-------	-------	TO14A/TO15
Isopropylbenzene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
m & p xylene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15; TO3/TO15 SIM
Methyl tert-butyl ether (MTBE)	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15; TO3
Methylene chloride	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15/ TO15 SIM
Naphthalene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15/ TO15 SIM
n-Butanol	-------	-------	TO14A/TO15
n-Butylbenzene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
n-Heptane	-------	-------	TO14A/TO15
n-Nonane	-------	-------	TO14A/TO15
n-Octane	-------	-------	TO14A/TO15
n-Propylbenzene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
o-xylene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15; TO3/TO15 SIM

Parameter/Analyte	**Program: Solid/Hazardous Waste Matrix: Non-Potable Water**	**Program: Solid/Hazardous Waste Matrix: Solid/Chemical Materials**	**Air**
Pentane	-------	-------	TO14A/TO15
Propene	-------	-------	TO14A/TO15
sec-Butylbenzene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
Styrene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
t-Amyl methyl ether (TAME)	EPA 8260B/8260C	EPA 8260B/8260C	-------
t-1,4-Dichloro-2-Butene	EPA 8260B/8260C	EPA 8260B/8260C	-------
tert-Butylbenzene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
Tetrachloroethene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15/ TO15 SIM
Tetrahydrofuran	-------	-------	TO14A/TO15
Toluene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15; TO3
trans-1,2-Dichloroethene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15/ TO15 SIM
trans-1,3-Dichloropropene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
Trichloroethene	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15/ TO15 SIM
Trichlorofluoromethane	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
Vinyl acetate	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
Vinyl bromide	-------	-------	TO14A/TO15
Vinyl chloride	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15/ TO15 SIM
Xylenes, Total	EPA 8260B/8260C	EPA 8260B/8260C	TO14A/TO15
Hydrogen sulfide	-------	-------	EPA 15/16
Carbonyl sulfide	-------	-------	EPA 15/16
Methanethiol (Methyl mercaptan)	-------	-------	EPA 15/16
Ethanethiol (Ethyl mercaptan)	-------	-------	EPA 15/16
Dimethyl sulfide	-------	-------	EPA 15/16
TPH as Gasoline	-------	-------	TO3
Carbon Dioxide	-------	-------	ASTM1946D /3C
Nitrogen	-------	-------	ASTM1946D /3C
Oxygen	-------	-------	ASTM1946D /3C
Helium	-------	-------	ASTM1946D /3C
Hydrogen	-------	-------	ASTM1946D /3C
Methane	-------	-------	ASTM1946D /3C
Gasoline Range Organics (GRO)	EPA 8260B/AK101MS	EPA 8260B/AK101MS	TO14A/TO15
TPH as Gasoline			TO3

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Parameter/Analyte	**Program: Solid/Hazardous Waste Matrix: Non-Potable Water**	**Program: Solid/Hazardous Waste Matrix: Solid/Chemical Materials**	**Air**
Extractable Organics (semivolatiles)			
1,2,4,5-Tetrachlorobenzene	EPA 8270C/8270D	EPA 8270C/8270D	-------
1,2,4-Trichlorobenzene	EPA 8270C/8270D	EPA 8270C/8270D	-------
1,2-Dichlorobenzene	EPA 8270C/8270D	EPA 8270C/8270D	-------
1,2-Diphenylhydrazine (as Azobenzene)	EPA 8270C/8270D	EPA 8270C/8270D	-------
1,3-Dichlorobenzene	EPA 8270C/8270D	EPA 8270C/8270D	-------
1,3-Dinitrobenzene	EPA 8270C/8270D	EPA 8270C/8270D	-------
1,4-Dichlorobenzene	EPA 8270C/8270D	EPA 8270C/8270D	-------
1-Methylnaphthalene	EPA 8270C/8270D	EPA 8270C/8270D	-------
2,3,4,6-Tetrachlorophenol	EPA 8270C/8270D	EPA 8270C/8270D	-------
2,4,5-Trichlorophenol	EPA 8270C/8270D	EPA 8270C/8270D	-------
2,4,6-Trichlorophenol	EPA 8270C/8270D	EPA 8270C/8270D	-------
2,4-Dichlorophenol	EPA 8270C/8270D	EPA 8270C/8270D	-------
2,4-Dimethylphenol	EPA 8270C/8270D	EPA 8270C/8270D	-------
2,4-Dinitrophenol	EPA 8270C/8270D	EPA 8270C/8270D	-------
2,4-Dinitrotoluene	EPA 8270C/8270D	EPA 8270C/8270D	-------
2,6-Dichlorophenol	EPA 8270C/8270D	EPA 8270C/8270D	-------
2,6-Dinitrotoluene	EPA 8270C/8270D	EPA 8270C/8270D	-------
2-Chloronaphthalene	EPA 8270C/8270D	EPA 8270C/8270D	-------
2-Chlorophenol	EPA 8270C/8270D	EPA 8270C/8270D	-------
2-Methylnaphthalene	EPA 8270C/8270D/ WS-MS-0008 8270C-SIM/8270D-SIM	EPA 8270C/8270D/ WS-MS-0008 8270C-SIM/8270D-SIM	WS-MS-0006
2-Methylphenol	EPA 8270C/8270D	EPA 8270C/8270D	-------
2-Naphthylamine	EPA 8270C/8270D	EPA 8270C/8270D	-------
2-Nitroaniline	EPA 8270C/8270D	EPA 8270C/8270D	-------
2-Nitrophenol	EPA 8270C/8270D	EPA 8270C/8270D	-------
3&4-Methylphenol	EPA 8270C/8270D	EPA 8270C/8270D	-------
3,3'-Dichlorobenzidine	EPA 8270C/8270D	EPA 8270C/8270D	-------
3-Nitroaniline	EPA 8270C/8270D	EPA 8270C/8270D	-------
4,6-Dinitro-2-methylphenol	EPA 8270C/8270D	EPA 8270C/8270D	-------
4-Bromophenyl phenyl ether	EPA 8270C/8270D	EPA 8270C/8270D	-------
4-Chloro-3-methylphenol	EPA 8270C/8270D	EPA 8270C/8270D	-------
4-Chloroaniline	EPA 8270C/8270D	EPA 8270C/8270D	-------
4-Chlorophenyl phenyl ether	EPA 8270C/8270D	EPA 8270C/8270D	-------
4-Nitroaniline	EPA 8270C/8270D	EPA 8270C/8270D	-------
4-Nitrophenol	EPA 8270C/8270D	EPA 8270C/8270D	-------
Acenaphthene	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	WS-MS-0006

Parameter/Analyte	**Program: Solid/Hazardous Waste Matrix: Non-Potable Water**	**Program: Solid/Hazardous Waste Matrix: Solid/Chemical Materials**	**Air**
Acenaphthylene	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	WS-MS-0006
Aniline	EPA 8270C/8270D	EPA 8270C/8270D	-------
Anthracene	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	WS-MS-0006
Benzo(a)anthracene	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	WS-MS-0006
Benzo(a)pyrene	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	WS-MS-0006
Benzo(b)fluoranthene	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	WS-MS-0006
Benzo(g,h,i)perylene	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	WS-MS-0006
Benzo(k)fluoranthene	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	WS-MS-0006
Benzoic acid	EPA 8270C/8270D	EPA 8270C/8270D	-------
Benzyl alcohol	EPA 8270C/8270D	EPA 8270C/8270D	-------
Benzyl butyl phthalate	EPA 8270C/8270D	EPA 8270C/8270D	-------
Biphenyl	EPA 8270C/8270D	EPA 8270C/8270D	-------
Bis(2-chloroethoxy) Methane	EPA 8270C/8270D	EPA 8270C/8270D	-------
Bis(2-chloroethyl) ether	EPA 8270C/8270D	EPA 8270C/8270D	-------
Bis(2-chloroisopropyl) ether	EPA 8270C/8270D	EPA 8270C/8270D	-------
Carbazole	EPA 8270C/8270D	EPA 8270C/8270D	-------
Chrysene	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	WS-MS-0006
Bis (2-ethylhexyl) phthalate	EPA 8270C/8270D	EPA 8270C/8270D	-------
Diallate	EPA 8270C/8270D	EPA 8270C/8270D	-------
Dibenz(a,h)anthracene	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	WS-MS-0006
Dibenzofuran	EPA 8270C/8270D	EPA 8270C/8270D	-------
Diethyl Phthalate	EPA 8270C/8270D	EPA 8270C/8270D	-------
Dimethyl Phthalate	EPA 8270C/8270D	EPA 8270C/8270D	-------
Di-n-butyl phthalate	EPA 8270C/8270D	EPA 8270C/8270D	-------
Di-n-octyl phthalate	EPA 8270C/8270D	EPA 8270C/8270D	-------
Fluoranthene	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	WS-MS-0006
Fluorene	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	WS-MS-0006
Hexachlorobenzene	EPA 8270C/8270D	EPA 8270C/8270D	-------
Hexachlorobutadiene	EPA 8270C/8270D	EPA 8270C/8270D	-------
Hexachlorocyclopentadiene	EPA 8270C/8270D	EPA 8270C/8270D	-------
Hexachloroethane	EPA 8270C/8270D	EPA 8270C/8270D	-------

Parameter/Analyte	**Program: Solid/Hazardous Waste Matrix: Non-Potable Water**	**Program: Solid/Hazardous Waste Matrix: Solid/Chemical Materials**	**Air**
Indeno(1,2,3-c,d)pyrene	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	WS-MS-0006
Isophorone	EPA 8270C/8270D	EPA 8270C/8270D	-------
Naphthalene	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	WS-MS-0006
Nitrobenzene	EPA 8270C/8270D	EPA 8270C/8270D	-------
n-Nitrosodimethylamine	EPA 8270C/8270D	EPA 8270C/8270D	-------
n-Nitrosodi-n-propylamine	EPA 8270C/8270D	EPA 8270C/8270D	-------
n-Nitrosodiphenylamine	EPA 8270C/8270D	EPA 8270C/8270D	-------
Pentachlorophenol	EPA 8270C/8270D	EPA 8270C/8270D	-------
Phenanthrene	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	WS-MS-0006
Phenol	EPA 8270C/8270D	EPA 8270C/8270D	-------
Pyrene	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	EPA 8270C/8270D/8270C-SIM/8270D-SIM/WS-MS-0008	WS-MS-0006
1,4-Dioxane	WS-MS-0011	WS-MS-0011	-------
Diesel Range Organics (DRO)	EPA 8015B/8015D/AK102	EPA 8015B/8015D/AK102	-------
Residual Range Organics	AK103	AK103	-------
<u>Dioxins</u>			
2,3,7,8-TeCDD	EPA 8280A/8280B/8290/8290A/1613B	EPA 8280A/8280B/8290/8290A/1613B	-------
1,2,3,7,8-PeCDD	EPA 8280A/8280B/8290/8290A/1613B	EPA 8280A/8280B/8290/8290A/1613B	-------
1,2,3,4,7,8-HxCDD	EPA 8280A/8280B/8290/8290A/1613B	EPA 8280A/8280B/8290/8290A/1613B	-------
1,2,3,6,7,8-HxCDD	EPA 8280A/8280B/8290/8290A/1613B	EPA 8280A/8280B/8290/8290A/1613B	-------
1,2,3,7,8,9-HxCDD	EPA 8280A/8280B/8290/8290A/1613B	EPA 8280A/8280B/8290/8290A/1613B	-------
1,2,3,4,6,7,8-HpCDD	EPA 8280A/8280B/8290/8290A/1613B	EPA 8280A/8280B/8290/8290A/1613B	-------
OCDD	EPA 8280A/8280B/8290/8290A/1613B	EPA 8280A/8280B/8290/8290A/1613B	-------
2,3,7,8-TeCDF	EPA 8280A/8280B/8290/8290A/1613B	EPA 8280A/8280B/8290/8290A/1613B	-------

Parameter/Analyte	**Program: Solid/Hazardous Waste Matrix: Non-Potable Water**	**Program: Solid/Hazardous Waste Matrix: Solid/Chemical Materials**	**Air**
1,2,3,7,8-PeCDF	EPA 8280A/8280B/8290/8290A/1613B	EPA 8280A/8280B/8290/8290A/1613B	-------
2,3,4,7,8-PeCDF	EPA 8280A/8280B/8290/8290A/1613B	EPA 8280A/8280B/8290/8290A/1613B	-------
1,2,3,4,7,8-HxCDF	EPA 8280A/8280B/8290/8290A/1613B	EPA 8280A/8280B/8290/8290A/1613B	-------
1,2,3,6,7,8-HxCDF	EPA 8280A/8280B/8290/8290A/1613B	EPA 8280A/8280B/8290/8290A/1613B	-------
1,2,3,7,8,9-HxCDF	EPA 8280A/8280B/8290/8290A/1613B	EPA 8280A/8280B/8290/8290A/1613B	-------
2,3,4,6,7,8-HxCDF	EPA 8280A/8280B/8290/8290A/1613B	EPA 8280A/8280B/8290/8290A/1613B	-------
1,2,3,4,6,7,8-HpCDF	EPA 8280A/8280B/8290/8290A/1613B	EPA 8280A/8280B/8290/8290A/1613B	-------
1,2,3,4,7,8,9-HpCDF	EPA 8280A/8280B/8290/8290A/1613B	EPA 8280A/8280B/8290/8290A/1613B	-------
OCDF	EPA 8280A/8280B/8290/8290A/1613B	EPA 8280A/8280B/8290/8290A/1613B	-------
Total TCDD	EPA 8280A/8280B/8290/8290A/1613B	EPA 8280A/8280B/8290/8290A/1613B	-------
Total PeCDD	EPA 8280A/8280B/8290/8290A/1613B	EPA 8280A/8280B/8290/8290A/1613B	-------
Total HxCDD	EPA 8280A/8280B/8290/8290A/1613B	EPA 8280A/8280B/8290/8290A/1613B	-------
Total HeptaCDD	EPA 8280A/8280B/8290/8290A/1613B	EPA 8280A/8280B/8290/8290A/1613B	-------
Total TCDF	EPA 8280A/8280B/8290/8290A/1613B	EPA 8280A/8280B/8290/8290A/1613B	-------
Total PeCDF	EPA 8280A/8280B/8290/8290A/1613B	EPA 8280A/8280B/8290/8290A/1613B	-------
Total HxCDF	EPA 8280A/8280B/8290/8290A/1613B	EPA 8280A/8280B/8290/8290A/1613B	-------
Total HpCDF	EPA 8280A/8280B/8290/8290A/1613B	EPA 8280A/8280B/8290/8290A/1613B	-------

Parameter/Analyte	Program: Solid/Hazardous Waste Matrix: Non-Potable Water	Program: Solid/Hazardous Waste Matrix: Solid/Chemical Materials	Air
Chemical Warfare Degradates			
1,4-Dithiane	WS-MS-0003	WS-MS-0003	-------
Benzothiazole	WS-MS-0003	WS-MS-0003	-------
p-Chlorophenyl methylsulfide	WS-MS-0003	WS-MS-0003	-------
p-Chlorophenyl methylsulfoxide	WS-MS-0003	WS-MS-0003	-------
p-Chlorophenyl methylsulfone	WS-MS-0003	WS-MS-0003	-------
Chloropicrin	WS-MS-0003	WS-MS-0003	-------
Acetophenone	WS-MS-0003	WS-MS-0003	-------
2-Chloroacetophenone	WS-MS-0003	WS-MS-0003	-------
1,4-Oxathiane	WS-MS-0003	WS-MS-0003	-------
Dimethyl Disulfide	WS-MS-0003	WS-MS-0003	EPA 15/16
Diisopropylmethylphosphate (DIMP)	WS-LC-0004	WS-LC-0004	-------
Dimethylmethylphosphonate (DMMP)	WS-LC-0004	WS-LC-0004	-------
Ethyl methylphosphonic acid (EMPA)	WS-LC-0004	WS-LC-0004	-------
Isopropyl methylphosphonic acid (IMPA)	WS-LC-0004	WS-LC-0004	-------
Methylphosphonic acid (MPA)	WS-LC-0004	WS-LC-0004	-------
Thiodiglycol (2,2'-Thiodiethanol) (TDG)	WS-LC-0004	WS-LC-0004	-------
Nitroaromatics			
2-Amino-4,6-dinitrotoluene	EPA 8330A/8330B	EPA 8330A/8330B	-------
4-Amino-2,6-dinitrotoluene	EPA 8330A/8330B	EPA 8330A/8330B	-------
3,5-Dinitroaniline	EPA 8330B	EPA 8330B	-------
1,3-Dinitrobenzene	EPA 8330A/8330B	EPA 8330A/8330B	-------
2,4-Dinitrotoluene	EPA 8330A/8330B	EPA 8330A/8330B	-------
2,6-Dinitrotoluene	EPA 8330A/8330B	EPA 8330A/8330B	-------
Glycerol trinitrate (Nitroglycerin)	EPA 8330B	EPA 8330B	-------
Hexahydro-1,3,5-trinitro-1,3,5-triazine (Hexogen)	EPA 8330A/8330B	EPA 8330A/8330B	-------
Methyl-2,4,6-trinitrophenylnitramine	EPA 8330A/8330B	EPA 8330A/8330B	-------
Nitrobenzene	EPA 8330A/8330B	EPA 8330A/8330B	-------
2-Nitrotoluene (o-Nitrotoluene)	EPA 8330A/8330B	EPA 8330A/8330B	-------

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Parameter/Analyte	**Program: Solid/Hazardous Waste Matrix: Non-Potable Water**	**Program: Solid/Hazardous Waste Matrix: Solid/Chemical Materials**	**Air**
3-Nitrotoluene (m-Nitrotoluene)	EPA 8330A/8330B	EPA 8330A/8330B	-------
4-Nitrotoluene (p-Nitrotoluene)	EPA 8330A/8330B	EPA 8330A/8330B	-------
Octahydro-1,3,5,7-tetranitro1,3,5,7-tetracine (Octogen)	EPA 8330A/8330B	EPA 8330A/8330B	-------
Picric acid	EPA 8330B	EPA 8330B	-------
Pentaerythritol tetranitrate	EPA 8330B	EPA 8330B	-------
1,3,5-Trinitrobenzene	EPA 8330A/8330B	EPA 8330A/8330B	-------
2,4,6-Trinitrotoluene	EPA 8330A/8330B	EPA 8330A/8330B	-------
Hexahydro-1,3-dinitroso-5-nitro-1,3,5,triazine (DNX)	EPA 8330A/8330B	EPA 8330A/8330B	-------
Hexahydro-1,3,5-trinitroso-1,3,5-triazine (TNX)	EPA 8330A/8330B	EPA 8330A/8330B	-------
1-Nitroso-3,5-dinitro-1,3,5-triazacyclohexane (MNX)	EPA 8330A/8330B	EPA 8330A/8330B	-------
Nitroguanidine	WS-LC-0010	WS-LC-0010	-------
Nitrosamines			
N-Nitrosodimethyl amine (NDMA)	WS-MS-0012	WS-MS-0012	-------
Perfluoro Compounds			
Perfluorooctanoic acid	WS-LC-0025	WS-LC-0025	-------
Perfluorooctane sulfonate	WS-LC-0025	WS-LC-0025	-------
Perfluorobutyric acid (PFBA)	WS-LC-0025	WS-LC-0025	-------
Perfluoropentanoic acid (PFPA)	WS-LC-0025	WS-LC-0025	-------
Perfluorohexanoic acid (PFHxA)	WS-LC-0025	WS-LC-0025	-------
Perfluoroheptanoic acid (PFHpA)	WS-LC-0025	WS-LC-0025	-------
Perfluorononanoic acid (PFNA)	WS-LC-0025	WS-LC-0025	-------
Perfluorodecanoic acid (PFDA)	WS-LC-0025	WS-LC-0025	-------
Perfluoroundecanoic acid (PFUDA	WS-LC-0025	WS-LC-0025	-------
Perfluorododecanoic acid (PFDoDA)	WS-LC-0025	WS-LC-0025	-------
Perfluorotridecanoic acid (PFTriA)	WS-LC-0025	WS-LC-0025	
Perfluorotetradecanoic acid	WS-LC-0025	WS-LC-0025	

Parameter/Analyte	**Program: Solid/Hazardous Waste Matrix: Non-Potable Water**	**Program: Solid/Hazardous Waste Matrix: Solid/Chemical Materials**	**Air**
(PFTeA)			
Perfluorobutane Sulfonate (PFBS)	WS-LC-0025	WS-LC-0025	-------
Perfluorohexane Sulfonate (PFHxS)	WS-LC-0025	WS-LC-0025	-------
Perfluoroheptane Sulfonate (PFHpS)	WS-LC-0025	WS-LC-0025	-------
Perfluorodecane Sulfonate (PFDS)	WS-LC-0025	WS-LC-0025	-------
Perfluorooctane Sulfonamide (FOSA)	WS-LC-0025	WS-LC-0025	
Pesticides/PCBs			
Aldrin	EPA 8081A/8081B	EPA 8081A/8081B	-------
a-BHC	EPA 8081A/8081B	EPA 8081A/8081B	-------
b-BHC	EPA 8081A/8081B	EPA 8081A/8081B	-------
d-BHC	EPA 8081A/8081B	EPA 8081A/8081B	-------
g-BHC (Lindane)	EPA 8081A/8081B	EPA 8081A/8081B	-------
a-Chlordane	EPA 8081A/8081B	EPA 8081A/8081B	-------
g-Chlordane	EPA 8081A/8081B	EPA 8081A/8081B	-------
4,4'-DDD	EPA 8081A/8081B	EPA 8081A/8081B	-------
4,4'-DDE	EPA 8081A/8081B	EPA 8081A/8081B	-------
4,4'-DDT	EPA 8081A/8081B	EPA 8081A/8081B	-------
Dieldrin	EPA 8081A/8081B	EPA 8081A/8081B	-------
Endosulfan I	EPA 8081A/8081B	EPA 8081A/8081B	-------
Endosulfan II	EPA 8081A/8081B	EPA 8081A/8081B	-------
Endosulfan sulfate	EPA 8081A/8081B	EPA 8081A/8081B	-------
Endrin	EPA 8081A/8081B	EPA 8081A/8081B	-------
Endrin aldehyde	EPA 8081A/8081B	EPA 8081A/8081B	-------
Endrin ketone	EPA 8081A/8081B	EPA 8081A/8081B	-------
Heptachlor	EPA 8081A/8081B	EPA 8081A/8081B	-------
Heptachlor epoxide	EPA 8081A/8081B	EPA 8081A/8081B	-------
Methoxychlor	EPA 8081A/8081B	EPA 8081A/8081B	-------
Toxaphene	EPA 8081A/8081B	EPA 8081A/8081B	-------
Chlordane (technical)	EPA 8081A/8081B	EPA 8081A/8081B	-------
PCB (Aroclors)			
PCB-1016	EPA 8082/8082A	EPA 8082/8082A	TO-4A/TO-10A
PCB-1221	EPA 8082/8082A	EPA 8082/8082A	TO-4A/TO-10A
PCB-1232	EPA 8082/8082A	EPA 8082/8082A	TO-4A/TO-10A
PCB-1242	EPA 8082/8082A	EPA 8082/8082A	TO-4A/TO-10A

Parameter/Analyte	Program: Solid/Hazardous Waste Matrix: Non-Potable Water	Program: Solid/Hazardous Waste Matrix: Solid/Chemical Materials	Air
PCB-1248	EPA 8082/8082A	EPA 8082/8082A	TO-4A/TO-10A
PCB-1254	EPA 8082/8082A	EPA 8082/8082A	TO-4A/TO-10A
PCB-1260	EPA 8082/8082A	EPA 8082/8082A	TO-4A/TO-10A
PCB-1262	EPA 8082/8082A	EPA 8082/8082A	TO-4A/TO-10A
PCB-1268	EPA 8082/8082A	EPA 8082/8082A	TO-4A/TO-10A
PCB (congeners) – removed references to BZ and IUPAC numbers.			
PCB 1	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 2	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 3	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 4	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 5	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 6	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 7	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 8	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 9	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 10	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 11	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 12	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 13	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 14	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 15	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 16	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 17	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 18	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 19	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 20	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 21	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 22	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 23	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 24	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 25	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 26	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 27	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 28	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 29	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 30	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 32	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 31	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------

Parameter/Analyte	**Program: Solid/Hazardous Waste Matrix: Non-Potable Water**	**Program: Solid/Hazardous Waste Matrix: Solid/Chemical Materials**	**Air**
PCB 33	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 34	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 35	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 36	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 37	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 38	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 39	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 40	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 41	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 42	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 43	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 44	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 45	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 46	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 47	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 48	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 49	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 50	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 51	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 52	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 53	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 54	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 55	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 56	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 57	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 58	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 59	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 60	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 61	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 62	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 63	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 64	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 65	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 66	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 67	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 68	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 69	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 70	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 71	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 72	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 73	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 74	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------

Parameter/Analyte	**Program: Solid/Hazardous Waste Matrix: Non-Potable Water**	**Program: Solid/Hazardous Waste Matrix: Solid/Chemical Materials**	**Air**
PCB 75	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 76	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 77	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 78	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 79	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 80	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 81	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 82	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 83	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 84	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 85	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 86	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 87	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 88	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 89	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 90	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 91	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 92	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 93	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 94	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 95	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 96	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 97	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 98	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 99	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 100	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 101	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 102	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 103	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 104	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 105	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 106	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 107	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 108	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 109	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 110	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 111	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 112	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 113	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 114	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 115	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 116	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------

Parameter/Analyte	Program: Solid/Hazardous Waste Matrix: Non-Potable Water	Program: Solid/Hazardous Waste Matrix: Solid/Chemical Materials	Air
PCB 117	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 118	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 119	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 120	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 121	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 122	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 123	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 124	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 125	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 126	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 127	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 128	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 129	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 130	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 131	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 132	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 133	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 134	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 135	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 136	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 137	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 138	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 139	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 140	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 141	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 142	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 143	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 144	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 145	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 146	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 147	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 148	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 149	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 150	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 151	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 152	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 153	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 154	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 155	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 156	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 157	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 158	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------

Parameter/Analyte	**Program: Solid/Hazardous Waste Matrix: Non-Potable Water**	**Program: Solid/Hazardous Waste Matrix: Solid/Chemical Materials**	**Air**
PCB 159	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 160	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 161	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 162	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 163	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 164	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 165	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 166	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 167	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 168	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 169	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 170	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 171	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 172	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 173	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 174	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 175	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 176	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 177	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 178	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 179	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 180	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 181	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 182	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 183	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 184	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 185	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 186	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 187	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 188	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 189	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 190	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 191	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 192	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 193	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 194	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 195	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 196	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 197	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 198	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 199	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 200	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------

Parameter/Analyte	**Program: Solid/Hazardous Waste Matrix: Non-Potable Water**	**Program: Solid/Hazardous Waste Matrix: Solid/Chemical Materials**	**Air**
PCB 201	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 202	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 203	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 204	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 205	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 206	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 207	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 208	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
PCB 209	EPA 1668A mod/1668C mod	EPA 1668A mod/ 1668C mod	-------
Metals Digestion			
Acid Digestion Total Rcoverable or Dissolved Metals	EPA 3005A	-------	-------
Acid Digestion for Total Metals	EPA 3010A	-------	-------
Acid Digestion of Sediments, Sludges and Soils	-------	EPA 3050B	EPA 3050B
Organic Preparation Methods			
Separatory Funnel Liquid-Liquid Extraction	-------	EPA 3510C	-------
Ultrasonic Extraction	-------	EPA 3550B, EPA 3550C	-------
Waste Dilution	EPA 3580A	EPA 3580A	-------
Solid-Phase Extraction	EPA 3535A		-------
Volatiles Purge and Trap	EPA 5030B, EPA 5030C	EPA 5030B	-------
Volatiles Purge and Trap for Solids	-------	EPA 5035, EPA 5035A	-------
Semivolatiles in Air	-------	-------	EPA 3542 TO-13
Chemical Warfare Degradates (in solid)	-------	WS-OP-0005	-------
Organic Cleanup Procedures			
Florisil Cleanup	EPA 3620B, EPA3620C	EPA 3620B, EPA3620C	EPA 3620B, EPA3620C
Sulfur Cleanup	EPA 3660A	EPA 3660A	EPA 3660A
Sulfuric Acid Cleanup	EPA 3665A	EPA 3665A	EPA 3665A
Silica Gel Cleanup	EPA 3630C	EPA 3630C	-------

Accredited Laboratory

A2LA has accredited

TESTAMERICA LABORATORIES SACRAMENTO

West Sacramento, CA

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 13th day of May 2014.

Peter Unger

President & CEO
For the Accreditation Council
Certificate Number 2928.01
Valid to January 31, 2016

For the tests to which this accreditation applies, please refer to the laboratory's Environmental Scope of Accreditation.