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NAS CECIL FIELD, FL
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"FINAL SAMPLING AND ANALYSIS PLAN FOR PETROLEUM SITES NORTH SOUTH APRON PLUME, BUILDING 82 TANK G82, BP WELLS SITE AND BUILDING 815 WASH RACK AREA WITH TRANSMITTAL LETTER NAS CECIL FIELD FL"
5/10/2010
TETRA TECH NUS INC

TETRA TECH

PITT-05-10-025

May 10, 2010

Project Number 112G02267

BRAC PMO SE
Attn: Mr. Art Sanford
4130 Faber Place Drive
North Charleston, South Carolina 29405

Reference: CLEAN Contract No. N62470-08-D-1001
Contract Task Order JM09

Subject: Final Sampling and Analysis Plan, Petroleum Sites: North-South Apron; Building 82, Tank G82; BP Wells; and 815 Wash Rack
Naval Air Station Cecil Field
Jacksonville, Florida

Dear Mr. Sanford:

Enclosed please find one copy of the subject deliverable. Copies have been sent to the members of the NAS Cecil Field Partnering Team as noted below. This is the formal distribution of the signed version of this UFP SAP. This submission is for distribution purposes only, therefore review and approval is not required.

If you have any questions, please call me at 412-921-8163 or Megan Boerio at 412-921-7271.

Sincerely,

Robert F. Simcik, P.E.
Task Order Manager

RFS/clm

Enclosure

cc: G. Fraley, U.S. EPA (electronic copy)
D. Grabka, FDEP (1 copy)
M. Halil, J.A. Jones (electronic copy)
J. Trepanowski, Tetra Tech NUS
S. Curry/Tetra Tech NUS File JM09 (1 copy unbound)

Tetra Tech NUS, Inc.
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Comprehensive **L**ong-term **E**nvironmental **A**ction **N**avy

CONTRACT NUMBER N62470-08-D-1001

Sampling and Analysis Plan
for
Petroleum Sites: North-South Apron; Building 82, Tank G82; BP Wells; and 815 Wash Rack

Naval Air Station Cecil Field
Jacksonville, Florida

Contract Task Order JM09

April 2010

BRAC Program Management Office Southeast
4130 Faber Place Drive, Suite 202
North Charleston, South Carolina 29405

TETRA TECH NUS, Inc.

SAP Worksheet #1 -- Title and Approval Page

(UFP-QAPP Manual Section 2.1)

FINAL
SAMPLING AND ANALYSIS PLAN
APRIL 2010

PETROLEUM SITES: NORTH-SOUTH APRON; BUILDING 82, TANK G82; BP WELLS; AND 815 WASH RACK
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

Prepared for:
BRAC Program Management Office Southeast
4130 Faber Place Drive
North Charleston, South Carolina 29405

Prepared by:
Tetra Tech NUS, Inc.
234 Mall Boulevard, Suite 260
King of Prussia, Pennsylvania 19406

Prepared under:
Contract N62470-08-D-1001
CONTRACT TASK ORDER JM09

Review Signatures:

T. Johnston 4-8-10
Tom Johnston, PhD/CLEAN QAM/Date
Tetra Tech

4/8/10
Rob Simcik/Project Manager/Date
Tetra Tech

Approval Signatures:

Arthur Sanford 4/12/10
Art Sanford/RPM/Date
BRAC PMO SE

see attached
Government Chemist/Date
NAVFAC QAO

David P. Grabka 4/30/10
David Grabka/RPM/Date
FDEP, Bureau of Waste Cleanup, Fed Section.

SAP Worksheet #1 – Title and Approval Page

(UFP-QAPP Manual Section 2.1)

DRAFT-FINAL
SAMPLING AND ANALYSIS PLAN
FEBRUARY 2010

PETROLEUM SITES: NORTH-SOUTH APRON; BUILDING 82, TANK G82; BP WELLS; AND 815 WASH RACK
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

Prepared for:
BRAC Program Management Office Southeast
4130 Faber Place Drive
North Charleston, South Carolina 29405

Prepared by:
Tetra Tech NUS, Inc.
234 Mall Boulevard, Suite 260
King of Prussia, Pennsylvania 19406

Prepared under:
Contract N62470-08-D-1001
CONTRACT TASK ORDER JM09

Review Signatures:

2/23/10
Tom Johnston, PhD/CLEAN QAM/Date
Tetra Tech

2/23/10
Rob Simoik/Project Manager/Date
Tetra Tech

Approval Signatures:

Art Sanford/RPM/Date
BRAC PMO SE

3/29/10
Government Chemist/Date
NAVFAC QAO

David Grabka/RPM/Date
FDEP, Bureau of Waste Cleanup, Fed Section.

EXECUTIVE SUMMARY

Tetra Tech, Inc. (Tetra Tech) has prepared this Sampling and Analysis Plan (SAP) for Long-term Monitoring for Petroleum Sites North-South Apron Plume (NSAP); Building 82, Tank G82; British Petroleum (BP) Wells; and 815 Wash Rack at the former Naval Air Station (NAS) Cecil Field in Jacksonville, Florida under Comprehensive Long-term Environmental Action-Navy Contract Number N62470-08-D-1001, Contract Task Order Number JM09. This SAP follows the format of the Uniform Federal Policy (UFP) for Quality Assurance Project Plans (QAPPs) and was prepared to address several ongoing long-term monitoring investigations at the former NAS Cecil Field. The sites addressed in this SAP are already part of long-term monitoring programs and all are under the Petroleum Program based on the contaminants of concern (COCs) at the sites.

The NSAP is located on the north-south flight line, east of Building 815, on the eastern edge of the apron. Benzene was detected in one direct push technology (DPT) sample groundwater sample in this area during sampling for the Sampling and Analysis Outline and Report for the Main Base Open Area 18 (HLA, 1999). The groundwater concentrations of benzene continue to exceed the Florida Department of Environmental Protection (FDEP) Groundwater Cleanup Target Level (GCTL) in the intermediate zone of the surficial Aquifer. Semi-annual monitoring is conducted to verify that contaminants do not migrate off site.

The Building 82, Tank G82 site is comprised of an air traffic control tower and underground storage tank (UST), which was used to store diesel fuel for emergency generators. Tank G82 was removed in June 1997. Soil and groundwater have been impacted near the UST as a result of leaks originating from Tank G82. The groundwater concentrations of polycyclic aromatic hydrocarbons (PAHs) and volatile organic compounds (VOCs) exceed their respective FDEP GCTL in the shallow zone of the surficial Aquifer. Semi-annual monitoring is conducted to verify that contaminants do not migrate off site.

The BP Wells Area is an aboveground storage tank farm located on the north-south flight line, southeast of Building 880, on the western edge of the apron. Contamination was discovered in the area in a due diligence investigation in October 1999 and was followed by a Site Assessment Report. The groundwater concentrations of PAHs and VOCs exceed their respective FDEP GCTL and Natural Attenuation Default Concentrations (NADCs) in the shallow zone of the surficial Aquifer. Semi-annual monitoring is conducted to verify that contaminants do not migrate off site.

Building 815 is a maintenance hangar and is located at the northern end of the flight line, at the eastern end of Lake Newman Street (formerly 6th Street). There was an aircraft wash rack to the north of the hangar on a concrete apron. Naphthalene contamination, most likely due to residual petroleum products

in the runoff, was identified in the groundwater monitoring wells at the wash rack in the 1999 Sampling and Analysis Report for Hangar 815. There are no tanks associated with this particular area of contamination. Semi-annual monitoring is conducted to verify that contaminants do not migrate off site.

The SAP contained herein was generated for and complies with applicable UFP-QAPP, FDEP, and USEPA Region 4 requirements, regulations, guidance, and technical standards as appropriate. This SAP outlines the organization, project management, objectives, planned activities, measurement, data acquisition, assessment, oversight, and data review procedures associated with the planned investigations at petroleum sites at former NAS Cecil Field. The scope of work includes but is not limited to groundwater sampling for analysis of select volatile and semivolatile compounds at the NSAP, Building 82, Tank G82 site, the BP Wells Area, and Building 815. The data will be used by the NAS Cecil Field Partnering Team to determine whether continued groundwater monitoring is appropriate or other actions must be taken to be protective of human health and the environment. Protocols for sample collection, handling, storage, chain of custody, laboratory and field analyses, data validation, and reporting are also addressed in this SAP. The investigation procedures utilized will comply with FDEP and Tetra Tech Standard Operating Procedures (SOPs). The field work and sampling are already ongoing on a regular basis. A complete schedule is detailed in SAP Worksheet #16.

Field activities conducted under this SAP shall meet the requirements of the NAS Cecil Field Site-Specific Health and Safety Plan (HASP).

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Appendices

Appendix A Field Documentation Forms and Standard Operating Procedures
Appendix B DQO Meeting Minutes
Appendix C Laboratory Standard Operating Procedures
Appendix D Laboratory DoD ELAP Certification

ACRONYMS AND ABBREVIATIONS

ABB-ES	ABB Environmental Services, Inc.
BCT	BRAC Cleanup Team
BEC	Base Environmental Coordinator
bgs	Below ground surface
bls	Below land surface
BRAC	Base Realignment and Closure
Broward	Broward Environmental Remediation Times
BTEX	Benzene, toluene, ethylbenzene, and xylenes
°C	Degree Celsius
CA	Corrective Action
CAS	Chemical Abstract Service
CCC	Calibration Check Compound
CG	Certified Geologist
CH2MHill	CH2MHill Constructors, Inc.
CLEAN	Comprehensive Long-term Environmental Action Navy
COC	Contaminant of concern
CSM	Conceptual site model
CTO	Contract Task Order
DoD	Department of Defense
DPT	Direct push technology
DQI	Data Quality Indicator
DQO	Data Quality Objective
DVM	Data Validation Manager
EGIS	Environmental Geographic Information System
FDEP	Florida Department of Environmental Protection
FOL	Field Operations Leader
FTMR	Field Task Modification Request
GC/MS	Gas Chromatograph/Mass Spectrometer
GCTL	Groundwater Cleanup Target Level
GWMR	Groundwater Monitoring Report
HASP	Health and Safety Plan
HLA	Harding Lawson Associates
HSM	Health and Safety Manager
IDW	Investigation-derived waste
IR	Installation Restoration

JEDC	Jacksonville Economic Development Commission
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LOD	Limit of Detection
LOQ	Limit of Quantitation
µg/L	Micrograms per liter
MDL	Method Detection Limit
mL	Milliliter
MOP	Monitoring Only Plan
MPC	Measurement Performance Criterion
MS/MSD	Matrix spike/matrix spike duplicate
NADC	Natural Attenuation Default Concentration
NAMP	Natural Attenuation Monitoring Plan
NAMPAO	Natural Attenuation Monitoring Plan Approval Order
NAS	Naval Air Station
NAVFAC	Naval Facilities Engineering Command
NFA	No Further Action
NSAP	North-South Apron Plume
NTU	Nephelometric turbidity unit
OSHA	Occupational Safety and Health Administration
PAH	Polycyclic Aromatic Hydrocarbon
PAL	Project Action Level
PARCCS	Precision, accuracy, representativeness, comparability, completeness, and sensitivity
PCB	Polychlorinated Biphenyl
PM	Project Manager
PMO	Project Management Office
QA	Quality Assurance
QAM	Quality Assurance Manager
QAPP	Quality Assurance Project Plan
QC	Quality Control
QSM	Quality Systems Manual
RAP	Remedial Action Plan
RF	Response Factor
RMO	Risk Management Option
RPD	Relative Percent Difference
RPM	Remedial Project Manager
RSD	Relative standard deviation

SAP	Sampling and Analysis Plan
SAR	Site Assessment Report
SARA	Site Assessment Report Addendum
SCTL	Soil Cleanup Target Level
SDG	Sample Delivery Group
SE	Southeast
SIM	Selected Ion Monitoring
SOP	Standard operating procedure
SPCC	System performance check compound
SPLP	Synthetic Precipitation Leaching Procedure
SQL	Standard query language
SSAR	Supplemental Site Assessment Report
SVOC	Semivolatile organic compound
TBD	To be determined
TMB	Trimethylbenzene
TRPH	Total recoverable petroleum hydrocarbon
Tetra Tech	Tetra Tech, Inc.
TtNUS	Tetra Tech NUS, Inc.
UFP	Uniform Federal Policy
USEPA	United States Environmental Protection Agency
UST	Underground storage tank
VOA	Volatile organic aromatic
VOC	Volatile organic compound

SAP Worksheet #2 -- SAP Identifying Information

(UFP-QAPP Manual Section 2.2.4)

Site Name/Number:	Petroleum Sites: North-South Apron Plume (NSAP); Building 82, Tank G82; BP Wells; and 815 Wash Rack
Operable Unit:	Not applicable
Contractor Name:	Tetra Tech, Inc. (Tetra Tech)
Contract Number:	N62470-08-D-1001
Contract Title:	Comprehensive Long-term Environmental Action Navy (CLEAN)
Work Assignment Number:	Contract Task Order (CTO) JM09

1. This Sampling and Analysis Plan (SAP) was prepared for Petroleum Sites NSAP; Building 82, Tank G82; BP Wells; and the 815 Wash Rack in accordance with the requirements of the United States Environmental Protection Agency (USEPA) *Uniform Federal Policy (UFP) for Quality Assurance Project Plans (QAPPs)* (USEPA, 2005) and *Guidance for Quality Assurance Project Plans, EPA QA/G-5, Quality Assurance Management Staff* (USEPA 2002).

2. Identify regulatory program: Florida Department of Environmental Protection (FDEP) Petroleum Contamination Site Cleanup Criteria, Regulation Chapter 62-770, Florida Administrative Code.

3. This document is a project-specific SAP.

4. List dates of scoping sessions that were held:

Scoping Session	Date
Data Quality Objective (DQO)/SAP Meeting – Tetra Tech Internal	August 4, 2009
DQO Scoping Meeting with Base Realignment and Closure (BRAC) Cleanup Team (BCT)	August 13, 2009
SAP Meeting – Tetra Tech Internal	September 4, 2009

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

Title	Date
NSAP	
Supplemental Site Assessment Letter II	August 3, 2005
Monitoring Only Plan (MOP) Approval Order, FDEP	October 21, 2005
Groundwater Monitoring Report (GWMR), 4th Year, 1st Semi-Annual Event	December 30, 2008
Building 82, Tank G82	
Total Recoverable Petroleum Hydrocarbons (TRPH) Report	June 25, 2002
Evaluation of Groundwater Analytical Results for BP Wells and Tank G82	April 27, 2007
Natural Attenuation Work Plan for BP Wells and Tank G82	March 29, 2008
GWMR Year 1, 4th Quarter Event	August 13, 2009
BP Wells	
Treatability Study Evaluation	April 8, 2004
Evaluation of Groundwater Analytical Results for BP Wells and Tank G82	April 27, 2007
Natural Attenuation Work Plan for BP Wells and Tank G82	March 29, 2008
GWMR Year 1, 2nd Semi-Annual Event	July 10, 2009

Title	Date
815 Wash Rack	
Source Removal Report	July 14, 2000
Supplemental Site Assessment Report (SSAR)	August 24, 2005
Site Assessment Report (SAR) Addendum (SARA)	May 15, 2008
FDEP Natural Attenuation Monitoring Plan (NAMP) Approval Order (NAMPAO)	November 6, 2008
GWMR, Year 1, 2nd Quarter	December 5, 2008

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

BRAC Project Management Office (PMO) Southeast (SE) (property owner), USEPA (regulatory), FDEP (regulatory)

7. Lead organization (see Worksheet #7 for detailed list of data users)

BRAC PMO SE (property owner)

8. 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:

Not applicable

SAP Worksheet #3 -- Distribution List

(UFP-QAPP Manual Section 2.3.1)

Name of SAP Recipients	Title	Organization	Telephone Number (Optional)	E-Mail Address
Mr. Art Sanford	Navy Remedial Project Manager (RPM)	BRAC PMO SE	(843) 743-2135	art.sanford@navy.mil
Mr. Gregory Fraley	USEPA RPM	USEPA Region 4	(404) 562-8544	fraley.gregory@epa.gov
Mr. David Grabka	FDEP RPM	FDEP	(850) 245-8997	david.grabka@dep.state.fl.us
Mr. Mark Davidson	BRAC Environmental Coordinator (BEC)	BRAC PMO SE	(843) 743-2124	mark.davidson@navy.mil
Mr. Robert Simcik	Tetra Tech Project Manager (PM) CLEAN Contractor	Tetra Tech	(412) 921-8163	robert.simcik@tetratech.com
Mr. Mike Halil	CH2M Hill PM Remedial Action Contactor (RAC)	CH2M Hill	(904) 777- 4812 ext. 233	michael.halil@CH2M.com

Name of SAP Recipients	Title	Organization	Telephone Number (Optional)	E-Mail Address
Mr. Matt Soltis	Tetra Tech Health and Safety Program Manager	Tetra Tech	(412) 921-8912	matt.soltis@tetratech.com
Ms. Bonnie Capito	Librarian and Records Manager	Naval Facilities Engineering Command (NAVFAC) Atlantic	757-322-4785	bonnie.capito@navy.mil
Mr. Ronald Kotun	Tetra Tech Project Risk Assessor and DQO Facilitator	Tetra Tech	(412) 921-8291	ronald.kotun@tetratech.com
Ms. Ralinda Miller	Tetra Tech Florida Certified Geologist (CG)	Tetra Tech	(412) 921-8995	ralinda.miller@tetratech.com
Dr. Tom Johnston	Tetra Tech QA Manager (QAM)	Tetra Tech	(412) 921-8615	tom.johnston@tetratech.com
Mr. Joe Samchuck	Data Validation Manager (DVM)	Tetra Tech	(412) 921-8510	joseph.samchuck@tetratech.com
Ms. Kara Wimble	Tetra Tech Field Operations Leader (FOL) – Petroleum Sites	Tetra Tech	(904) 636-6125	kara.wimble@tetratech.com

Name of SAP Recipients	Title	Organization	Telephone Number (Optional)	E-Mail Address
Mr. Mark Jonnet	Tetra Tech Project Environmental Geographic Information System (EGIS) Specialist	Tetra Tech	(412) 921-8622	mark.jonnet@tetratech.com
Ms. Kim Kostzer	Laboratory PM	Empirical Laboratories	(615) 345-1115	Kkostzer@empirlabs.com

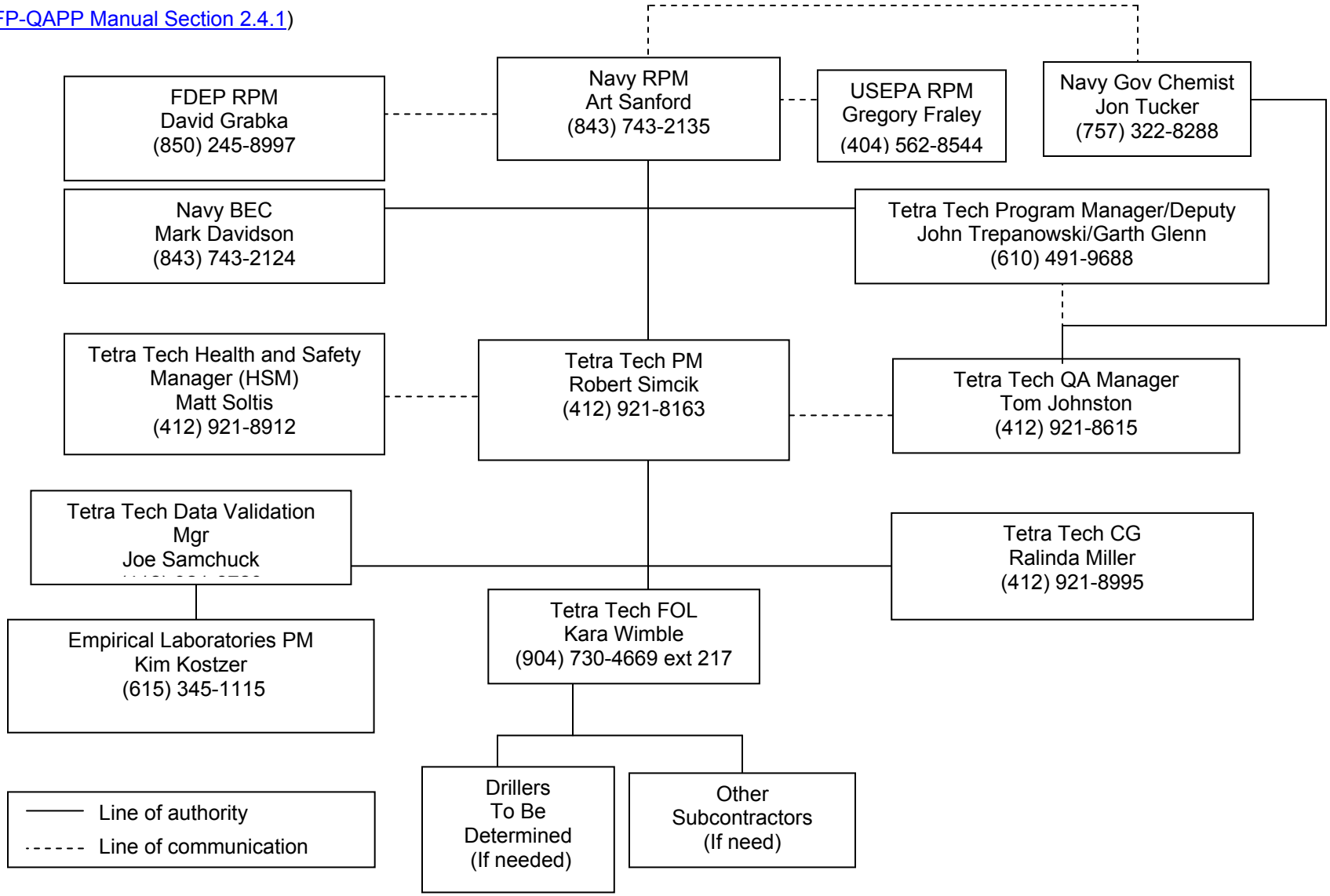
SAP Worksheet #4 -- Project Personnel Sign-Off Sheet

(UFP-QAPP Manual Section 2.3.2)

Name	Organization/Title/Role	Signature/E-Mail Receipt	SAP Section Reviewed	Date SAP Read
Robert Simcik, PE	Tetra Tech PM	See Worksheet No. 1A Tetra Tech Title and Approval Page	All	
Kara Wimble	FOL – Petroleum Sites		All	
Ralinda Miller, PG	Tetra Tech CG		All	
Joseph Samchuck	DVM		Worksheets #12, #14, #15, #19, #20, #23-28, #30, #34-37	
Tom Johnston, PhD	Tetra Tech QAM	See Worksheet #1A Tetra Tech Title and Approval Page	All	
Kim Kostzer	Laboratory PM		Worksheets #12, #14, #15A-D, #19, #20, #23-28, #30, #34-37	
Project Chemist	Ed Sedlmyer		Worksheet #s 12, 14, 15, 19, 23 through 28, 30, 34 through 37	
Ronald Kotun, PhD	DQO Facilitator and Human Health Risk Assessor		All	

SAP Worksheet #5 -- Project Organizational Chart

(UFP-QAPP Manual Section 2.4.1)



SAP Worksheet #6 -- Communication Pathways

(UFP-QAPP Manual Section 2.4.2)

Communication Drivers	Responsible Affiliation	Name	Phone Number	Procedure
Changes in schedule	Tetra Tech PM Navy RPM	Robert Simcik Art Sanford	412-921-8163 843-743-2135	Tetra Tech PM informs the Navy RPM via email within one week and Navy RPM informs via email Regulatory RPMs within one week.
Issues in the field that result in minor modifications of field methodology or sampling protocol	Tetra Tech FOL Tetra Tech PM	Kara Wimble – Petroleum Sites Robert Simcik	904-730-4669 ext: 217 412-921-8163	Tetra Tech FOL informs via email and phone call, if necessary, Tetra Tech PM within one business day, and Tetra Tech PM informs Navy RPM via and Tetra Tech CG within one week. Tetra Tech FOL documents in field log book, and Navy RPM informs Regulatory RPMs.
Field conditions that result in changes in scope of field work or major modifications in field methodology or sampling protocol	Tetra Tech FOL Tetra Tech PM	Kara Wimble – Petroleum Sites Robert Simcik	904-730-4669 ext: 217 412-921-8163	Tetra Tech FOL informs Tetra Tech PM via email within one business day, who informs the Navy RPM and Tetra Tech CG within the same business day. Tetra Tech FOL and PM prepare a field task modification request (FTMR), and Navy RPM provides request via e-mall within one week to Regulatory RPMs.
Recommendation to stop work and initiate work upon CA	Tetra Tech FOL Tetra Tech PM Tetra Tech QAM Tetra Tech Health and Safety Manager (HSM) Navy RPM	Kara Wimble – Petroleum Sites Robert Simcik Tom Johnston Matt Soltis Art Sanford	904-730-4669 ext: 217 412-921-8163 412-921-8615 412-921-8912 843-743-2135	Responsible party immediately (within one hour) informs subcontractors, Navy, and Tetra Tech PM via email and phone call. Navy RPM informs Regulatory RPMs.
Analytical data quality issues	Analytical Laboratory Tetra Tech Project Chemist	Empirical Laboratories (Kim Kostzer) Ed Sedlmyer	615-345-1115 412-921-8704	Laboratory PM notifies Tetra Tech Project Chemist within one business day via email, who notifies Tetra Tech PM within one day.

SAP Worksheet #7 – Personnel Responsibilities and Qualifications Table

(UFP-QAPP Manual Section 2.4.3)

Name	Title/ Role	Organizational Affiliation	Responsibilities
Art Sanford	Navy RPM	BRAC PMO SE	Functions as primary Navy interface with the Tetra Tech PM and Regulatory RPMs. • Oversees Tetra Tech management of project. • Provides Navy input through participation in technical meetings, review of SAP and project documents, and regular discussion with Tetra Tech PM and Regulatory RPMs.
Mark Davidson	Navy BEC	BRAC PMO SE	Functions to support elevated issues as identified by the Navy RPM
Gregory Fraley	Regulatory RPM	USEPA Region 4	Function as BCT member providing input when requested. • Provide input through participation in technical meetings and regular discussion with Navy RPM, but does not have direct regulatory input in the Petroleum Program.
David Grabka	Regulatory RPM	FDEP	Function as primary regulatory interface with the Navy RPM. • Provide regulatory input through participation in technical meetings, review of SAP and project documents, and regular discussion with Navy RPM. • Provide approval of documents in accordance with the requirements of the current Amended Site Management Plan (SMP) for former NAS Cecil Field.

Name	Title/ Role	Organizational Affiliation	Responsibilities
Robert Simcik	PM	Tetra Tech	Oversees project, manages financial, schedule, and technical day-to-day activities of the project. • Ensures timely resolution of project-related technical, quality, and safety questions associated with Tetra Tech operations. • Certifies reports. • Functions as the primary Tetra Tech interface with the Navy RPM, CG, Tetra Tech field and office personnel, and laboratory points of contact. • Ensures that Tetra Tech health and safety issues related to this project are communicated effectively to all personnel and offsite laboratories. • Monitors and evaluates all Tetra Tech subcontractor performance. • Coordinates and oversees work performed by Tetra Tech field and office technical staff (including data validation, data interpretation, and report preparation). • Coordinates and oversees maintenance of all Tetra Tech project records. • Coordinates and oversees review of Tetra Tech project deliverables. • Prepares and issues Tetra Tech deliverables to the Navy and project team.

Name	Title/ Role	Organizational Affiliation	Responsibilities
Kara Wimble	FOL	Tetra Tech	Supervises, coordinates, and performs field sampling activities. • Ensures that all health and safety requirements applicable to the field work are implemented. • Functions as the onsite communications link between field staff members, CG and Tetra Tech PM. • Alerts offsite analytical laboratories of any special health and safety hazards associated with environmental samples. • Oversees the mobilization and demobilization of all field equipment and subcontractors. • Coordinates and manages the field technical staff. • Adheres to the work schedules provided by the Tetra Tech PM. • Ensures the proper maintenance of site logbooks, field logbooks, and field recordkeeping. • Initiates FTMRs (if necessary). • Identifies and resolves problems in the field, resolves difficulties via consultation with the Tetra Tech PM and Navy RPM, implements and documents corrective actions (CAs) related to field work, and serves as communication link between the field team and project management. The FOL (or designee) will act as the Site Quality Assurance (QA)/Quality Control (QC) Advisor and will be responsible for ensuring adherence to all QA/QC requirements as defined in this SAP. Strict adherence to these procedures is critical to the collection of acceptable and representative data. • Ensures that field QC samples are collected at the proper frequencies. • Ensures that additional volumes of sample are supplied to the analytical laboratory with the proper frequency to accommodate laboratory QA/QC analyses. • Ensures that measuring and test equipment are calibrated, used, and maintained in accordance with applicable procedures and technical standards.

Name	Title/ Role	Organizational Affiliation	Responsibilities
Kara Wimble (cont.)	FOL	Tetra Tech	• Acts as liaison between site personnel, laboratory personnel, and the QA Manager. • Manages bottleware shipments and oversees field preservation. • Prepares a daily log of all work being performed. • Controls specific health and safety-related field operations such as personnel decontamination, monitoring of worker heat or cold stress, and distribution of safety equipment. • Conducts and documents a daily health and safety briefing each day while on site. • Assures that field personnel comply with all procedures established in the Health and Safety Plan (HASP). • Identifies assistant FOLs in her absence. • Terminates work if an imminent safety hazard, emergency situation, or other potentially dangerous situation is encountered. • Assures the availability and the condition of health and safety monitoring equipment. • Coordinates with FOL and PM to institute and document any necessary HASP modifications. • Ensures that facility personnel and subcontractors are adequately advised and kept clear of potentially contaminated materials.
Tom Johnston, PhD	QAM	Tetra Tech	Approves SAP and ensures that quality aspects of the CLEAN program are implemented. • Develops, maintains, and monitors QA policies and procedures. • Provides training to Tetra Tech staff in QA/QC policies and procedures. • Conducts management and technical audits to monitor compliance with environmental regulations, contractual requirements, QAPP requirements, and corporate policies and procedures. • Audits project records. • Monitors subcontractor quality controls and records. • Assists in the development of corrective action plans and ensuring correction of non-conformances reported in internal or external audits. • Ensures that this SAP meets Tetra Tech, Navy, USEPA and MEDEP requirements. • Oversees the responsibilities of the Tetra Tech Site QA/QC Advisor.

Name	Title/ Role	Organizational Affiliation	Responsibilities
Ed Sedlmyer	Project Chemist	Tetra Tech	Prepares laboratory scopes of work, coordinates analyses with laboratory chemists, ensures that the laboratory scope of work is followed, and communicates with Tetra Tech staff. Performs data quality reviews (DQRs). • Ensures that the project meets objectives from the standpoint of laboratory performance. • Provides technical advice to the Tetra Tech team on matters of data quality and project chemistry. • Monitors and evaluates subcontractor laboratory performance. • Ensures timely resolution of laboratory-related technical, quality, or other issues effecting project goals. • Functions as the primary interface between the subcontracted laboratory and the Tetra Tech PM. • Coordinates and oversees work performed by the subcontracted laboratory. • Oversees the completion of Tetra Tech data validation. • Coordinates and oversees review of laboratory deliverables. • Recommends appropriate laboratory CAs.
Ralinda Miller	CG	Tetra Tech	Oversees planning, collection, reporting, and interpretation of geologic and hydrogeologic data. • Provides oversight of the project geologist. • Reviews the SAP. • Oversees field activities, field decisions, and modifications based on field conditions. • Reviews geological and hydrogeological data evaluation and reporting.
Ronald Kotun, Ph.D.	Human Health Risk Assessor and DQO Facilitator	Tetra Tech	Performs human health risk assessment and oversees preparation of human health risk assessment and risk management decisions as well as coordination of the DQO process.
Joseph Samchuck	DVM	Tetra Tech	Provides QA of data validation deliverables.

Name	Title/ Role	Organizational Affiliation	Responsibilities
Matt Soltis	HSM	Tetra Tech	Oversees CLEAN Program Health and Safety Program. • Provides technical advice to the Tetra Tech PM on matters of health and safety. • Oversees the development and review of the HASP. • Conducts health and safety audits. • Prepares health and safety reports for management.
Kim Kostzer	Laboratory PM	Empirical Laboratory	• The subcontracted laboratory for long-term monitoring program (LTMP) is responsible for analyzing all samples in accordance with the analytical methods and additional requirements specified in this SAP. It will also be the analytical laboratory's responsibility to properly dispose of unused sample aliquots. Responsibilities of key laboratory personnel are outlined below. Interfaces directly with the Tetra Tech Project Chemist, Tetra Tech PM, and Tetra Tech QA Manager. • Ensures that methods and project-specific requirements are properly communicated and understood by laboratory personnel. • Ensures that all laboratory resources are available on an as-required basis. • Ensures compliance with analytical and project QA requirements. • Reviews data packages for completeness, clarity, and compliance with project requirements. • Informs the Tetra Tech PM of project status and any sample receipt or analytical problems. • Oversees the preparation of and approves final analytical reports before they are submitted to Tetra Tech.
Marcia McGinnity	Laboratory Operations Manager	Empirical Laboratory	Supports the QA program within the laboratory. • Provides management overview of both production- and quality-related laboratory activities. • Maintains adequate staffing to meet project analytical and quality objectives. • Approves all laboratory standard operating procedures (SOPs) and QA documents. • Supervises in-house chain-of-custody documentation

Name	Title/ Role	Organizational Affiliation	Responsibilities

To Be Determined (TBD)	Laboratory QA Officer	Empirical Laboratory	Reports directly to the Laboratory Operations Manager and is independent of laboratory production management to ensure that laboratory quality performance is assessed without schedule and considerations.
			
			• Defines appropriate laboratory QA procedures and monitors overall laboratory QA.
			• Stops work if a condition adverse to the quality of work is encountered, if QA or QC procedures are not followed, or if analytical out-of-control events are encountered that have not been corrected.
			  • Approves and maintains document control of all QA documents and SOPs.
			  • Performs and/or implements internal system and performance audits and verifies completion of CAs cited in audits.
			  • Directs laboratory participation in laboratory accreditation and certification programs.
			• Reviews overall data packages and case narratives for completeness according to project requirements and analytical methods.

SAP Worksheet #8 -- Special Personnel Training Requirements Table

(UFP-QAPP Manual Section 2.4.4)

All field personnel will have appropriate training to conduct the field activities to which they are assigned. Additionally, each site worker will be required to have completed a 40-hour course (and 8-hour refresher, if applicable) in health and safety training (HAZWOPER) as described under Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) 1910.120(b)(4) (OSHA, 2002).

SAP Worksheet #9 -- Project Scoping Session Participants Sheet

(UFP-QAPP Manual Section 2.5.1)

Project Name: Former NAS Cecil Field PM: Rob Simcik	Site Name: Petroleum Sites: NSAP; Building 82, Tank G82; BP Wells; 815 Wash Rack Site Location: Jacksonville, Florida

Date of Session: August 4, 2009
Scoping Session Purpose: Tetra Tech internal discussion to prepare the presentations of the DQOs for the August 13, 2009, DQO meeting for the BCT.

Name	Title	Affiliation	Phone #	E-Mail Address	Project Role
Ronald Kotun, Ph.D.	Senior Toxicologist	Tetra Tech	(412) 921-8291	ronald.kotun@tetratech.com	DQO Facilitator and Risk Assessor
Robert Simcik, P.E.	PM	Tetra Tech	(412) 921-8361	robert.simcik@tetratech.com	PM
Megan Ritchie	Project Chemist	Tetra Tech	(610) 491-9688	megan.ritchie@tetratech.com	Installation Restoration (IR) Sites Project Chemist
Kara Wimble	Geologist	Tetra Tech	(904) 730-4669 ext. 217	kara.wimble@tetratech.com	FOL for Petroleum Sites

Comments/Decisions:

Draft Worksheets 10 and 11 were prepared as a departure point for discussion at the August 13th meeting. It was decided that all of the sites to be investigated under the Petroleum Program would be included in one SAP, expect for the Tanks 81 A/B/C SAP.

Action Items:

Ron requested that Kara and Megan make Power Point slides of DQO Problem Statements, Decision Statements, Inputs, and Decision Rules for each Site at NAS Cecil Field included in the UFP-SAP.

Consensus Decisions:

The slides would serve as a straw man for the DQO Facilitation meeting on August 13, 2009.

Project Name: Former NAS Cecil Field PM: Rob Simcik	Site Name: Petroleum Sites: NSAP; Building 82, Tank G82; BP Wells; 815 Wash Rack Site Location: Jacksonville, Florida
Date of Session: August 13, 2009 **Scoping Session Purpose:** DQO meeting with Tetra Tech, Navy, and Regulatory Team.	

Name	Title	Affiliation	Phone #	E-Mail Address	Project Role
David Grabka	RPM	FDEP	(850) 245-8997	david.grabka@dep.state.fl.us	RPM
Art Sanford	RPM	Navy	(843) 743-2135	art.sanford@navy.mil	RPM
Ronald Kotun, Ph.D.	Senior Toxicologist	Tetra Tech	(412) 921-8291	ronald.kotun@tetratech.com	DQO Facilitator and Risk Assessor
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Mark Jonnet	EGIS/Engineer	Tetra Tech	(412) 921-8622	mark.jonnet@tetratech.com	EGIS/Engineer
Mike Halil	Remedial Action Contractor PM	CH2M Hill	(904) 777-4812 ext. 233	michael.halil@CH2M.com	RAC PM
Kara Wimble	Scientist	Tetra Tech	(904) 730-4669 ext. 217	kara.wimble@tetratech.com	Petroleum PM

Comments/Decisions:

Draft SAP Worksheets #10 and #11 were provided to the meeting participants on August 13, 2009. Revisions to Worksheets #10 and #11 and figures were made based on the meeting discussion. The meeting minutes are included in Appendix B.

Action Items:

Complete UFP-SAP for Petroleum Sites and Tanks 81 A, B, and C based on BCT agreement of the DQOs.

Consensus Decisions:

BCT decisions regarding DQOs are included in meeting minutes in Appendix B.

SAP Worksheet #10 -- Conceptual Site Model

(UFP-QAPP Manual Section 2.5.2)

The sites discussed in this SAP are all located within NAS Cecil Field. The majority of former NAS Cecil Field is located in southwestern Duval County, and the southernmost portion of NAS Cecil Field is located in Clay County, as shown on Figure 10A-1. The base was operated by the Navy from approximately 1943 to 1999. This SAP governs work to be conducted at four NAS Cecil Field sites where petroleum compounds are the primary contaminants of concern (COCs): 1) NSAP; 2) Building 82, Tank G82; 3) BP Wells ;and 4) 815 Wash Rack. These four sites are being investigated and acted upon under the FDEP Petroleum Program. Groundwater at all four of the sites is currently being monitored, and this SAP is being used to identify and refine the LTMP for each site. Figure 10A-1 provides a location map for all four petroleum sites. Additional details concerning conceptual site models for each site, including historical site activities, past investigations, current site conditions, and potential unacceptable ecological and human exposures are provided below.

10A NORTH-SOUTH APRON PLUME

10A.1 SITE DESCRIPTION

The NSAP is located on the north-south flight line, east of Building 815, on the eastern edge of the apron (see Figure 10A-2). The site has been under the LTMP since 2001. Aviation related activities were conducted in this area since Cecil Field was established in 1941 including fueling operations, aircraft maintenance, and operational activities. Information regarding potential source of contamination at this site is very limited.

10A.2 HISTORY OF ENVIRONMENTAL INVESTIGATIONS AND ACTIONS

A direct push technology (DPT) investigation by Harding Lawson and Associates (HLA) in 1999 led to Tetra Tech conducting a site assessment of Main Base Open Area 18 (not shown on Figure 10A-2). The SAR indicated “the contamination is limited to non-chlorinated hydrocarbons and the site should be managed under the Florida Petroleum Contamination Sites regulations, Chapter 62-770, Florida Administrative Code (FAC)”. Two shallow wells (CEF-M18-01S and CEF-M18-02S) and five intermediate wells (CEF-M18-01I through CEF-M18-05I) were installed and sampled as part of the SAR. The investigation confirmed the presence of benzene and xylenes in the groundwater at concentrations greater than the FDEP Groundwater Cleanup Target Levels (GCTLs). The SAR stated that no upgradient shallow contaminant source could be identified that explained the presence of this groundwater contamination (Tetra Tech NUS, Inc [TtNUS], 2001). The FDEP approved the MOP presented in the SAR on March 16, 2001.

Tetra Tech conducted four quarterly groundwater monitoring events for the site on the following dates: May 2, 2001; August 7, 2001; November 6, 2001; and, February 14, 2002. The data indicated that benzene concentrations had increased in monitoring wells CEF-M18-02I and CEF-M18-04I, and the Year 1 milestone objectives had not been achieved in those wells (TtNUS, 2002). The report recommended the Navy suspend monitoring and conduct a supplemental site assessment and FDEP concurred in May 2002.

Between August and December 2004, Tetra Tech conducted a DPT investigation and installed and sampled five intermediate monitoring wells (CEF-M18-06I through CEF-M18-10I) and two deep monitoring wells (CEF-M18-11D and CEF-M18-12D) (TtNUS, 2005a).

On October 21, 2005, the FDEP agreed with an SSAR recommendation to conduct long-term groundwater monitoring (LTM) and submitted a NAMPAO (FDEP, 2005). Since 2005, regular LTM has occurred at the site. Results from the most recent sampling event (October 2008) indicate that benzene continues to exceed its GCTL at monitoring well CEF-M18-04I but benzene is less than its GCTL at all other LTM wells (TtNUS, 2008a).

10A.3 CONCEPTUAL SITE MODEL

A summary of the conceptual site model (CSM) based on post-removal action site conditions at the NSAP is shown on Figure 10A-3. The text below describes the CSM.

10A.3.1 Sources of Contamination

Based on the 2001 SAR, no upgradient shallow source could be identified that would explain the presence of benzene, toluene, ethylbenzene, and xylenes (BTEX) in groundwater.

Dioxins, semivolatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), and other metal analyses are not required during this investigation because data from previous investigations indicated that these analytes were not detected or were detected at concentrations less than FDEP GCTLs on a consistent basis.

10A.3.2 Potential Contaminant Migration Mechanisms

Because the benzene contamination is located between 30 feet to 35 feet below land surface (bls) in the groundwater only, the contamination could migrate to the southeast in the intermediate zones of the surficial Aquifer based on the historical groundwater flow data. Soil leaching to groundwater under the

influence of infiltrating precipitation is a potential contaminant migration mechanism. Upon entering the water column, contaminants are carried with the flow of groundwater to downgradient locations. Groundwater contaminants may be deposited in sediment or surface water. Surface water runoff in the NSAP area is collected by the storm sewer system, thus overland runoff does not affect the contamination, which is only present from 30-35 ft bls.

10A.3.3 Land Uses and Potential Exposure

The Jacksonville Economic Development Commission (JEDC) Reuse Plan provides for continued industrial and/or commercial uses of the site.

Land use controls were developed for this site in January 2005 and identified the site has aromatics exceeding human health criteria in groundwater. The LUCs are as follows (TtNUS, 2007):

- Groundwater may not be used for human consumption.
- Groundwater may not be used for industrial purposes.
- Tampering or damaging any Navy wells or remediation systems is prohibited.

Former NAS Cecil Field is supplied with public water; therefore, human exposure to potentially contaminated site groundwater through ingestion, inhalation, or direct contact with potable water is not a consideration. Ecological receptors are not exposed to groundwater however, contamination exceeding regulatory criteria remains.

The petroleum sites are located in highly developed areas, consist largely of paved areas and buildings, and do not allow for direct access for contact with groundwater. The resulting lack of ecological habitat and complete exposure pathways preclude potential unacceptable risks for ecological receptors. Direct exposure of potential human receptors to soil and groundwater is restricted based upon the current and future land use.

Because potential contaminant sources no longer exist at the site and because the levels of contamination are low, additional contributions to the contaminant plume will not occur.

10B BUILDING 82, TANK G82

10B.1 SITE DESCRIPTION

The Building 82, Tank G82 site comprises an air traffic control tower and underground storage tank (UST), G82, which used to store diesel fuel for emergency generators. Tank G82 was removed in

June 1997. Soil and groundwater have been contaminated near the UST as a result of leaks originating from Tank G82. The leaking tank released an unknown volume of fuel to the environment. A detailed site plan is shown on Figure 10B-1.

10B.2 HISTORY OF ENVIRONMENTAL INVESTIGATIONS AND ACTIONS

From 1997 to 2006, several environmental investigations were conducted to determine levels and extent of polycyclic aromatic hydrocarbon (PAH) and volatile organic compound (VOC) contaminants which were identified to be related to site operations. Dioxins, pesticides, PCBs, and metals were not detected or were detected at concentrations less than FDEP GCTLs on a consistent basis (ABB-ES, 1998). The investigations required installation of several groundwater monitoring wells, and soil and groundwater sampling and analyses. Synthetic Precipitation Leaching Procedure (SPLP) analyses and organic carbon chain speciation were conducted on select samples.

In 2001, CH2M Hill removed approximately 148 cubic yards of soil contaminated with PAHs and VOCs. Removal of contaminated soil in the northern and southern portions of this site was confirmed as complete in 2001 (CH2MHill, 2001). A 2001 SARA concluded that approximately 49 cubic yards of contaminated soil remained along Building G82 and the flight line eastern and western areas. In samples collected from the unexcavated soil, TRPH was reported present in soil at concentrations greater than the FDEP SCTL. Xylenes, naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene also were present in the leachate of SPLP samples at concentrations that exceeded their respective GCTLs (FDEP, 2001). One carbon chain fraction (C12-C16, aliphatic) exceeded its subclassification SCTL (Residential SCTL - 4,500; Leachability SCTL – 1,000,000 mg/kg) (Broward, 2001).

CH2M Hill conducted a site-wide groundwater monitoring event in November 2006. Natural attenuation of contaminants was concluded to be occurring, with COC concentrations shown to be decreasing in the absence of active remediation (CH2MHill, 2007).

A NAMP for Building 82, Tank G82, is currently awaiting FDEP approval pending the receipt of a sealed and signed copy of the NAMP. Tetra Tech performed quarterly groundwater sampling in accordance with the May 2008 NAMP per verbal FDEP approval from July 2008 to April 2009 (CH2MHill, 2008).

10B.3 CONCEPTUAL SITE MODEL

A summary of the CSM based on post-removal action site conditions at Building 82, Tank G82 is shown on Figure 10B-2. The text below describes the CSM.

10B.3.1 Sources of Contamination

Soil and shallow groundwater (near the top of the water table) are contaminated near the UST as a result of leaks originating from Tank G82. Soil excavation in this area was terminated to prevent potential damage to infrastructure, leaving approximately 49 cubic yards of contaminated soil along Building 82 and the flight line apron.

Benzene, naphthalene, isopropyl benzene, 1,2,4-Trimethylbenzene (TMB), 1-methylnaphthalene, and 2-methylnaphthalene have been detected at the site downgradient from the unexcavated soil at concentrations exceeding their respective GCTLs.

10B.3.2 Potential Contaminant Migration Mechanisms

Soil contaminants may migrate to groundwater due to leaching under the influence of infiltrating precipitation. Upon entering the water column, a chemical may be carried with the flow of groundwater to downgradient locations. Groundwater contaminants may ultimately be deposited in sediment or surface water. The Building 82, Tank G82 shallow groundwater VOC contamination is migrating from the former location of the UST to the southeast in the shallow zones of the surficial Aquifer. Surface water runoff in the Building 82, Tank G82 area is also a possible migration mechanism.

The most recent data indicate that contamination is located under the apron at flight line (approximately 15 feet bls in the groundwater only) and is migrating in the shallow zone of the surficial Aquifer. In addition, the site is located on the apron and is covered with concrete. The groundwater flow at the site is to the east-southeast.

10B.3.3 Land Uses and Potential Exposure

The JEDC Reuse Plan provides for continued industrial and/or commercial uses of the site.

Land use controls were developed for this site in January 2005 and identified the site has aromatics, naphthalenes, and TRPH exceeding human health criteria in groundwater. The LUCs are as follows (TtNUS, 2007):

- Land may not be used for residential use.
- Surface soils may not be disturbed.
- Subsurface soils may not be disturbed.
- Groundwater may not be used for human consumption.

- Groundwater may not be used for industrial purposes.
- Tampering or damaging any Navy wells or remediation systems is prohibited.

Former NAS Cecil Field is supplied with public water; therefore, human exposure to potentially contaminated site groundwater as a result of potable water use is not a consideration. Ecological receptors are not exposed to groundwater; however, contamination exceeding regulatory criteria remains.

The petroleum sites are located in highly developed areas, consist largely of paved areas and buildings, and do not allow for direct access for contact with groundwater. The resulting lack of ecological habitat and complete exposure pathways preclude potential unacceptable risks for ecological receptors. Direct exposure of potential human receptors to soil and groundwater is prevented based upon the current and future land use.

10C BP WELLS

10C.1 SITE DESCRIPTION

The BP Wells area is located on the north-south flight line, southeast of Building 880, on the western edge of the apron. The BP Wells area is associated with a secondary containment for several large aboveground storage tanks that actively serve to refuel planes and other vehicles. In October 1999, Golder Associates, Inc. performed a due diligence investigation of the area for construction of a proposed aircraft fueling station on behalf of BP Kaman. The history of the BP Wells area prior to the due diligence investigation is not documented. As part of the due diligence investigation, four shallow monitoring wells (CEF-BP-1 through CEF-BP-4) were installed and sampled for organic compounds. TRPH; toluene; ethylbenzene; xylenes; naphthalene; 1,2,4-TMB; and 1,3,5-TMB were detected in one well at concentrations greater than FDEP GCTLs. Based on the initial results, the Navy directed Tetra Tech to further investigate the nature and extent of the groundwater contamination. A detailed site plan is shown on Figure 10C-1. There have been no remedial actions at the site other than monitoring.

10C.2 HISTORY OF ENVIRONMENTAL INVESTIGATIONS AND ACTIONS

A SAR was initiated by Tetra Tech in February 2000 based on the results of the due diligence investigation. Xylenes and TMBs were detected in monitoring well CEF-BP-1S at concentrations above the FDEP GCTLs. The SAR recommended a groundwater MOP for xylenes, 1,2,4-TMB, and 1,3,5-TMB, which was subsequently approved on August 31, 2000 (FDEP, 2000a).

During MOP implementation, the direction of groundwater flow continued to be to the southeast. The analytical results indicated that the action levels for 1,2,4-TMB; 1,3,5-TMB; and xylenes were exceeded in

the groundwater sample from monitoring well CEF-BP-1S. The concentrations of 1,2,4-TMB; 1,3,5-TMB; and xylenes in groundwater samples from CEF-BP-1S also exceeded the Natural Attenuation Default Concentrations (NADCs). Under the petroleum program, when concentrations exceed the NADCs, then a Remedial Action Plan is recommended for the site (see next paragraph). The concentrations in monitoring well CEF-BP-1S were also significantly greater than those observed in the previous sampling event (April 2001).

The monitoring report recommended that the semi-annual monitoring program be suspended and that a Remedial Action Plan (RAP) be prepared for the site because the contaminant concentrations at the source well were greater than the NADCs and because there was a significant increase in contaminant concentrations. On February 20, 2002, the FDEP agreed that a RAP was warranted. Subsequently, Tetra Tech recommended that a treatability study be conducted for this small petroleum plume. The Treatability Study was completed in five installments from October 2002 through October 2003, and tested the effectiveness of an iSOC^{TM} system in reducing hydrocarbon concentrations in groundwater at the BP Wells site. The Treatability Study Report (TtNUS, 2004), stated that the iSOC^{TM} system was not effective and it was recommended that an air sparging pilot study be conducted. At the March 2004 BCT meeting, it was agreed that the treatability study approach would be discontinued and an additional site assessment would occur.

No action was taken until a site-wide groundwater monitoring event was performed by CH2M Hill in November 2006. Cumene; ethylbenzene; total xylenes; 1,3,5-TMB; and 1,2,4-TMB were detected in monitoring well CEF-BP-1S at concentrations exceeding their respective GCTLs (CH2MHill, 2007). CH2M Hill submitted a NAMP for the BP Wells, in conjunction with the adjacent Building 82, Tank G82 site, identifying that long-term monitoring of natural attenuation in groundwater for 3 years was needed (CH2MHill, 2008).

For the first two semi-annual monitoring events for Year 1 at the BP Wells site (July 2008 and January 2009), increasing concentrations and potential plume migration were observed in monitoring wells CEF-BP-1S and CEF-BP-6S. Concentrations of ethylbenzene; total xylenes; naphthalene; 1,2,4-TMB; 1,3,5-TMB; and isopropyl benzene exceeded GCTLs and NADCs in the source well CEF-BP-1S. The GCTL for 2-methylnaphthalene was exceeded in monitoring well CEF-BP-1S. Concentrations of isopropyl benzene and 1,2,4-TMB exceeded their respective GCTLs in monitoring well CEF-BP-6S (TtNUS, 2008b and TtNUS, 2009a).

10C.3 CONCEPTUAL SITE MODEL

A summary of the CSM based on post-removal action site conditions at the BP Wells site is shown on Figure 10C-2. The text below describes the CSM.

10C.3.1 Sources of Contamination

The contaminant source area well (CEF-BP-1S) is located at the southeastern corner of the secondary containment for several large aboveground storage tanks that actively serve to refuel planes and other vehicles at the former NAS Cecil Field. The pipe used to direct accumulated water inside the secondary containment empties adjacent to source well CEF-BP-1S. This pipe leads to the oil/water separator located directly to the west of source cell CEF-BP-1S and, according to a representative of the Jacksonville Aviation Authority employee in July 2009, the oil/water separator has overflowed repeatedly possibly contributing to the source of the contamination. This pipe is still in place and functioning, and the water from the oil/water separator discharges into the stormwater sewer maintained by Jacksonville Electric Authority.

Ethylbenzene, 2-methylnaphthalene, isopropyl benzene, naphthalene, 1,2,4-TMB, 1,3,5-TMB, and total xylenes were previously detected at the BP Wells at concentrations greater than their respective GCTLs. Ethlybenzene, isopropylbenzene and xylenes are considered to be volatile chemicals; the others in this list are considered to be semivolatile. The COCs are listed below:

COC	USEPA Method
Ethylbenzene	8260
2-Methylnaphthalene	8270
Isopropyl benzene (LOQ = 1.0 µg/L)	8260
Naphthalene	8270
1,2,4-TMB	8260
1,3,5-TMB	8260
Total xylenes	8260

10C.3.2 Potential Contaminant Migration Mechanisms

VOC and PAH contamination is located in the shallow zone of the surficial groundwater aquifer only and the contamination is migrating from the source area to the southeast in the shallow zone of the aquifer. Soil contaminants may continue to migrate to groundwater under the influence of infiltrating precipitation. Upon entering the water column, a chemical may be carried with the flow of groundwater to downgradient locations. Groundwater contaminants may be ultimately deposited in sediment or surface water. Surface water runoff in the BP Wells area is also a possible migration mechanism.

The most recent data indicate that the contamination is located under the flight line apron at the top of the water table in groundwater only, and the contamination is migrating in the shallow zone of the surficial

Aquifer. In addition, the site is located on the apron and is covered with concrete. The contamination groundwater flow is to the east-southeast.

10C.3.3 Land Uses and Potential Exposure

The JEDC Reuse Plan provides for continued industrial and/or commercial uses of the site.

Land use controls were developed for this site in January 2005, revised in June 2005, and identified the site has aromatics and naphthalenes exceeding human health criteria in groundwater. The LUCs are as follows (TtNUS, 2007):

- Land may not be used for residential, recreational, or agricultural use.
- Surface soils may not be disturbed.
- Subsurface soils may not be disturbed.
- Groundwater may not be used for human consumption.
- Groundwater may not be used for industrial purposes.
- Tampering or damaging any Navy wells or remediation systems is prohibited.

Former NAS Cecil Field is supplied with public water; therefore, human exposure to potentially contaminated site groundwater for through ingestion, inhalation, or direct contact is not a consideration. Ecological receptors are not exposed to groundwater; however contamination exceeding regulatory criteria remains.

The petroleum sites are located in highly developed areas, consist largely of paved areas and buildings, and do not allow for direct access for contact with groundwater. The resulting lack of ecological habitat and complete exposure pathways preclude potential unacceptable risks for ecological receptors. Direct exposure of potential human receptors to soil and groundwater is restricted based upon the current and future land use.

10D 815 WASH RACK

10D.1 SITE DESCRIPTION

Building 815 is a maintenance hangar and is located at the northern end of the flight line, at the eastern end of Lake Newman Street (formerly 6th Street). There was a wash rack north of the hangar. A site plan is included as Figure 10D-1.

10D.2 HISTORY OF ENVIRONMENTAL INVESTIGATIONS AND ACTIONS

Naphthalene contamination in groundwater was identified in wells at the location of the former wash rack in the 1999 Sampling and Analysis Report for Hangar 815. There are no tanks associated with this particular area of contamination. For the 1999 SAR, two shallow monitoring wells were installed at the wash rack. The extent of contamination was delineated, and semi-annual monitoring was proposed and approved under the FDEP Petroleum Program (FDEP, 2000b).

Long-term monitoring occurred at the site per FDEP approval of the recommended sampling. Following the results from the July 2003 groundwater sampling event, Tetra Tech concluded that naphthalene concentrations in the well CEF-815-1S were continuously exceeding the annual milestone cleanup objectives (TtNUS, 2004b). Tetra Tech recommended that the monitoring program be discontinued and a RAP be developed for the site. The FDEP concurred with discontinuing the monitoring program and recommended conducting a soil assessment prior to preparation of a RAP. The results from the soil assessment indicated that the FDEP SCTL for TRPH was not exceeded where TRPH was detected. The COCs benzene, toluene, ethyl benzene, total xylenes, methyl tert-butyl ether, and PAHs were not detected and the reporting limits were less than SCTLs (TtNUS, 2005b).

Based on results from the January 2005 supplemental soil sampling results, during the February 2005 partnering meeting, the BCT agreed to transfer the site from the UST program to the IR Program so site remediation could occur concurrently with Site 59. Therefore, the remedial action was scheduled to be conducted under the IR Program.

During the September 2007 BCT meeting, it was decided that groundwater at the 815 Wash Rack area would be investigated under the Petroleum Program. Because nearly two years had passed since the most recent groundwater sampling event had occurred at the site and a RAP had not been prepared for of the site's transfer to the IR Program, a SARA was completed in May 2008 (TtNUS, 2008c). In November 2007, TNUS collected groundwater samples from monitoring wells CEF-815-1S and NG-12S and sampled for naphthalene and TRPH. Elevated levels of naphthalene were detected in CEF-815-1S; therefore, monitoring well CEF-815-5S was installed downgradient from the site to further delineate the contamination plume in February 2008. Based on the recommendation of the SARA, FDEP approved long-term monitoring of the site (FDEP, 2008).

10D.3 CONCEPTUAL SITE MODEL

A summary of the CSM based on post-removal action site conditions at the 815 Wash Rack area is shown on Figure 10D-2. The text below describes the CSM.

10D.3.1 Sources of Contamination

The source of 815 Wash Rack groundwater contamination is soil in the area of the wash rack located to the north of Building 815. Dioxins, SVOCs, pesticides, PCBs, and other metal analyses were conducted at this site but naphthalene is the only COC, as no other chemicals have been detected at concentrations exceeding GCTLs.

10D.3.2 Potential Contaminant Migration Mechanisms

Naphthalene contamination is limited to the shallow zone of the surficial groundwater aquifer and the contamination is migrating to the southeast from the 815 Wash Rack area. Surface water runoff from the 815 Wash Rack area is collected by below-ground storm sewer pipes that discharge to a flight line outfall on the eastern side of the north-south runways. A stormwater retention pond located west of the 815 Wash Rack was investigated as PSC 56. The pond received discharges from floor drains in Hangar 1845 and from a nearby oil/water separator. No further action was recommended based on the results of the PSC investigation of the stormwater pond (TtNUS, 2001e).

Soil contaminants may migrate to groundwater under the influence of infiltrating precipitation. Upon entering the water column, a chemical may be carried with the flow of groundwater to downgradient locations. Groundwater contaminants may be ultimately deposited in sediment or surface water.

10D.3.3 Land Uses and Potential Exposure

The JEDC Reuse Plan provides for continued industrial and/or commercial uses of the site.

Land use controls were developed for Site 59 in May 2009 (TtNUS, 2009b) and Building 815 Wash Rack is contained within this area. The LUC RD identified the site has chlorinated volatiles exceeding human health criteria in groundwater. The LUCs are as follows (TtNUS, 2007):

- Groundwater may not be used for human consumption.
- Groundwater may not be used for industrial purposes.
- Tampering or damaging any Navy wells or remediation systems is prohibited.

Former NAS Cecil Field is supplied with public water; therefore, human exposure to potentially contaminated site groundwater as a result of potable use is not a consideration. Ecological receptors are not exposed to groundwater; however contamination exceeding regulatory criteria remains.

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The petroleum sites are located in highly developed areas, consist largely of paved areas and buildings, and do not allow for direct access for contact with groundwater. The resulting lack of ecological habitat and complete exposure pathways preclude potential unacceptable risks for ecological receptors. Direct exposure of potential human receptors to soil and groundwater is prevented based upon the current and future land use.

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

(UFP-QAPP Manual Section 2.6.1)

11A NORTH-SOUTH APRON PLUME

11A.1 PROBLEM DEFINITION

Benzene groundwater contamination remains in the area of the NSAP site. Concentrations exceed FDEP GCTLs. Long-term monitoring verified that no contaminant migration is occurring. The source of contamination is unknown, and the plume appears to be contained. Groundwater is monitored semi-annually. To confirm whether natural attenuation is occurring at the site, data regarding the benzene levels in the groundwater must be collected and evaluated. These data will be used to determine an appropriate path forward as described in Section 11A.4.

11A.2 INFORMATION INPUTS

Requirements for groundwater sampling and analysis methods are described below. Additional detail (e.g., the methods and SOPs to be used) is provided in Worksheet #s 15, 19, and 21.

Required Analyses

Matrix	VOCs	Purpose
Groundwater	Benzene only	Long-term monitoring

Analytical Methods

Analytical methods were selected to be the same as those used previously or at least comparable to previously used analytical methods with respect to precision, accuracy, representativeness, comparability, completeness, and sensitivity (PARCCS) parameters. See Worksheets Nos. 20 and 23 for a list of the analytical methods applicable to each site.

Sampling Methods

Sampling methods were selected to be the same as those used previously or to at least be consistent with the representativeness and comparability of data for each media being sampled at each site. See Worksheet No. 21 for a list of sampling methods.

Action Levels

A full list of project action levels (PALs) is included within Worksheet 15. The BCT has ensured that the selected laboratory Limits of Quantitation (LOQs) are generally low enough to measure constituent concentrations in site media that are less than the PALs in order to conduct comparisons of site data to

the PALs. The LOQ for benzene is equal to the PAL, and the Method Detection Limit (MDL) is less than the LOQ.

The groundwater benzene results from individual wells will be combined with previously collected data in the same wells and compared to the FDEP benzene GCTL to determine whether the temporal benzene concentration trend in each well indicates that GCTL levels have been attained or appear to be attainable within two consecutive sampling rounds.

11A.3 STUDY BOUNDARIES

The NSAP area covers approximately 25.2 acres, delineated from the northwest corner to the southeast corner by CEF-M18-01S and CEF-M18-05I, respectively. This area is shown in Figure 10A-2. The vertical boundary for the groundwater plume is the water table. The groundwater benzene contaminant plume is the population of interest and constitutes the spatial decision unit. The temporal decision unit is each round of monitoring when determined whether an exceedance of GCTL has occurred and it is two consecutive monitoring rounds when determining whether parameters or wells may be eliminated from monitoring.

11A.4 ANALYTIC APPROACH

A direct comparison of measured concentrations within the groundwater will be made against the appropriate PAL. The PAL for benzene is detailed in Worksheet No. 15. Additionally, if none of the measured benzene concentrations within any groundwater sample exceed criteria after two consecutive rounds of monitoring, then the monitoring program will be discontinued after coordination with the BCT. The following decision rules govern data use for the monitoring programs at NSAP.

Decision Rule #1: If the measured benzene concentration from any non-compliance/source well groundwater sample is greater than the GCTL, then continue long-term monitoring until levels of benzene are below the GCTL for two consecutive sampling rounds.

Decision Rule #2: If the measured benzene concentration is greater than the GCTL in any compliance well sample, then additional delineation will be performed by Tetra Tech and an FTMR will be issued to govern the delineation.

Decision Rule #3: If the measured benzene concentration in any well sample exceeds the GCTL in a given sampling round, but no migration is detected downgradient of the compliance wells for two consecutive semi-annual events, then a permanent groundwater restriction will be evaluated for Risk Management Option (RMO) III (62-780.680, F.A.C.). This will indicate that contamination exists and the

contaminated area is defined. RMO III would put a restriction on the use of the groundwater, but allow it to remain onsite.

Decision Rule #4: If all measured benzene concentrations in all groundwater samples collected from the targeted monitoring wells are less than action levels for two consecutive quarters, then recommend No Further Action (NFA).

Decision Rule #5: Throughout the groundwater monitoring, if any particular measured benzene concentration is less than its GCTL for two consecutive sampling rounds, then the BCT will discuss the elimination of the well from the monitoring program, in accordance with the Navy guidance on groundwater monitoring well optimization. The well will be eliminated unless it is a compliance well, or the BCT determines that the inclusion of the well provides useful information on evaluating the overall program and should not be removed.

11A.5 PERFORMANCE CRITERIA

Benzene concentrations in individual samples and temporal benzene concentration trends within individual wells will be compared to the project action level. The BCT will use the measured results to determine whether the amount and type of data collected are sufficient to support the attainment of Remedial Action Objectives. If all data have been collected as planned and no data points are missing or rejected for quality reasons, the type and amount of data collected will be considered satisfactory. If any data gaps are identified, including missing or rejected data, the BCT will assess whether a claim of having obtained project objectives is reasonable. This assessment will depend on the number and type of identified data gaps; therefore, a more detailed strategy cannot be presented. All stakeholders will be involved in rendering the final conclusion regarding adequacy of the data.

11A.6 PLAN FOR OBTAINING DATA

The plan for obtaining data at the NSAP site is described in detail on Worksheet #17 along with the sampling designs and rationales.

11B BUILDING 82, TANK G82

11B.1 PROBLEM DEFINITION

Contaminant concentrations in source area well CEF-G82-2S exceed GCTLs. Soil contamination that exceeds leachability SCTLs remains at this site. Approximately 49 yd^3 of impacted soil was not accessible for removal due to proximity to Building 82 and is now capped with a concrete handicap ramp, thus groundwater is the medium of concern. Natural attenuation is the selected remedy for groundwater

at the site, so groundwater monitoring is required to determine whether natural attenuation is occurring at the site or a different remedy should be considered.

11B.2 INFORMATION INPUTS

Requirements for groundwater sampling and analysis methods are described below. Additional detail (e.g., the exact methods and SOPs to be used) is provided in Worksheet #s 15, 19, and 21.

Required Analyses

COC	USEPA Method	GCTL (µg/L)	NADC (µg/L)
Benzene	8260	1.0	100
1-Methylnaphthalene	8270	28	280
2-Methylnaphthalene	8270	28	280
Isopropyl benzene (LOQ = 1.0 µg/L)	8260	0.8	8
Naphthalene	8270	14	140
1,2,4-TMB	8260	10	100
TRPH	FDEP FLPRO	5000	50000

Analytical Methods

Analytical methods were selected to be the same as those used previously or at least comparable to previously used analytical methods with respect to PARCCS parameters. See Worksheets Nos. 20 and 23 for a list of the analytical methods applicable to each site.

Sampling Methods

Sampling methods were selected to be the same as those used previously or to at least be consistent with the representativeness and comparability of data for each media being sampled at each site. See Worksheet No. 21 for a list of sampling methods.

Action Levels

A full list of PALs is included within Worksheet 15. The BCT has ensured that the selected laboratory LOQs are generally low enough to measure constituent concentrations in site media that are less than the PALs in order to conduct comparisons of site data to the PALs. Results of a magnitude between the LOQ and MDL will be "J" flagged to indicate than the reported results are less precise than results that are greater than the LOQ. The BCT will accept these analytic results as usable (without additional qualification) unless quality evaluations indicate that the data quality has been compromised. If, for any analyte in any site medium, the PAL is less than the laboratory MDL, the BCT accepts the laboratory LOQ as the PAL for decision making purposes, as is suggested in "Guidance for the Selection of Analytical Methods for the Evaluation of Practical Quantitation Limits" (FDEP, 2004).

The groundwater COC concentrations for individual samples and temporal concentration trends for individual wells (using new and previously collected data) will be compared with the FDEP GCTLs listed PALs in WS #15 to determine whether natural attenuation has caused COC concentrations to attain, or will lead to attainment, of the GCTLs within two consecutive sampling rounds.

11B.3 STUDY BOUNDARIES

The Building 82, Tank G82 area covers approximately 100 ft by 75 ft, or 7,500 ft^2. This is delineated from the northwest corner to the southeast corner by CEF-G82-3S and CEF-G82-5S, respectively, as shown on Figure 10B-1. The vertical boundary for the groundwater plume is from the 5 ft to no deeper than 15 ft below ground surface (bgs). The contaminated groundwater plume is the population of interest and constitutes the spatial decision unit. The temporal decision unit is each round of monitoring when determined whether an exceedance of GCTL has occurred and it is two consecutive monitoring rounds when determining whether parameters or wells may be eliminated from monitoring.

11B.4 ANALYTIC APPROACH

A direct comparison of measured concentrations within the groundwater will be made against the appropriate PAL. PALs are detailed for each COC in Worksheet No. 15. Additionally, if none of the measured COC concentrations within any groundwater sample exceed criteria after two consecutive rounds of monitoring, then the monitoring program will be discontinued after coordination with the BCT. The following decision rules govern data use for the monitoring programs at Building 82, Tank 82.

Decision Rule #1: If any measured concentration of any COC from any sample is greater than or equal to the GCTL in non-compliance/source wells, then continue long-term monitoring until levels of COCs in a particular well are less than the GCTL for two consecutive sampling rounds.

Decision Rule #2: If any sample taken from a compliance well has a measured COC concentration that is greater than or equal to the GCTL, then conduct additional delineation of groundwater contamination. An FTMR would be issued to govern the delineation.

Decision Rule #3: If any measured COC concentration is greater than or equal to the GCTL in any sample but no migration is detected outside of the compliance wells for two consecutive semi-annual events, then a permanent groundwater restriction will be evaluated for RMO III (62-780.680, F.A.C). This will indicate that contamination exists and the contaminated area is defined. RMO III will put a restriction on the use of the groundwater, but allow it to remain onsite.

Decision Rule #4: If all measured concentrations of COCs in all groundwater samples are less than action levels for two consecutive quarters in all wells at the site, then recommend NFA.

Decision Rule #5: Throughout the groundwater monitoring, if any particular measured COC concentration is less than its GCTL for two consecutive sampling rounds or all measured COC concentrations in any particular well are less than GCTLs for at least two consecutive sampling rounds, then the BCT will discuss the elimination of the well or COC from the monitoring program, in accordance with the Navy guidance on groundwater monitoring well optimization. The well (or COC) will be eliminated unless the well is a compliance well, or the BCT determines that the inclusion of the well (or COC) provides useful information on evaluating the overall program and should not be removed.

11B.5 PERFORMANCE CRITERIA

Refer to Section 11A.5.

11B.6 PLAN FOR OBTAINING DATA

The plan for obtaining data at Building 82, Tank G82 is described in detail on Worksheet #17 along with the sampling designs and rationales.

11C BP WELLS

11C.1 PROBLEM DEFINITION

The COCs exceeded their action levels (GCTLs and NADCs) in groundwater. Contaminant concentrations appear to be increasing and migrating downgradient. The current downgradient well (CEF-BP-6S) exceeded the GCTL from July 2008 to July 2009 and has not shown GCTL exceedances prior to July 2008. Natural attenuation was the selected remedy for the site, so groundwater monitoring is required to determine whether natural attenuation is occurring at the site or other actions should be taken.

11C.2 INFORMATION INPUTS

Requirements for groundwater sampling and analysis methods are described below. Additional detail (e.g., the exact methods and SOPs to be used) is provided in Worksheet #s 15, 19, and 21.

Required Analyses

COC	USEPA Method	GCTL (µg/L)	NADC (µg/L)
Ethylbenzene	8260	30	300
2-Methylnaphthalene	8270	28	280
Isopropyl benzene (LOQ = 1.0 µg/L)	8260	0.8	8
Naphthalene	8270	14	140
1,2,4-TMB	8260	10	100
1,3,5-TMB	8260	10	100
Total xylenes	8260	20	200
TRPH	FDEP FLPRO	5000	50000

Analytical Methods

Analytical methods were selected to be the same as those used previously or at least comparable to previously used analytical methods with respect to PARCCS parameters. See Worksheets Nos. 20 and 23 for a list of the analytical methods applicable to each site.

Sampling Methods

Sampling methods were selected to be the same as those used previously or to at least be consistent with the representativeness and comparability of data for each media being sampled at each site. See Worksheet No. 21 for a list of sampling methods.

Action Levels

The groundwater data will be screened against the FDEP GCTLs and NADCs. A full list of PALs which, in this case are the lower of the NADC and GCTL for each parameter, is included within Worksheet 15. The BCT has ensured that the selected laboratory LOQs are generally low enough to measure constituent concentrations in site media that are less than the PALs in order to conduct comparisons of site data to the PALs. Results of a magnitude between the LOQ and MDL will be "J" flagged to indicate than the reported results are less precise than results that are greater than the LOQ. The BCT will accept these analytic results as usable (without additional qualification) unless quality evaluations indicate that the data quality has been compromised. If, for any analyte in any site medium, the PAL is less than the laboratory MDL, (as with isopropylbenzene) the BCT accepts the laboratory LOQ as the PAL for decision making purposes, as is suggested in "Guidance for the Selection of Analytical Methods for the Evaluation of Practical Quantitation Limits" (FDEP, 2004).

11C.3 STUDY BOUNDARIES

The BP Wells area covers approximately 9,375 ft^2 surrounding Building 82. The area is delineated from the northwest corner by CEF-BP-2S to the southeast corner by CEF-BP-6S and CEF-BP-4S, as shown

on Figure 10C-1. The vertical boundary for the groundwater contaminant plume is the water table. The contaminated groundwater is the population of interest and constitutes the spatial decision unit. The temporal decision unit is each round of monitoring when determined whether an exceedance of GTCTL has occurred and it is two consecutive monitoring rounds when determining whether parameters or wells may be eliminated from monitoring.

11C.4 ANALYTIC APPROACH

A direct comparison of measured concentrations within the groundwater will be made against the appropriate PAL. PALs are detailed for each COC in Worksheet No. 15. Additionally, if none of the measured COC concentrations within any groundwater sample exceed criteria after two consecutive rounds of monitoring, then the monitoring program will be discontinued after coordination with the BCT. The following decision rules govern data use for the monitoring programs at BP Wells.

Decision Rule #1: If any measured source well groundwater COC concentration in any sample is greater than its GCTL, then continue long-term monitoring until measured COC concentrations are less than their GCTL for two consecutive sampling rounds.

Decision Rule #2: If any measured COC concentration in any sample is greater than its GCTL in the compliance well, then conduct additional delineation of contamination in groundwater. An FTMR would be issued to govern the delineation.

Decision Rule #3: If the measured COC concentration exceeds the GCTL in any sample but no migration is detected outside of the compliance wells for four consecutive quarters, then a permanent groundwater restriction will be evaluated for RMO III (62-780.680, F.A.C.). This will indicate that contamination exists and the contaminated area is defined. RMO III will put a restriction on the use of the groundwater, but allow it to remain onsite.

Decision Rule #4: If all measured COC concentrations in all groundwater samples are less than action levels for two consecutive quarters in all wells within the BP Wells area, then recommend NFA.

Decision Rule #5: If measured COC concentrations are between GCTLs and NADCs in the source wells, then a Monitored Natural Attenuation Plan will be developed by Tetra Tech once it is deemed necessary by the BCT Team.

Decision Rule #6: Throughout the groundwater monitoring, if any particular measured COC concentration is less its than GCTL for two consecutive sampling rounds or all measured COC concentrations in any particular well are less than GCTLs for at least two consecutive sampling rounds,

then the BCT will discuss the elimination of the well or COC from the monitoring program, in accordance with the Navy guidance on groundwater monitoring well optimization. The well (or COC) will be eliminated unless the well is a compliance well, or the BCT determines that the inclusion of the well (or COC) provides useful information on evaluating the overall program and should not be removed.

11C.5 PERFORMANCE CRITERIA

Refer to Section 11A.5.

11C.6 PLAN FOR OBTAINING DATA

The plans for obtaining data at the BP Wells site are described in detail on Worksheet #17 along with the sampling designs and rationales.

11D 815 WASH RACK

11D.1 PROBLEM DEFINITION – 815 WASH RACK

Naphthalene exceeded the action levels (GCTLs and NADCs) in groundwater in the area of the former wash rack to the north of Building 815. Long-term monitoring indicates that contaminant concentrations are increasing; however contaminant migration currently does not appear to be occurring. Natural attenuation was the selected remedy for the site, so groundwater monitoring is required to determine whether natural attenuation is occurring at the site or other actions should be taken.

11D.2 INFORMATION INPUTS

Requirements for groundwater sampling and analysis methods are described below. Additional detail (e.g., the exact methods and SOPs to be used) is provided in Worksheet #s 15, 19, and 21.

Required Analyses

Matrix	VOCs	Purpose
Groundwater	Naphthalene only	Long-term monitoring

Analytical Methods

Analytical methods were selected to be the same as those used previously or at least comparable to previously used analytical methods with respect to PARCCS parameters. See Worksheets Nos. 20 and 23 for a list of the analytical methods applicable to each site.

Sampling Methods

Sampling methods were selected to be the same as those used previously or to at least be consistent with the representativeness and comparability of data for each media being sampled at each site. See Worksheet No. 21 for a list of sampling methods.

Action Levels

The groundwater data will be screened against the FDEP GCTLs and NADCs. A full list of PALs which, in this case are the lower of the NADC and GCTL for each parameter, is included within Worksheet 15. The BCT has ensured that the selected laboratory LOQs are generally low enough to measure constituent concentrations in site media that are less than the PALs in order to conduct comparisons of site data to the PALs. The LOQ for naphthalene is less than the PAL, and the MDL is less than the LOQ.

11D.3 STUDY BOUNDARIES

The 815 Wash Rack area covers approximately 0.5 acre between Buildings 1845 and 815, as shown on Figure 10D-1. The vertical boundary for the groundwater plume is between 5 ft and 15 ft bgs. The contaminated groundwater is the population of interest and constitutes the spatial decision unit. The temporal decision unit is each round of monitoring when determined whether an exceedance of GCTL has occurred and it is two consecutive monitoring rounds when determining whether parameters or wells may be eliminated from monitoring.

11D.4 ANALYTIC APPROACH

A direct comparison of measured concentrations within the groundwater will be made against the appropriate PAL. The PAL for naphthalene is detailed in Worksheet No. 15. Additionally, if none of the measured naphthalene concentrations within any groundwater sample exceed criteria after two consecutive rounds of monitoring, then the monitoring program will be discontinued after coordination with the BCT. The following decision rules govern data use for the monitoring programs at 815 Wash Rack.

Decision Rule #1: If the measured naphthalene concentration is greater than its GCTL in any non-compliance/source well sample, then continue long-term monitoring until levels of naphthalene are below the GCTL for two consecutive sampling rounds.

Decision Rule #2: If any sample taken from the compliance wells has a measured naphthalene concentration greater than the GCTL, then conduct additional delineation of groundwater contamination. An FTMR would be issued to govern the delineation.

Decision Rule #3: If any measured naphthalene concentration in any sample exceeds the GCTL but no migration is detected outside of the compliance wells for four consecutive monitoring events, then a permanent groundwater restriction will be evaluated for RMO III (62-780.680, F.A.C.). This will indicate that contamination exists and the contaminated area is defined. RMO III will put a restriction on the use of the groundwater, but allow it to remain onsite.

Decision Rule #4: If measured naphthalene concentrations in all groundwater samples are less than action levels for two consecutive quarters in all wells at the site, then recommend NFA.

Decision Rule #5: Throughout the groundwater monitoring, if any particular measured COC concentration is less than its GCTL for two consecutive sampling rounds or all measured COC concentrations in any particular well are less than GCTLs for at least two consecutive sampling rounds, then the BCT will discuss the elimination of the well or COC from the monitoring program, in accordance with the Navy guidance on groundwater monitoring well optimization. The well (or COC) will be eliminated unless the well is a compliance well, or the BCT determines that the inclusion of the well (or COC) provides useful information on evaluating the overall program and should not be removed.

11D.5 PERFORMANCE CRITERIA

Refer to Section 11A.5.

11D.6 PLAN FOR OBTAINING DATA

The plan for obtaining data at the 815 Wash Rack area is described in detail on Worksheet #17 along with the sampling designs and rationales.

SAP Worksheet #12 -- Measurement Performance Criteria Table

(UFP-QAPP Manual Section 2.6.2)

Measurement Performance Criteria Table – Field QC Samples –Groundwater

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Trip Blank	VOC	1 per cooler containing VOCs	Accuracy / Bias Contamination	No analytes ≥ ½ LOQ, except common lab contaminants, which must be < LOQ.	S & A
Rinsate Blank	All fractions	1 per 20 samples per sampling equipment	Accuracy / Bias Contamination	No analytes ≥ ½ LOQ, except common lab contaminants, which must be < LOQ.	S & A
Field Duplicate	All fractions	1 per 10 environmental samples	Precision	Values >5X the LOQ: Relative percent difference (RPD) of ≤30% Values <5X LOQ: absolute difference of values must be <2xLOQ	S & A
Temperature Indicator	All fractions	1 per cooler	Representativeness	Temperature between 2 and 6 degrees Celsius (°C) (4 ± 2 °C)	S

SAP Worksheet #13 -- Secondary Data Criteria and Limitations Table

(UFP-QAPP Manual Section 2.7)

North-South Apron Plume

Secondary Data	Data Source (originating organization, report title, and date)	Data Generator(s) (originating organization, data types, data generation / collection dates)	How Data Will Be Used	Limitations on Data Use
Historical groundwater data	Supplemental Site Assessment Letter II, August 3, 2005	Tetra Tech, groundwater data	For milestones and historical reference	None
Groundwater data since NAMPAO	GWMR, 4th Year, 1st Semi-Annual Event, December 30, 2008	Tetra Tech, groundwater data since 2005 with most recent sampling event	For milestones, historical references, and path forward	None

Building 82, Tank G82

Secondary Data	Data Source (originating organization, report title, and date)	Data Generator(s) (originating organization, data types, data generation / collection dates)	How Data Will Be Used	Limitations on Data Use
Groundwater data	GWMR – Year 1, 4th Quarter (April 2009), TtNUS, August 13, 2009	Tetra Tech, groundwater data	Information from previous site activities is provided, and quarterly monitoring data since the NAMP was approved is detailed. Data will be used to check against current data to monitor progress of the contamination levels in the groundwater plume.	None
Groundwater data	Natural Attenuation Work Plan , CH2M Hill, May 28, 2008	CH2M Hill, groundwater data	Data will be used as a guide for how the monitoring sampling is conducted for current and future events.	None
Groundwater data	Evaluation of Groundwater Analytical Results BP Wells and Tank G82, CH2M Hill, April 27, 2007	CH2M Hill, groundwater data collected in November 2006	Data used for 2008 Natural Attenuation Work Plan.	None

BP Wells

Secondary Data	**Data Source** (originating organization, report title, and date)	**Data Generator(s)** (originating organization, data types, data generation / collection dates)	**How Data Will Be Used**	**Limitations on Data Use**
Recent groundwater data	GWMR, Year 1, 2nd Semi-Annual Report, TtNUS, July 10, 2009	Tetra Tech, groundwater from July 2008 to July 2009	To determine the path forward	None
Groundwater data	Natural Attenuation Work Plan , CH2M Hill, May 28, 2008	CH2M Hill, groundwater data	Data will be used as a guide for how the monitoring sampling is conducted for current and future events.	None
Groundwater data	Treatability Study Evaluation, TtNUS, April 8, 2004	Results from Treatability Study conducted from 2002 to 2004	Natural Attenuation Parameters will be used for historical reference	None

815 Wash Rack

Secondary Data	**Data Source** (originating organization, report title, and date)	**Data Generator(s)** (originating organization, data types, data generation / collection dates)	**How Data Will Be Used**	**Limitations on Data Use**
Groundwater data	GWMR, Year 1, 2nd Quarter, TtNUS, December 5, 2008	Tetra Tech, groundwater data collected in 2008	Data will be compared with current data to monitor progress of the contamination levels in the groundwater plume.	None
Groundwater data for new well installation	SARA, TtNUS, May 15, 2008	Tetra Tech, groundwater data collected from new well installed	To include in new recommendation for NAMP.	None
Soil and groundwater data	Source Removal Report, TtNUS, July 14, 2000	Tetra Tech, soil and groundwater	To verify that the soil is no longer contributing to the contamination because it's been removed and to have old GW data to compare current results with.	None

SAP Worksheet #14 -- Summary of Project Tasks

(UFP-QAPP Manual Section 2.8.1)

Long-term monitoring at the petroleum sites includes the following tasks:

- Mobilization/Demobilization
- Site-Specific Health and Safety Training
- Monitoring Equipment Calibration
- Groundwater Sampling
- Water Level Measurements
- Investigation-Derived Waste (IDW) Management
- Field Decontamination Procedures

Mobilization/Demobilization

Mobilization shall consist of the delivery of all equipment, materials, and supplies to the site; the complete assembly in satisfactory working order of all such equipment at the site; and the satisfactory storage of all such materials and supplies at the site. Tetra Tech will coordinate with the Base to identify locations for the storage of equipment and supplies. Site-specific Health and Safety Training to all Tetra Tech subcontractors will be provided as part of the site mobilization.

Demobilization shall consist of the prompt and timely removal of all equipment, materials, and supplies from the site following completion of the work. Demobilization includes the cleanup and removal of IDW generated during the conduct of the investigation.

Site-Specific Health and Safety Training

Site-specific health and safety training to all Tetra Tech field staff and subcontractors will be provided as part of the site mobilization and is also addressed in Worksheet #8. A photoionization detector (PID) will be used as field instrumentation for health and safety reasons.

Monitoring Equipment Calibration

These procedures are described in Worksheet #22.

Water Level Measurements

One synoptic round of water-level measurements will be conducted at the site as part of each groundwater sampling event to provide information regarding groundwater flow patterns and gradients. Water-level measurements will be completed within the shortest time possible on the same day, and no sooner than 24 hours after a significant precipitation event to minimize the precipitation effects on the

data sets. Water level measurements will be recorded to the nearest 0.01 foot and referenced to a top of casing notch or, if a notch is absent, to the north side of the top of the well casing. The measurement instrument will be decontaminated prior to conducting the measurement event and between each monitoring well.

Groundwater Sampling

Groundwater samples will be collected using low-flow purging techniques (discharge rate of less than 1 liter per minute) with a peristaltic pump using Teflon™ tubing dedicated to each well. When a well is developed for sampling, a water quality meter will be used to monitor pH, ORP, dissolved oxygen, turbidity, and conductivity. All groundwater samples will be collected using the procedures specified in FS 2200, Groundwater Sampling. Worksheet #s 17 and 18 specify the groundwater sample locations and analytes for this investigation Worksheet #23 specifies the analytical methods to be used.

Prior to groundwater sample collection, the monitoring wells will be purged. Both purging and sampling operations will be conducted at a flow rate that results in a groundwater turbidity measurement of 20 Nephelometric turbidity units (NTUs) or less (inherent turbidity will be minimized to the greatest extent possible using low flow techniques; individual well conditions and local geology may preclude meeting the 20 NTU criteria).

The sample aliquot for VOC analysis will be collected last by slowly pulling the Teflon™ tubing out of the well to minimize agitation of the water in the monitoring well and then transferring the contents of the tubing to a VOC vial. After collection, the samples will be placed in a cooler, chilled with ice, and shipped under chain of custody protocol to the off-site laboratory for analysis.

IDW Management

IDW generated during the activities will be managed in accordance with the NAS Cecil Field IDW Plan and will be conducted in an environmentally responsible manner consistent with NAS Cecil Field requirements (e.g. designation of staging areas). The objectives of the IDW management are:

- Management of IDW in a manner that prevents contamination of uncontaminated areas (by IDW) and that is protective of human health and the environment.

- Minimization of IDW, thereby reducing costs and the potential for human or ecological exposure to contaminated materials.

- Compliance with federal and state requirements that are Applicable or Relevant and Appropriate Requirements.

- Used personal protective equipment, such as gloves, will be bagged and disposed of as regular trash in an appropriate facility waste container.

Field Decontamination Procedure

Decontamination of major equipment and sampling equipment will be in general accordance with FDEP SOP FC 1000, Cleaning / Decontamination Procedures.

Field Documentation Procedures

Pre-preserved, certified-clean bottleware will be supplied by the subcontracted laboratory. Matrix-specific sample logsheets will be maintained for each sample collected. In addition, sample collection information will be recorded in bound field notebooks or specific field forms. Samples will be packaged and shipped according to FDEP SOP FS 1000, General Sampling Procedures.

Field documentation will be performed in accordance with Tetra Tech SOP SA-6.3. A summary of all field activities will be properly recorded in a bound logbook with consecutively number pages that cannot be removed. Logbooks will be assigned to field personnel and will be stored in a secured area when not in use. Field documentation forms and SOPs can be found in Appendix A.

At a minimum, the following information will be recorded in the site logbook:

- Name of the person to whom the logbook is assigned.
- Project name.
- Project start date.
- Names and responsibilities of on-site project personnel including subcontractor personnel.
- Arrival/departure of site visitors.
- Arrival/departure of equipment.
- Sampling activities and sample log sheet references.
- Description of subcontractor activities.
- Sample pick-up information, including chain of custody numbers, air bill numbers, carrier, time, and date.
- Description of borehole or monitoring well installation activities and operations.
- Health and safety issues.
- Description of photographs including date, time, photographer, roll and picture number, location, and compass direction of photograph.

All entries will be written in ink and no erasures will be made. If an incorrect entry is made, striking a single line through the incorrect information will make the correction; the person making the correction will initial and date the change.

Long-term Monitoring Reports

Long-term monitoring reports will be issued following each sampling event. The reports will include appropriate sections concerning site background, investigation activities, physical characteristics, nature and extent of contamination, and conclusions and recommendations.

Each long-term monitoring report will be issued in draft to BRAC PMO SE for initial review. BRAC PMO SE comments will be addressed, and the draft final report will be issued for regulatory review.

SAP Worksheet #15 -- Reference Limits for Groundwater

(UFP-QAPP Manual Section 2.8.1)

SAP Worksheet #15A -- Reference Limits for Groundwater – North-South Apron Plume

Matrix: Groundwater
Analytical Group: VOCs

Analyte	Chemical Abstract Service (CAS) Number	PAL [1] (µg/L)	PAL Reference	Project QL Goal (µg/L)	Empirical[2]		
					LOQ (µg/L)	Limit of Detection (LOD) (µg/L)	MDL (µg/L)
Benzene	71-43-2	1.0	FDEP GCTL	0.3	1.0	0.50	0.3

1 FDEP GCTLs. Groundwater Cleanup Target Levels F.A.C. 62-777 Table I, April 2005.
2 Empirical MDLs are current as of May 2009.

SAP Worksheet #15B -- Reference Limits for Groundwater – Building 82, Tank G82

Matrix: Groundwater
Analytical Group: VOCs

Analyte	CAS Number	PAL [1] (µg/L)	PAL Reference	Project QL Goal (µg/L)	Empirical[2]		
					LOQ (µg/L)	LOD (µg/L)	MDL (µg/L)
Benzene	71-43-2	1.0	FDEP GCTL	0.3	1.0	0.50	0.3
Isopropyl benzene	98-82-8	0.8	FDEP GCTL	0.26[3]	1.0	0.50	0.3
1,2,4-TMB	95-63-6	10	FDEP GCTL	3.3	1.0	0.50	0.3

1 FDEP GCTLs. Groundwater Cleanup Target Levels F.A.C. 62-777 Table I, April 2005.
2 Empirical MDLs are current as of May 2009.
3 The laboratory LOQ does not meet the Project QL Goal or the PAL; however, the MDL is below the Action Level. The LOQ will be used as the comparison criteria for this analyte. Results reported between the LOQ and the MDL will be flagged by the laboratory ("J") and will also receive additional scrutiny. Project Chemist to ensure the data support attainment of project objectives.

Matrix: Groundwater
Analytical Group: PAHs

Analyte	CAS Number	PAL [1] (µg/L)	PAL Reference	Project QL Goal (µg/L)	Empirical[2]		
					LOQ (µg/L)	LOD (µg/L)	MDL (µg/L)
Naphthalene	91-20-3	14	FDEP GCTL	4.6	0.10	0.04	0.013
1-Methylnaphthalene	90-12-0	28	FDEP GCTL	9.3	0.10	0.04	0.015
2-Methylnaphthalene	91-57-6	28	FDEP GCTL	9.3	0.10	0.04	0.013

1 FDEP GCTLs. Groundwater Cleanup Target Levels F.A.C. 62-777 Table I, April 2005.
2 Empirical MDLs are current as of May 2009.

Matrix: Groundwater
Analytical Group: TRPH

Analyte	CAS Number	PAL [1] (mg/L)	PAL Reference	Project QL Goal (mg/L)	Empirical[2]		
					LOQ (mg/L)	LOD (µg/L)	MDL (mg/L)
TRPH	No CAS	5	FDEP GCTL	1.67	0.34	0.17	0.085

1 FDEP GCTLs. Groundwater Cleanup Target Levels F.A.C. 62-777 Table I, April 2005.
2 Empirical MDLs are current as of May 2009.

SAP Worksheet #15C -- Reference Limits for Groundwater – BP Wells

Matrix: Groundwater
Analytical Group: VOCs

Analyte	CAS Number	PAL (1) (µg/L)	PAL Reference	Project QL Goal (µg/L)	Empirical(2)		
					LOQ (µg/L)	LOD (µg/L)	MDL (µg/L)
Ethylbenzene	100-14-4	30	FDEP GCTL	10	1.0	0.50	0.3
Isopropyl benzene	98-82-8	0.8	FDEP GCTL	0.26(3)	1.0	0.50	0.3
1,2,4-TMB	95-63-6	10	FDEP GCTL	3.3	1.0	0.50	0.3
1,3,5-TMB	108-67-8	10	FDEP GCTL	3.3	1.0	0.50	0.3
Total xylenes	1330-20-7	20	FDEP GCTL	6.7	3.0	1.5	0.3

1 FDEP GCTLs. Groundwater Cleanup Target Levels F.A.C. 62-777 Table I, April 2005.
2 Empirical MDLs are current as of May 2009.
3 The laboratory LOQ does not meet the Project QL Goal or the PAL; however, the MDL is below the Action Level. The LOQ will be used as the comparison criteria for this analyte. Results reported between the LOQ and the MDL will be flagged by the laboratory ("J") and these results will also receive additional scrutiny by the Project Chemist to ensure the data support attainment of project objectives.

Matrix: Groundwater
Analytical Group: PAHs

Analyte	CAS Number	PAL (1) (µg/L)	PAL Reference	Project QL Goal (µg/L)	Empirical(2)		
					LOQ (µg/L)	LOD (µg/L)	MDL (µg/L)
Naphthalene	91-20-3	14	FDEP GCTL	4.6	0.10	0.04	0.013
2-Methylnaphthalene	91-57-6	28	FDEP GCTL	9.3	0.10	0.04	0.013

1 FDEP GCTLs. Groundwater Cleanup Target Levels F.A.C. 62-777 Table I, April 2005.
2 Empirical MDLs are current as of May 2009.

Matrix: Groundwater
Analytical Group: TRPH

Analyte	CAS Number	PAL [1] (mg/L)	PAL Reference	Project QL Goal (mg/L)	Empirical[2]		
					LOQ (mg/L)	LOD (µg/L)	MDL (mg/L)
TRPH	No CAS	5	FDEP GCTL	1.67	0.34	0.17	0.085

1 FDEP GCTLs. Groundwater Cleanup Target Levels F.A.C. 62-777 Table I, April 2005.
2 Empirical MDLs are current as of May 2009.

SAP Worksheet #15D -- Reference Limits for Groundwater – 815 Wash Rack

Matrix: Groundwater
Analytical Group: PAHs

Analyte	CAS Number	PAL [1] (µg/L)	PAL Reference	Project QL Goal (µg/L)	Empirical[2]		
					LOQ (µg/L)	LOD (µg/L)	MDL (µg/L)
Naphthalene	91-20-3	14	FDEP GCTL	4.6	0.10	0.040	0.013

1 FDEP GCTLs. Groundwater Cleanup Target Levels F.A.C. 62-777 Table I, April 2005.
2 Empirical MDLs are current as of May 2009.

SAP Worksheet #16 -- Project Schedule/Timeline Table

(UFP-QAPP Manual Section 2.8.2)

Activities	Organization	Dates (MM/DD/YY)		Deliverable	Deliverable Due Date
		Anticipated Date(s) of Initiation	Anticipated Date of Completion		
NSAP Year 5, 1st Semi-Annual Sampling Event	Tetra Tech	January 28, 2010	January 28, 2010	GWMR	March 15, 2009
Building 82, Tank G82 Year 2, 2nd Semi-Annual	Tetra Tech	April 21, 2010	April 21, 2010	GWMR	June 21, 2010
Building 82, Tank G82 Year 3, 1st Semi-Annual	Tetra Tech	October 22, 2010	October 22, 2010	GWMR	December 20, 2010
BP Wells Year 2, 2nd Semi-Annual	Tetra Tech	January 21, 2010	January 24, 2010	GWMR	March 30, 2010
815 Wash Rack – Year 2, 1st Semi-Annual	Tetra Tech	January 12, 2010	January 12, 2010	GWMR	March 12, 2010

SAP Worksheet #17 -- Sampling Design and Rationale

(UFP-QAPP Manual Section 3.1.1)

The sampling design and rationale for each site is presented below for each site. The objective of the sampling designs is to obtain data that fulfills the DQOs presented in Worksheet No. 11. The BCT has selected a biased sampling approach appropriate for LTM at each site. The numbers of selected sampling points for each site are based on the available wells and a need to obtain comprehensive spatial coverage over the area of interest. Upgradient and downgradient sampling locations at each site have been selected to monitor the source areas or contaminated groundwater plumes at each site and to execute the decision rules presented in Worksheet No. 11. The samples will be collected according to field sampling procedures presented in Worksheet No. 21.

North-South Apron Plume

The NSAP sampling strategy consists of semi-annual sampling of three intermediate monitoring wells. The wells were chosen based on historical groundwater flow data, detections of the benzene in the wells, and whether they are downgradient or upgradient from the contamination plume. The intent was to include wells that indicate whether contaminant concentrations are naturally attenuating. The sampling locations are detailed in Worksheet #18. Semi-annual sampling will occur for an additional year per the MOP issued on October 21, 2005. The sampling locations are detailed in Worksheet #18. A map of the monitoring wells is provided in Figure 10A-2.

Building 82, Tank G82

The sampling design and rationale are based on the NAMP submitted by CH2M Hill on May 29, 2008. The seven shallow wells were chosen based on historical groundwater flow data, detections of the COC in the wells, and whether they are downgradient or upgradient from the contamination plume. The intent was to include wells that indicate whether contaminant concentrations are naturally attenuating. Semi-annual sampling will occur for two years based on the NAMP. As of the production of this plan, the NAMP has not been approved by the FDEP, but the FDEP issued verbal approval at the June 2008 BCT meeting to proceed with sampling at the site. The sampling locations are detailed in Worksheet #18. A map of the monitoring wells is provided in Figure 10B-1.

BP Wells

The sampling design and rationale is based on the NAMP submitted by CH2M Hill on May 29, 2008. The six shallow wells were chosen based on historical groundwater flow data, detections of the COC in the wells, and whether they are downgradient or upgradient from the contamination plume. The intent was to include wells that indicate whether contaminant concentrations are naturally attenuating. The sampling locations are detailed in Worksheet #18. Semi-annual sampling will occur for an additional year based on

the NAMP. As of the production of this report, the NAMP has not been approved by the FDEP, but the FDEP gave verbal approval at the June 2008 BCT meeting to proceed with sampling at the site. The sampling locations are detailed in Worksheet #18. A map of the monitoring wells is provided in Figure 10C-1.

815 Wash Rack

The sampling strategy at the 815 Wash Rack area consists of quarterly sampling of four shallow monitoring wells and the NAMPAO approval submitted on November 6, 2008. The wells were chosen based on historical groundwater flow data, detections of the COC in the wells, and whether they are downgradient or upgradient from the contamination plume. The intent was to include wells that indicate whether contaminant concentrations are naturally attenuating. The sampling locations are detailed in Worksheet #18. A map of the monitoring wells is provided in Figure 10D-1.

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

(UFP-QAPP Manual Section 3.1.1)

SAP Worksheet #18A -- Sampling Locations and Methods/SOP Requirements Table – North-South Apron Plume

Sampling Location / Identification Number	Matrix	Screen Interval	Analytical Group	Number of Samples (identify field duplicates)(1)	Sampling SOP Reference(2)
CEF-M18-04I, CEF-M18-05I, CEF-M18-09I	Groundwater	30 to 35 feet bgs	VOCs (benzene only)	4 plus 1 duplicate	FDEP FS 2200, 2008; TtNUS, SA-1.1, April 2008
CEF-M18-12D	Groundwater	50 to 55 feet bgs			

1 Field duplicates may be consolidated across sites at FOL's discretion so as to yield one field duplicate per 10 environmental samples.
2 SOP that describes the sample collection procedures.

SAP Worksheet #18B -- Sampling Locations and Methods/SOP Requirements Table – Building 82, Tank G82

Sampling Location / Identification Number	Matrix	Screen Interval	Analytical Group	Number of Samples (identify field duplicates)(1)	Sampling SOP Reference(2)
CEF-G82-1S, CEF-G82-2S, CEF-G82-3S, CEF-G82-4S, CEF-G82-5S, CEF-G82-6S	Groundwater	5 to 15 feet bgs or 4 to 14 feet bgs	VOCs (Benzene, Isopropyl benzene, 1,2,4-TMB) PAHs (Naphthalene, 1-Methylnaphthalene, 2-Methylnaphthalene), TRPH	7 plus 1 duplicate for each Analytical Group	FDEP FS 2200, 2008; TtNUS, SA-1.1, April 2008
CEF-G82-2I		30 to 35 feet bgs			

1 Field duplicates may be consolidated across sites at FOL's discretion so as to yield one field duplicate per 10 environmental samples.
2 SOP that describes the sample collection procedures.

SAP Worksheet #18C -- Sampling Locations and Methods/SOP Requirements Table – BP Wells

Sampling Location / Identification Number	Matrix	Screen Interval	Analytical Group	Number of Samples (identify field duplicates)(1)	Sampling SOP Reference(2)
CEF-BP-1S, CEF-BP-4S, CEF-BP-6S, CEF-BP-7S, CEF-BP-8S, CEF-BP-9S	Groundwater	5 to 15 feet bgs or 4 to 14 feet bgs	VOCs (Ethylbenzene, Isopropyl benzene, 1,2,4-TMB 1,3,5-TMB, Total xylenes) PAHs (2-Methylnaphthalene Naphthalene) TRPH	7 plus 1 duplicate for each Analytical Group	FDEP FS 2200, 2008; TtNUS, SA-1.1, April 2008
CEF-BP-5I		30 to 35 feet bgs			

1 Field duplicates may be consolidated across sites at FOL's discretion so as to yield one field duplicate per 10 environmental samples.
2 SOP that describes the sample collection procedures.

SAP Worksheet #18D -- Sampling Locations and Methods/SOP Requirements Table – 815 Wash Rack

Sampling Location / Identification Number	Matrix	Screen Interval	Analytical Group	Number of Samples (identify field duplicates)(1)	Sampling SOP Reference(2)
CEF-815-04S, CEF-815-05S, NG-12S, CEF-059-015-028	Groundwater	5 to 15 feet bgs or 4 to 14 feet bgs	PAHs (naphthalene only)	4 plus 1 duplicate	FDEP FS 2200, 2008; TtNUS, SA-1.1, April 2008

1 Field duplicates may be consolidated across sites at FOL's discretion so as to yield one field duplicate per 10 environmental samples.
2 SOP that describes the sample collection procedures.

SAP Worksheet #19 -- Analytical SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Matrix	Analytical Group	Analytical and Preparation Method / SOP Reference[1]	Containers (number, size, and type)	Sample Volume[2] (units)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time[3] (preparation / analysis)
Aqueous	VOCs	SW-846 5030/8260B, Empirical SOP-202	3 - 40 milliliter (mL) vials	5 mL	4 °C	14 days
Aqueous	PAHs by Selected Ion Monitoring (SIM)	SW-846 3510C/ 3520/8270C/8270C SIM, Empirical SOP-201/231/300	1 liter amber glass	1000 mL	4 °C	7 days / 40 days

1 The appropriate reference letter or number is from Worksheet #23.
2 The minimum sample volume or mass requirements are provided where different from the container volume.
3 Maximum holding time is calculated from the time the sample is collected to the time the sample is prepared/extracted.

SAP Worksheet #20 -- Field Quality Control Sample Summary Table

(UFP-QAPP Manual Section 3.1.1)

SAP Worksheet #20A -- Field QC Sample Summary Table – North-South Apron Plume

Matrix	Analytical Group	Number of Sampling Locations	Number of Field Duplicates	Number of Matrix Spike/ Matrix Spike Duplicate (MS/MSD)	Number of Rinsate Blanks	Number of Equipment Blanks	Number of [Volatile Organic Aromatic (VOA)] Trip Blanks	Number of Proficiency Testing Samples	Total Number of Samples to Lab
Groundwater	VOCs	4	1	0	1	0	1	0	7

SAP Worksheet #20B -- Field QC Sample Summary Table – Building 82, Tank G82

Matrix	Analytical Group	Number of Sampling Locations	Number of Field Duplicates	Number of MS/MSD	Number of Rinsate Blanks	Number of Equipment Blanks	Number of (VOA) Trip Blanks	Number of Proficiency Testing Samples	Total Number of Samples to Lab
Groundwater	VOCs PAHs TRPH	7	1	0	1	0	1	0	10

SAP Worksheet #20C -- Field QC Sample Summary Table – BP Wells

Matrix	Analytical Group	Number of Sampling Locations	Number of Field Duplicates	Number of MS/MSD	Number of Rinsate Blanks	Number of Equipment Blanks	Number of (VOA) Trip Blanks	Number of Proficiency Testing Samples	Total Number of Samples to Lab
Groundwater	VOCs PAHs TRPH	7	1	0	1	0	1	0	10

SAP Worksheet #20D -- Field QC Sample Summary Table – 815 Wash Rack

Matrix	Analytical Group	Number of Sampling Locations	Number of Field Duplicates	Number of MS/MSD	Number of Rinsate Blanks	Number of Equipment Blanks	Number of (VOA) Trip Blanks	Number of Proficiency Testing Samples	Total Number of Samples to Lab
Groundwater	PAHs	4	1	0	1	0	1	0	7

SAP Worksheet #21 -- Project Sampling SOP References Table

(UFP-QAPP Manual Section 3.1.2)

Reference Number	Title, Revision Date and/or Number[1]	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
FS2200	Groundwater Sampling	FDEP	Peristaltic pump	Y	See Tetra Tech SOP below.
FT1000 (plus series)	Field Testing General and Series including pH, Specific Conductance, Salinity, Temperature, Dissolved Oxygen, and Turbidity	FDEP	Multi-parameter water quality meter	Y	See Tetra Tech SOP below.
FC1000	Field Decontamination	FDEP	Decontamination Equipment (scrub brushes, phosphate free detergent, de-ionized water)	Y	See Tetra Tech SOP below.
SA-6.1	Non-Radiological Sample Handling Rev. 3, February 2004	Tetra Tech	NA	N	
SA-6.3	Field Documentation Rev. 3, March 2009	Tetra Tech	NA	N	
CT-04	Sample Nomenclature Rev. 2, March 2009	Tetra Tech	NA	Y	Project specific nomenclature is listed in Worksheet #18
SA-1.1	Groundwater Sample Acquisition and Onsite Water Quality Testing Rev. 7, April 2008	Tetra Tech	Peristaltic pump, Multi-parameter water quality meter	N	
SA-7.1	Decontamination of Field Equipment Rev. 6, January 2009	Tetra Tech	Decontamination Equipment (scrub brushes, phosphate free detergent, de-ionized water)	Y	Nitric acid is removed from the decontamination procedure. Isopropyl Alcohol to be used, if field conditions warrant.

1 FDEP SOPs can be downloaded from http://www.floridadep.org/labs/qa/sops.htm. Tetra Tech SOPs are located in Appendix A.

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

(UFP-QAPP Manual Section 3.1.2.4)

Field Equipment	Activity	Frequency	Acceptance Criteria	CA	Responsible Person	SOP Reference	Comments
Photoionization Detector	Calibration and Visual Inspection	Daily	Manufacturer's Guidance	Replace	FOL or designee	Manufacturer's Guidance	
Depth to Water Meter	Visual Inspection	Daily	Manufacturer's Guidance	Replace	FOL or designee	Manufacturer's Guidance	
Multi-Parameter Water Quality Meter	Visual Inspection, Calibration	Daily	Manufacturer's Guidance	Replace	FOL or designee	FDEP FT 1000 through 1500 and Manufacturer's Guidance	
LaMotte Model 2008 (or similar) Turbidity Meter	Visual Inspection, Calibration	Daily	RPD of ±10% (6 measurements of 2 successive samples of a 20 NTU standard) Accuracy of ±10% at 20 NTU (Mean of the measured values must be 18 to 22 NTU)	Replace	FOL or designee	FT 1600, Field Measurement of Turbidity (FDEP) and Manufacturer's Guidance	If an acceptable turbidity meter model is not used, submittal of an Alternate Test Procedure application is required

SAP Worksheet #23 -- Analytical SOP References Table

(UFP-QAPP Manual Section 3.2.1)

SOP Number	Title, Revision Date, and / or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work?(1) (Y/N)
Empirical SOP-202	Gas Chromatograph/Mass Spectrometer (GC/MS) Volatiles using USEPA Method 624 and SW846 Method 8260B, Rev. 21	Definitive	Organic / GC/MS	Agilent/HP GC/MS	Empirical	N
Empirical SOP-231	GC/MS Low Level PAH'S using USEPA SW-846 Method 8270C, SIM, Rev. 3	Definitive	Organic / GC/MS	Agilent/HP GC/MS	Empirical	N

1 No project specific modifications are needed; therefore, review and approval of modifications by the Navy QA Officer are not needed for this project.

SAP Worksheet #24 -- Analytical Instrument Calibration Table

(UFP-QAPP Manual Section 3.2.2)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference[1]
GC/MS Volatiles	Initial Calibration	Calibrate the instrument when it is received and after a major change or if the daily calibration fails. A minimum 5 point calibration is required.	The percent relative standard deviation (RSD) for each Calibration Check Compound (CCC) must be ≤ 30%. The minimum mean response factor (RF) for each System Performance Check Compound (SPCC) must meet that stated in 8260B. If the RSD for an analyte is > 15%, use a linear curve (≥ 0.995 correlation) or quadratic curve (≥ 0.99 correlation, minimum 6 points) for quantitation	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data.	Analyst/ Supervisor	Empirical SOP-202
	Continuing Calibration	Analyze a standard at the beginning of each 12 hour shift after a 4-bromofluoro-benzene (BFB) tune.	The minimum RF for SPCCs must meet that stated in method. The CCCs must be < 20 percent difference.	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data.	Analyst/ Supervisor	Empirical SOP-202
	Initial calibration Verification	Once after each initial calibration	±25% individual compounds.	Identify source of problem, correct, repeat calibration, rerun samples	Analyst/ Supervisor	Empirical SOP-202
GC/MS PAHs	ICAL – A 6-point initial calibration for all analytes.	Instrument receipt, instrument change (new column, source cleaning, etc.), when CCV is out of criteria.	Option 1: %RSD for each analyte must be ≤ 15% Option2: for linear regression, r ≥ 0.995. Option 3: non-linear regression coefficient of determination (COD) r squared ≥ 0.990(6 points second order, 7 points third order).	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data.	Analyst, Department Manager	Empirical SOP-231
	ICV – Second Source	Perform after each ICAL.	The %R of all project analytes must be within 80-120%.	Identify source of problem, correct, repeat calibration, rerun samples.	Analyst, Department Manager	Empirical SOP-231

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference[1]
GC/MS PAHs (cont)	CCV	Analyze a standard at the beginning of each 12-hour shift after tune.	%difference/Drift for all target analytes and surrogates ≤20%D (Note: D = difference when using RF's or drift when using least squares regression or non-linear calibration).	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data.	Analyst, Department Manager	Empirical SOP-231
	Tune Verification – decafluorotriphenyl-phosphine (DFTPP)	At the beginning of each 12-hour analytical sequence.	Must meet the ion abundance criteria required by the method. SIM: must meet the mass drift and peak width criteria required by the SOP. No samples may be accepted without a valid tune.	Retune and/or clean source.	Analyst, Department Manager	Empirical SOP-231

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

(UFP-QAPP Manual Section 3.2.3)

Instrument / Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	CA	Responsible Person	SOP Reference[1]
GC/MS	Clean the source and replace the filaments. Replace the seal, liner and septum. Change the column.	Volatiles	Check the gas supply. Check the seal, liner, and septum.	Source cleaning is performed when the instrument response deteriorates. Other instrument maintenance is done as needed to keep the instrument performing at peak performance.	The minimum RF for SPCCs must meet that stated in method. The CCCs must be < 20 percent difference.	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data.	Analyst/ Supervisor	Empirical SOP-202/231

1 The appropriate reference letter or number from Worksheet #23.

SAP Worksheet #26 -- Sample Handling System

(UFP-QAPP Manual Appendix A)

Sample Handling System
SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): FOL, Tetra Tech, Jacksonville, Florida
Sample Packaging (Personnel/Organization): FOL, Tetra Tech, Jacksonville, Florida
COORDINATION OF SHIPMENT (PERSONNEL/ORGANIZATION): FOL, TETRA TECH, JACKSONVILLE, FLORIDA
TYPE OF SHIPMENT/CARRIER: FEDEX
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Sample Custodians, Empirical Laboratories
Sample Custody and Storage (Personnel/Organization): Sample Custodians, Empirical Laboratories
Sample Preparation (Personnel/Organization): Preparation Laboratory Staff (organic / inorganic), Empirical Laboratories
Sample Determinative Analysis (Personnel/Organization): GC/MS, GC, VOC Laboratory Staff, Empirical Laboratories
SAMPLE ARCHIVING
Field Sample Storage (Number of days from sample collection): 60 days from submittal of final data report.
Sample Extract/Digestate Storage (Number of days from extraction/digestion): 6 months from submittal of final data report
Biological Sample Storage (Number of days from sample collection): Not applicable
SAMPLE DISPOSAL
Personnel/Organization: Sample Custodians, Empirical Laboratories

SAP Worksheet #27 – Sample Custody Requirements Table

(UFP-QAPP Manual Section 3.3.3)

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory): Tetra Tech CT-04 Sample Nomenclature, Tetra Tech SA-1.1 Groundwater Sampling, Tetra Tech SA-6.1 Non-Radiological Sample Handling
Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal): Empirical SOP-404 Laboratory Sample Receiving Log-In and Storage SOPs Rev. 13; Empirical SOP-405 Analytical Laboratory Waste Disposal, Rev. 5; Empirical SOP-410 SOPs for Laboratory Sample Storage, Secure Areas and Sample Custody, Rev. 7
Sample Identification Procedures: Empirical SOP-404 Laboratory Sample Receiving Log-In and Storage SOPs Rev. 13
Chain of custody Procedures: Empirical SOP-410 SOPs for Laboratory Sample Storage, Secure Areas and Sample Custody, Rev. 7

SAMPLE CUSTODY REQUIREMENTS

Field Chain of Custody

To ensure the integrity of a sample from collection through analysis, an accurate, written record that traces the possession and handling of the sample is necessary. This documentation is referred to as the chain of custody form. Chain of custody begins at the time of sample collection. A sample is under custody if any of the following conditions apply:

- It is in the owner's actual possession,
- It is in the owner's view, after being in his/her physical possession,
- It was in the owner's possession and was locked or sealed it up to prevent tampering,
- It is in a secure area.

Custody documentation is designed to provide documentation of preparation, handling, storage, and shipping of all samples collected. A multi-part chain of custody form is used with each page of the form signed and dated by the recipient of a sample or portion of sample. The person releasing the sample and the person receiving the sample each will retain a copy of the chain of custody form each time a sample transfer occurs.

Preservation of the integrity of the samples collected during the site investigation will be the responsibility of identified persons from the time the samples are collected until the samples, or their derived data, are incorporated into the final report. Sample custody is described in Worksheet #27.

The FOL is responsible for the care and custody of the samples collected until they are delivered to the laboratory or are entrusted to a carrier. When transferring samples, the individuals relinquishing and

receiving them will sign, date, and note the time on the chain of custody form. This form documents the sample custody transfer from the sampler to the laboratory, often through another person or agency (common carrier). Field chain of custody requirements are provided in SOP-03. Upon arrival at the laboratory, internal sample custody procedures will be followed as defined in the laboratory SOPs included in Appendix C.

Laboratory Chain of Custody

The Laboratory Sample Custody Procedures (Receipt of Samples, Archiving, and Disposal) documented in the selected laboratories SOPs will be followed. At a minimum, the following items will be included in the selected laboratories SOPs. Coolers will be received and checked for proper temperature. A sample cooler receipt form will be filled out to note conditions and any discrepancies. The chain of custody will be checked against the sample containers for correctness. Samples will be logged into the laboratory information management system and given a unique log number which can be tracked through processing. The client will be notified of any problems.

SAP Worksheet #28 -- Laboratory QC Samples Table

(UFP-QAPP Manual Section 3.4)

Matrix	Aqueous
Analytical Group	Volatiles
Analytical Method/ SOP Reference	SW-846 8260B/SOP-202

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Method Blank	One per batch of 20 or less	No target compounds should be ≥1/2 the reporting limit except common lab contaminants which should be < reporting limit.	Re-clean, retest, re-extract, reanalyze, and/or qualify the data.	Analyst, Laboratory Supervisor and Data Validator	Bias / Contamination	No target compounds should be ≥1/2 the reporting limit except common lab contaminants which should be < reporting limit.
Surrogates	3 per sample	Department of Defense (DoD) Quality Systems Manual (QSM) limits 80-120	(1) Re-prepare and reanalyze for confirmation of matrix interference when appropriate.	Analyst, Laboratory Supervisor and Data Validator	Accuracy / Bias	DoD QSM limits.
Laboratory Control Spike	One per batch of 20 or less	DoD QSM limits 80-120	(1) Evaluate and reanalyze if possible (2) If an MS/MSD was performed in the same 12 hour clock and acceptable narrate. (3) If the laboratory control sample (LCS) recoveries are high but the sample results are <reporting limit, narrate otherwise re-prepare and reanalyze the batch.	Analyst, Laboratory Supervisor and Data Validator	Precision / Accuracy / Bias	DoD QSM limits.
Internal Standards	3 per sample	Retention times for internal standards must be ± 30 seconds and the responses within -50% to +100% of last calibration verification (12 hours) for each internal standard.	Inspect mass spectrometer or gas chromatograph for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning	Analyst, Laboratory Supervisor and Data Validator	Precision / Accuracy / Bias	Retention times for internal standards must be ± 30 seconds and the responses within -50% to +100% of last calibration verification (12 hours) for each internal standard.
MS/MSD	One per sample delivery group (SDG) or every 20 samples.	DoD QSM limits 80-120	(1) CA will not be taken for samples when recoveries are outside limits and surrogate and LCS criteria are met (2) If both the LCS and MS/MSD are unacceptable re-prepare the samples and QC.	Analyst, Laboratory Supervisor and Data Validator	Precision / Accuracy / Bias	DoD QSM limits.

Matrix	Aqueous
Analytical Group	PAH SIM
Analytical Method/ SOP Reference	SW-846 8270C SIM/SOP-231

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per batch of 20 or less	No target compounds should be ≥1/2 the reporting limit except common lab contaminants which should be < reporting limit.	Reclean, retest, re-extract, reanalyze, and/or qualify the data.	Analyst, Laboratory Supervisor and Data Validator	Bias / Contamination	No target compounds should be ≥1/2 the reporting limit except common lab contaminants which should be < reporting limit.
Surrogates	2 per sample	2-Fluorobiphenyl 34-167%R Terphenyl-d14 34-167%R	(1) Reprepare and reanalyze for confirmation of matrix interference when appropriate.	Analyst, Laboratory Supervisor and Data Validator	Accuracy / Bias	2-Fluorobiphenyl 34-167%R Terphenyl-d14 34-167%R
Laboratory Control Spike	One per batch of 20 or less	Laboratory statistically derived limits listed in SOP-231 Appendix C.	(1) Evaluate and reanalyze if possible (2) If an MS/MSD was performed in the same 12 hour clock and acceptable narrate. (3) If the LCS recoveries are high but the sample results are <reporting limit, narrate otherwise reprepare and reanalyze the batch.	Analyst, Laboratory Supervisor and Data Validator	Precision / Accuracy / Bias	Laboratory statistically derived limits listed in SOP-231 Appendix C.
Internal Standards	3 per sample	Retention times for internal standards must be ± 30 seconds and the responses within -50% to +100% of last calibration verification (12 hours) for each internal standard.	Inspect mass spectrometer or Gas chromatograph for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning	Analyst, Laboratory Supervisor and Data Validator	Precision / Accuracy / Bias	Retention times for internal standards must be ± 30 seconds and the responses within -50% to +100% of last calibration verification (12 hours) for each internal standard.
Matrix spike / Matrix spike duplicate	One per SDG or every 20 samples.	Laboratory statistically derived limits listed in SOP-231 Appendix C. RPD ≤40%	(1) CA will not be taken for samples when recoveries are outside limits and surrogate and LCS criteria are met (2) If both the LCS and MS/MSD are unacceptable reprep the samples and QC.	Analyst, Laboratory Supervisor and Data Validator	Precision / Accuracy / Bias	Laboratory statistically derived limits listed in SOP-231 Appendix C. RPD ≤40%

Matrix	Aqueous
Analytical Group	TRPH
Analytical Method/ SOP Reference	FDEP FLPRO Empirical SOP - 338

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per preparation batch of twenty or fewer samples of similar matrix.	No analytes detected > ½ the LOQ.	Investigate source of contamination Evaluate the samples and associated QC: i.e. If the blank results are above the LOQ, then report sample results which are <LOQ or > 10X the blank concentration. Otherwise, reprepare a blank and samples >LOQ and <10X LOQ.	Analyst, Laboratory Department Manager, and Data Validator	Bias/ Contamination	No analytes detected > ½ the LOQ.
Surrogate	Two per sample.	o-Terphenyl - 30-140% 2-Fluorobiphenyl 50-150%	If surrogates recoveries are high and sample is <LOQ, then no CA is taken. If surrogates recoveries are low, then the affected samples are re-extracted and reanalyzed.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	o-Terphenyl - 30-140% 2-Fluorobiphenyl 50-150%
LCS	One is performed for each batch of up to 20 samples.	Recovery must be within Empirical Laboratories statistically derived limits which are provided in LIMS 55-118%.	If an MS/MSD was performed and is acceptable, then narrate. If an LCS/LCS Duplicate (LCSD) was performed and only one of the set was unacceptable, then narrate. If the LCS recovery is high but the sample results are <LOQ, then narrate. Otherwise, re-extract blank and affected sample batch.	Analyst, Laboratory Department Manager, and Data Validator	Precision/ Accuracy/ Bias	Recovery must be within Empirical Laboratories statistically derived limits which are provided in LIMS 55-118%.
MS/MSD	One per 20 samples of similar matrix.	Recovery should be within Empirical Laboratories statistically derived limits which are provided in LIMS 55-118%.	Evaluate the samples and associated QC and if the LCS results are acceptable, then narrate. If both the LCS and MS/MSD are unacceptable, then re-prepare the samples and QC.	Analyst, Laboratory Department Manager, and Data Validator	Precision/ Accuracy/ Bias	Recovery should be within Empirical Laboratories statistically derived limits which are provided in LIMS 55-118%.

SAP Worksheet #29 -- Project Documents and Records Table

(UFP-QAPP Manual Section 3.5.1)

Document	Where Maintained
Field Documents Field Logbook (and sampling notes) Field Sample Forms (e.g., boring logs, sample log sheets, drilling logs, etc.) Chain of custody Records Sample Shipment Air Bills Equipment Calibration Logs Photographs FTMR Forms This SAP HASP	Field documents will be maintained in the Tetra Tech project file, results will be discussed in the project report.
Laboratory Documents Sample Receipt, Custody, and Tracking Record Standards Traceability Logs Equipment Calibration Logs Sample Preparation Logs Analysis Run Logs Equipment Maintenance, Testing, and Inspection Logs CA Forms Reported Field Sample Results Reported Results for Standards, QC Checks, and QC Samples Sample Storage and Disposal Records Telephone Logs Extraction/Clean-up Records Raw Data Data Completeness Checklist	Laboratory documents will be included in the hardcopy and PDF deliverables from the laboratory. Laboratory data deliverables will be maintained in the Tetra Tech project file and in long-term data package storage at a third-party professional document storage firm. Electronic data results will be maintained in a database on a password protected Structured Query Language (SQL) server.
Assessment Findings Field Sampling Audit Checklist (if conducted) Analytical Audit Checklist (if conducted) Data Validation Memoranda (includes tabulated data summary forms)	All assessment documents will be maintained in the Tetra Tech project file.
Reports Regular Long-term Monitoring Reports	All versions of the reports and all support documents (e.g., Data Validation Reports) will be stored in hardcopy in the Tetra Tech project file and electronically in the server library.

SAP Worksheet #30 -- Analytical Services Table

(UFP-QAPP Manual Section 3.5.2.3)

Matrix	Analytical Group	Sample Locations/ Identification Number	Analytical Method	Data Package Turnaround Time	Laboratory/Organization	Backup Laboratory/ Organization
Aqueous	Volatiles	See Worksheet #18	SW-846 8260B	21 days	Empirical Laboratories, LLC 621 Mainstream Dr. Nashville, TN 37228 Kim Kostzer 615-345-1115	Not applicable
Aqueous	PAH SIM	See Worksheet #18	SW-846 8270C SIM	21 days		
Aqueous	TRPH	See Worksheet #18	FL PRO	21 Days		

SAP Worksheet #31 -- Planned Project Assessments Table

(UFP-QAPP Manual Section 4.1.1)

Assessment Type	**Frequency**	**Internal or External**	**Organization Performing Assessment**	**Person(s) Responsible for Performing Assessment** (title and organizational affiliation)	**Person(s) Responsible for Responding to Assessment Findings** (title and organizational affiliation)	**Person(s) Responsible for Identifying and Implementing CAs** (title and organizational affiliation)	**Person(s) Responsible for Monitoring Effectiveness of CA** (title and organizational affiliation)
Health and Safety Audit	One per contract year	Internal	Tetra Tech	Health and Safety Personnel, Tetra Tech	PM, Tetra Tech	Auditor and HSM, Tetra Tech	HSM, Tetra Tech
Laboratory Systems Audit[1]	Every 18 months	External	DoD Environmental Laboratory Accreditation Program (ELAP)	DoD ELAP Accrediting Body Auditor	QAM, Empirical	QAM, Empirical	QAM, Empirical
Field Sampling Systems Audit	One per contract year	Internal	Tetra Tech	Auditor, Tetra Tech	PM, Tetra Tech	Auditor and QAM, Tetra Tech	QAM, Tetra Tech

1 Empirical has successfully completed the laboratory evaluation process required as part of the DoD QSM v 4.1. A copy of the DOD ELAP accreditation letter is included in Appendix D.

SAP Worksheet #32 -- Assessment Findings and Corrective Action Responses

(UFP-QAPP Manual Section 4.1.2)

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (name, title, organization)	Timeframe of Notification	Nature of CA Response Documentation	Individual(s) Receiving CA Response (name, title, organization)	Timeframe for Response
Field Supervision	Site log book and sample collection logs	Rob Simcik, PM, Tetra Tech; Kara Wimble, FOL, Tetra Tech	Immediately	Entry in site log book	Rob Simcik, PM, Tetra Tech; Kara Wimble, FOL, Tetra Tech	Within 24 hours
Project Supervision	Written report	John Trepanowski, Program Manager, Tetra Tech; and Tom Johnston, QAM, Tetra Tech	Monthly	Written memo	John Trepanowski, Program Manager, Tetra Tech	Within 7 days of notification
Health and Safety Audit	Audit checklist and written audit finding summary	Rob Simcik, PM, Tetra Tech; Kara Wimble, FOL, Tetra Tech; John Trepanowski, Program Manager, Tetra Tech ; and Tom Johnston, QAM, Tetra Tech	Dependent on findings; if major, a stop work maybe issued immediately; however, if minor, within 1 week of audit	Written memo	Matt Soltis, HSM, Tetra Tech; Designee, Field Auditor; John Trepanowski, Program Manager, Tetra Tech	Within 21 days of notification
Field Sampling Systems Audit	Audit checklist and written audit finding summary	Rob Simcik, PM, Tetra Tech; Kara Wimble, FOL, Tetra Tech; John Trepanowski, Program Manager, Tetra Tech ; and Tom Johnston, QAM, Tetra Tech	Dependent on findings; if major, a stop work maybe issued immediately; however, if minor, within 1 week of audit	Written memo	Tom Johnston, QAM, Tetra Tech, or QAM Designee/Auditor Tetra Tech; and John Trepanowski, Program Manager, Tetra Tech	Within 21 days of notification
Laboratory Systems Audit	Written audit report	Laboratory QAM	Not specified by DoD ELAP	Letter	DoD ELAP Accrediting Body	Specified by DoD ELAP Accrediting Body

SAP Worksheet #33 -- QA Management Reports Table

(UFP QAPP Manual Section 4.2)

Type of Report	**Frequency** (daily, weekly monthly, quarterly, annually, etc.)	**Projected Delivery Date(s)**	**Person(s) Responsible for Report Preparation** (title and organizational affiliation)	**Report Recipient(s)** (title and organizational affiliation)
Data Validation Report	Per SDG	After validation is complete	DVM or designee, Tetra Tech	PM, Tetra Tech; project file
Major Analysis Problem Identification (Internal Memorandum)	When persistent analysis problems are detected	Immediately	QAM, Tetra Tech	PM, Tetra Tech; project file
Project Monthly Progress Report	Monthly for duration of the project	Monthly	PM, Tetra Tech	PM, Tetra Tech; QAM, Tetra Tech; Program Manager, Tetra Tech; project file
Laboratory QA Report	When significant plan deviations result from unanticipated circumstances	Immediately	Laboratory PM, Empirical	PM, Tetra Tech; project file

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

(UFP-QAPP Manual Section 5.2.1)

Verification Input	Description	Internal / External	Responsible for Verification (name, organization)
Chain-of-Custody Forms	The Tetra Tech FOL or designee will review and sign the Chain-of-Custody Form to verify that all samples listed are included in the shipment to the laboratory and the sample information is accurate. The forms will be signed by the sampler and a copy will be retained for the project file, and the Tetra Tech PM. See SOP SA-6.3.	Internal	Tetra Tech sampler and FOL
SAP Sample Tables	Verify that all proposed samples listed in the SAP tables have been collected.	Internal	Tetra Tech, FOL or designee
Sample Log Sheets	Verify that information recorded in the log sheets is accurate and complete.	Internal	Tetra Tech, FOL or designee
Sample Coordinates	Verify that sample locations are correct and in accordance with the SAP proposed locations.	Internal	Tetra Tech, FOL or designee
Field SOPs/Field logs/Sample collection	Ensure that all sampling SOPs were followed. Verify that deviations have been documented and MPCs have been achieved. Particular attention should be given to verify that samples were correctly identified, that sampling location coordinates are accurate, and that documentation establishes an unbroken trail of documented chain-of-custody from sample collection to report generation. Verify that the correct sampling and analytical methods/SOPs were applied. Verify that the sampling plan was implemented and carried out as written and that any deviations are documented.	Internal	Tetra Tech, TOM or designee
Analytical SOPs	Ensure that all laboratory SOPs were followed. Verify that the correct analytical methods/SOPs were applied.	Internal	Laboratory QAM, Empirical
Documentation of method QC results	Establish that all method QC samples were analyzed and in control as listed in the analytical SOPs. If method QA is not in control, the laboratory will contact Tetra Tech for guidance prior to report preparation.	Internal	Laboratory QAM, Empirical
Field QC Samples	Check that field QC samples listed in Worksheet #20 were collected as required.	Internal	Tetra Tech, FOL or designee

Verification Input	Description	Internal / External	Responsible for Verification (name, organization)
Chain-of-Custody Forms	The laboratory sample custodian will review the sample shipment for completeness, integrity, and sign accepting the shipment. The Tetra Tech data validator will check that the Chain-of-Custody Form was signed/dated by the Tetra Tech FOL or designee relinquishing the samples and also by the laboratory sample custodian receiving the samples for analyses.	Internal/ External	Laboratory sample custodian/ Tetra Tech data validator
Analytical Data Package	All analytical data packages will be verified internally for completeness by the laboratory performing the work. The laboratory QAM will sign the case narrative for each data package.	Internal	Laboratory QAM
Analytical Data Package	The data package will be verified for completeness by Tetra Tech data validator. Missing information will be requested by Tetra Tech from the laboratory.	External	Tetra Tech, Data Validator
Electronic Data Deliverables (EDDs)	The electronic data will be verified against the chain-of-custody and hard copy data package for accuracy and completeness. Laboratory analytical results will be verified and compared to the electronic analytical results for accuracy. Sample results will be evaluated for laboratory contamination and will be qualified for false positives using the laboratory method/preparation blank summaries. Positive results reported between the method detection limit and the reporting limit will be qualified as estimated. Extraneous laboratory qualifiers will be removed from the validation qualifier.	External	Tetra Tech, Data Validator

1 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 SAP (see Table 11, page 118, UFP-QAPP manual, V.1, March 2005).

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

(UFP-QAPP MANUAL SECTION 5.2.2) (FIGURE 37 UFP-QAPP MANUAL) (TABLE 9 UFP-QAPP MANUAL)

Step IIa / IIb[1]	Validation Input	Description	Responsible for Validation (name, organization)
IIa	Chain-of-Custody	Ensure that the custody and integrity of the samples was maintained from collection to analysis and the custody records are complete and any deviations are recorded.	Tetra Tech Project Chemist or data validators
IIa	Holding Times	Review that the samples were shipped and stored at the required temperature and sample pH for chemically-preserved samples meet the requirements listed in Worksheet #19. Ensure that the analyses were performed within the holding times listed in Worksheet #19.	Tetra Tech Project Chemist or Data Validators
IIa/IIb	Laboratory Data Results for Accuracy	Ensure that the laboratory QC samples listed in Worksheet #28 were analyzed and that the MPC listed in Worksheet #12 were met for all field samples and QC analyses. Check that specified field QC samples were collected and analyzed and that the analytical QC criteria set up for this project were met.	Tetra Tech Project Chemist or Data Validators
IIa/IIb	Laboratory Duplicate Analyses for Precision	Check the laboratory precision by reviewing the RPD or percent difference values from laboratory duplicate analyses; MS/MSDs; and LCS/LCSDs. Ensure compliance with the methods and project MPC accuracy goals listed in Worksheet #12.	Tetra Tech Project Chemist or Data Validators
IIa/IIb	Sample Results for Representativeness	Check that the laboratory recorded the temperature at sample receipt and the pH of the chemically preserved samples to ensure sample integrity from sample collection to analysis.	Tetra Tech Project Chemist or Data Validators
IIa/IIb	PALs	Discuss the impact on matrix interferences or sample dilutions performed because of the high concentration of one or more contaminant, on the other target compounds reported as no-detected. Document this usability issue and inform the PM.	Tetra Tech Project Chemist or Data Validators

Step IIa / IIb[1]	Validation Input	Description	Responsible for Validation (name, organization)
IIa/IIb	Data Validation Report	Summarize deviations from methods, procedures, or contracts. Qualify data results based on method or QC deviation and explain all the data qualifications. Print a copy of the project data base qualified data depicting data qualifiers and data qualifiers codes that summarize the reason for data qualifications. Determine if the data met the MPC and determine the impact of any deviations on the technical usability of the data.	Tetra Tech Project Chemist or Data Validators
IIa, IIb	SAP QC Sample Documentation	Ensure that all QC samples specified in the SAP were collected and analyzed and that the associated results were within prescribed SAP acceptance limits. Ensure that QC samples and standards prescribed in analytical SOPs were analyzed and within the prescribed control limits. If any significant QC deviations occur, the laboratory shall have contacted the Tetra Tech PM.	Tetra Tech PM or designee
IIa, IIb	Documentation of Analytical Reports for Completeness	Review the chain-of-custody form generated in the field to ensure that the required analytical samples have been collected, appropriate sample identifications have been used, and correct analytical methods have been applied. Validator will verify that elements of the data package required for validation are present, and if not, the laboratory will be contacted and the missing information will be requested. Validation will be performed as per Worksheet #36. Check that all data have been transferred correctly and completely to the final Structured Query Language (SQL) database.	Tetra Tech Project Chemist or Data Validators
IIa/IIb	PALs	Review and add PALs to the laboratory EDD. Flag samples and notify PM of samples that exceed PALs, as listed on Worksheet #15.	Tetra Tech PM or designee
IIb	QLs for Sensitivity	Ensure that the QLs listed in Worksheet #15 were achieved.	Tetra Tech Project Chemist or Data Validators
IIb	Analytical Data Deviations	Determine the impact of any deviation from sampling or analytical methods and SOPs requirements and matrix interferences effect on the analytical results.	Tetra Tech Project Chemist or Data Validators

1 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 SAP (see Table 11, page 118, UFP-QAPP Manual, V.1, March 2005).

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

(UFP-QAPP Manual Section 5.2.2.1)

Step IIa / IIb	Matrix	Analytical Group	Validation Criteria	Data Validator (title and organizational affiliation)
IIa and IIb	Aqueous	VOCs and PAH	Limited data validation will be performed to eliminate false positives and identify false negatives. Limited validation includes an evaluation of data completeness, holding times, calibrations, method blank contamination, and field duplicate precision, and detection limits. Validation will be performed using criteria for SW-846 8260B, 8270C, 8270C SIM, and 8082 method specific criteria and those criteria listed in Worksheets #s 12, 15, 24, 25, and 28, and the DoD QSM. If not included in the aforementioned, the logic outlined in USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review EPA-540-R-08-01, June 2008 will be used to apply qualifiers to data.	Tetra Tech Data Validation Specialist

SAP Worksheet #37 -- Usability Assessment

(UFP-QAPP Manual Section 5.2.3)

Data Usability Assessment
The usability of the data directly affects whether project objectives can be achieved. The following characteristics will be evaluated at a minimum. The results of these evaluations will be included in the project report. The characteristics will be evaluated for multiple concentration levels if the evaluator determines that this is necessary. To the extent required by the type of data being reviewed, the assessors will consult with other technically competent individuals to render sound technical assessments of these data characteristics: **Completeness** For each matrix that was scheduled to be sampled, the FOL, acting on behalf of the Project Team, will prepare a table listing planned samples/analyses to collected samples/analyses. If deviations from the scheduled sample collection or analyses are identified the Tetra Tech PM and Project Risk Assessor will determine whether the deviations compromise the ability to meet project objectives. If they do, the Tetra Tech PM will consult with the Navy RPM and other Project Team members, as necessary (determined by the Navy RPM), to develop appropriate CAs. **Precision** The Project Chemist, acting on behalf of the Project Team, will determine whether precision goals for field duplicates and laboratory duplicates were met. This will be accomplished by comparing duplicate results to precision goals identified in Worksheet #s 12 and 28. This will also include a comparison of field and laboratory precision with the expectation that field duplicate results will be no less precise than laboratory duplicate results. If the goals are not met, or data have been flagged as estimated (J qualifier), limitations on the use of the data will be described in the project report. **Accuracy** The Project Chemist, acting on behalf of the Project Team, will determine whether the accuracy/bias goals were met for project data. This will be accomplished by comparing percent recoveries of LCS, LCSD, MS, MSD, and surrogate compounds to accuracy goals identified in Worksheet #28. This assessment will include an evaluation of field and laboratory contamination; instrument calibration variability; and analyte recoveries for surrogates, matrix spike, and laboratory control samples. If the goals are not met, limitations on the use of the data will be described in the project report. Bias of the qualified results and a description of the impact of identified non-compliances on a specific data package or on the overall project data will be described in the project report. **Representativeness** A Project Scientist, identified by the Tetra Tech PM and acting on behalf of the Project Team, will determine whether the data are adequately representative of intended populations, both spatially and temporally. This will be accomplished by verifying that samples were collected and processed for analysis in accordance with the SAP, by reviewing spatial and temporal data variations, and by comparing these characteristics to expectations. The usability report will describe the representativeness of the data for each matrix and analytical fraction. This will not require quantitative comparisons unless professional judgment of the project scientist indicates that a quantitative analysis is required.

Comparability

The Project Chemist, acting on behalf of the Project Team, will determine whether the data generated under this project are sufficiently comparable to historical site data generated by different methods and for samples collected using different procedures and under different site conditions. This will be accomplished by comparing overall precision and bias among data sets for each matrix and analytical fraction. This will not require quantitative comparisons unless professional judgment of the Project Chemist indicates that such quantitative analysis is required.

Sensitivity

The Project Chemist, acting on behalf of the Project Team, will determine whether project sensitivity goals listed in Worksheet #15 are achieved. The overall sensitivity and quantitation limits (LOQs, LODs, and MDLs) from multiple data sets for each matrix and analysis will be compared. If sensitivity goals are not achieved, the limitations on the data will be described. The Project Chemist will enlist the help of the Project Risk Assessor to evaluate deviations from planned sensitivity goals.

Project Assumptions and Data Outliers

The Tetra Tech PM and designated team members will evaluate whether project assumptions are valid. This will typically be a qualitative evaluation but may be supported by quantitative evaluations. The type of evaluation depends on the assumption being tested. Potential outliers will be removed if a review of the associated indicates that the results have an assignable cause the renders them inconsistent with the rest of the data. During this evaluation, the team will consider whether outliers could be indications of unanticipated site conditions. Consideration will be given to whether outliers represent an unanticipated site condition.

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

After completion of the data validation, the data and data quality will be reviewed to determine whether sufficient data of acceptable quality are available for decision making. In addition to the evaluations described above, a series of inspections and statistical analyses will be performed to estimate these characteristics. Statistical evaluations will include simple summary statistics for target analytes, such as maximum concentration, minimum concentration, number of samples exhibiting non-detected results, number of samples exhibiting positive results, and the proportion of samples with detected and non-detected results. Tend lines will be generated to show concentrations over time, including data collected prior to this investigation. The Project Team members identified by the Tetra Tech PM will assess whether the data collectively support the attainment of project objectives. This will be accomplished in part by comparing concentrations to GCTLs abut also by inspecting temporal trend lines to determine whether there are any anomalies present that indicate a deviation from expected trends. They will consider whether any missing or rejected data have compromised the ability to make decisions or to make the decisions with the desired level of confidence. The data will be evaluated to determine whether missing or rejected data can be compensated by other data. Although rejected data will generally not be used, there may be reason to use them in a weight of evidence argument, especially when they supplement data that have not been rejected. If rejected data are used, their use will be supported by technically defensible rationales.

For statistical comparisons and mathematical manipulations, non-detected values will be represented by a concentration equal to the sample-specific detection limit. Duplicate results (original and duplicate) will not be averaged for the purpose of representing the range of concentrations. However, the average of the original and duplicate samples will be used to represent the concentration at a particular sampled location.

Identify the personnel responsible for performing the usability assessment:

The Tetra Tech PM, Project Chemist, FOL, and Project Scientist will be responsible for conducting the listed data usability assessments. The data usability assessment will be reviewed with the Navy RPM, the EPA RPM, and the FDEP RPM. If deficiencies affecting the attainment of project objectives are identified, the review will take place either in a face to face meeting or a teleconference depending on the extent of identified deficiencies. If no significant deficiencies are identified, the data usability assessment will simply be documented in the project report and reviewed during the normal document review cycle.

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

The data will be presented in tabular format, including data qualifications such as estimation (J, UJ) or rejection (R). Written documentation will support the non-compliance estimated or rejected data results. The project report will identify and describe the data usability limitations and suggest re-sampling or other CAs, if necessary.

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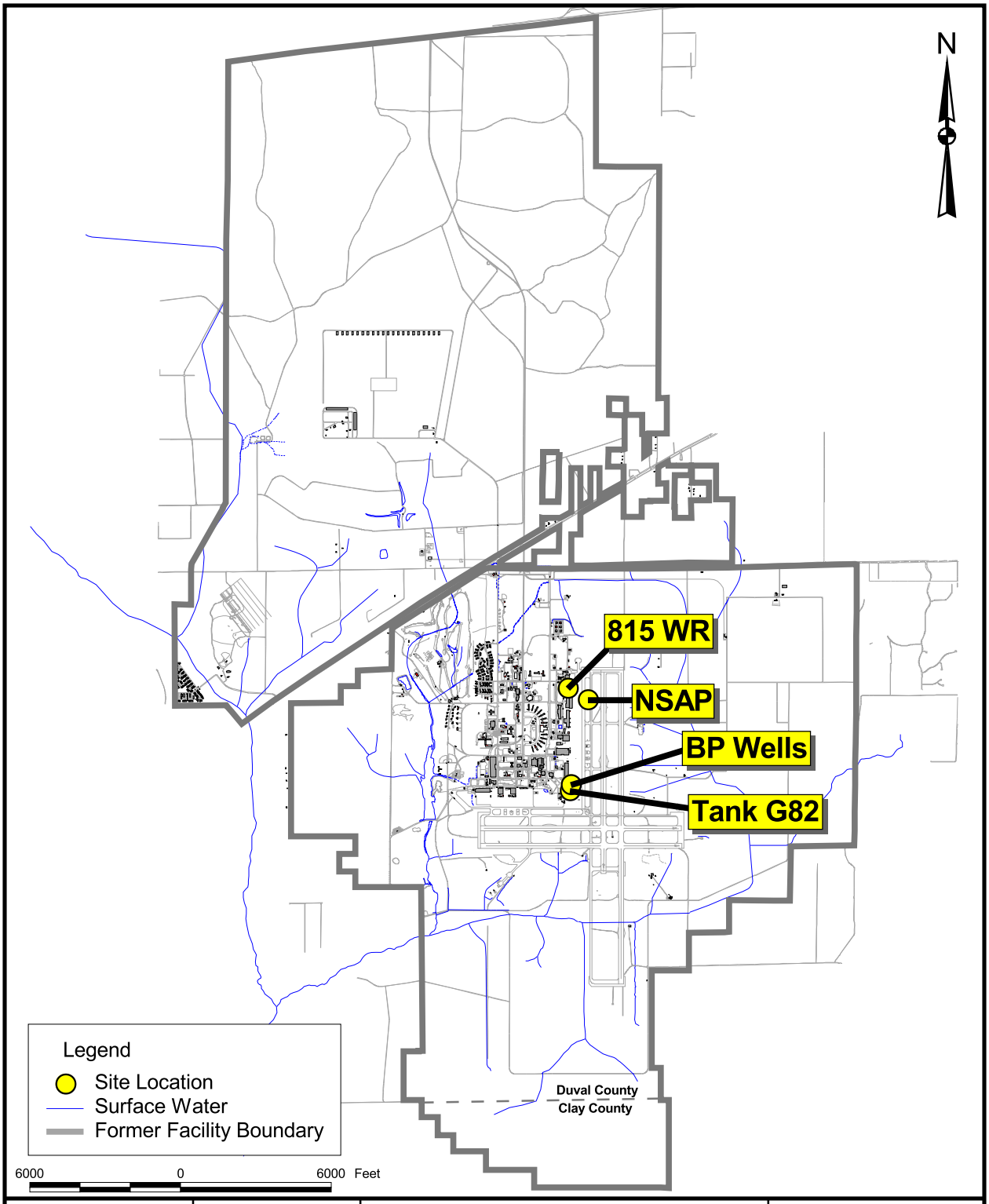
FIGURES



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CHECKED BY	DATE		APPROVED BY DATE
COST/SCHEDULE-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 10A-1 / REV 1

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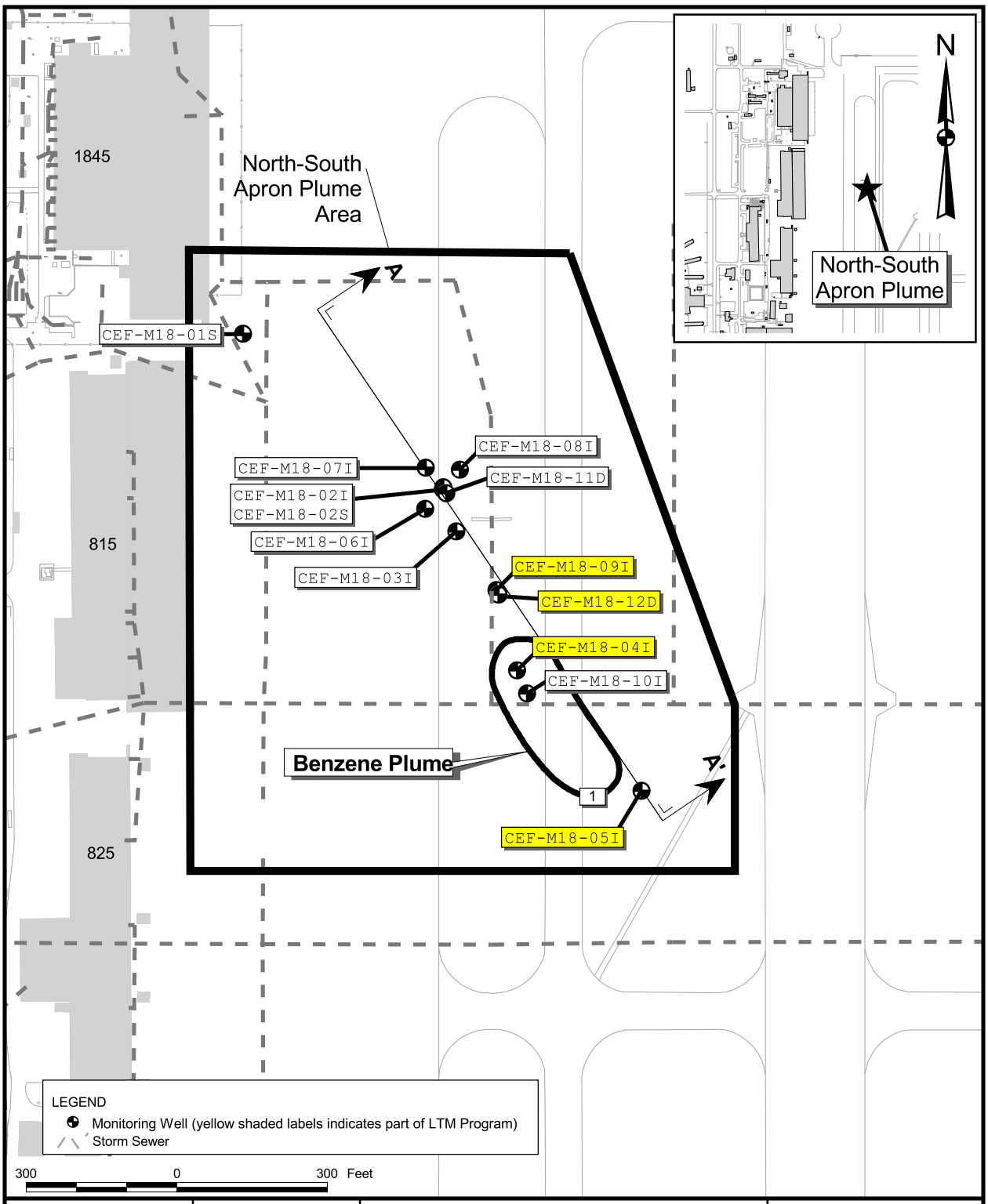

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CHECKED BY	DATE		APPROVED BY DATE
COST/SCHEDULE-AREA			APPROVED BY DATE
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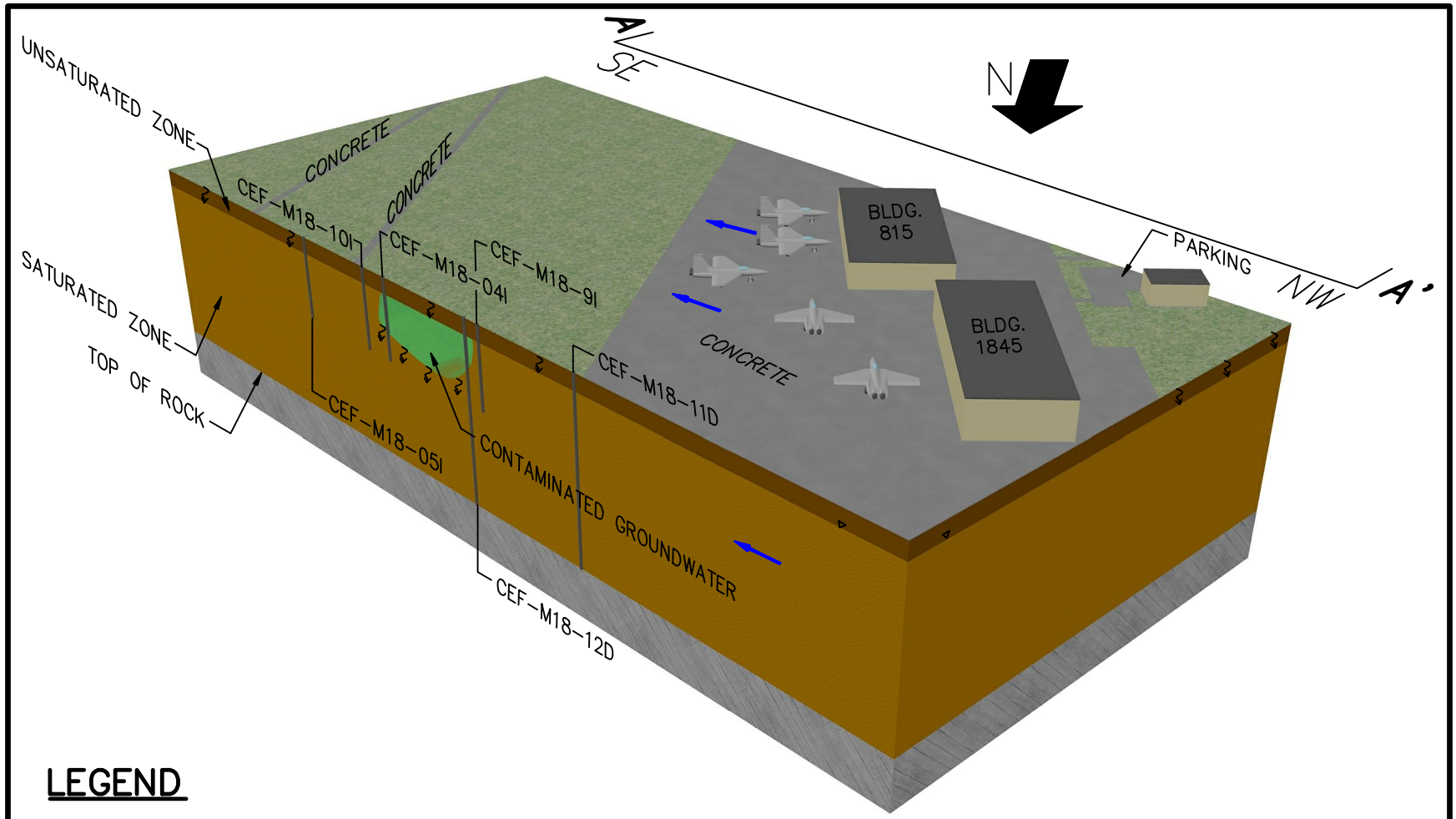

LEGEND

GRASS

RAINWATER INFILTRATION

TOP OF WATER TABLE

DIRECTION OF GROUNDWATER AND SURFACE WATER FLOW

DRAWN BY BH	DATE 12/16/09
CHECKED BY BP	DATE 12/16/09
REVISED BY ---	DATE ---
SCALE NOT TO SCALE	

NAVFAC

CONCEPTUAL SITE MODEL
NORTH-SOUTH APRON PLUME
NAS CECIL FIELD
JACKSONVILLE, FLORIDA

CONTRACT NO. 2267	
OWNER NO.	
APPROVED BY ---	DATE
DRAWING NO. FIGURE 10A-3	REV. 0

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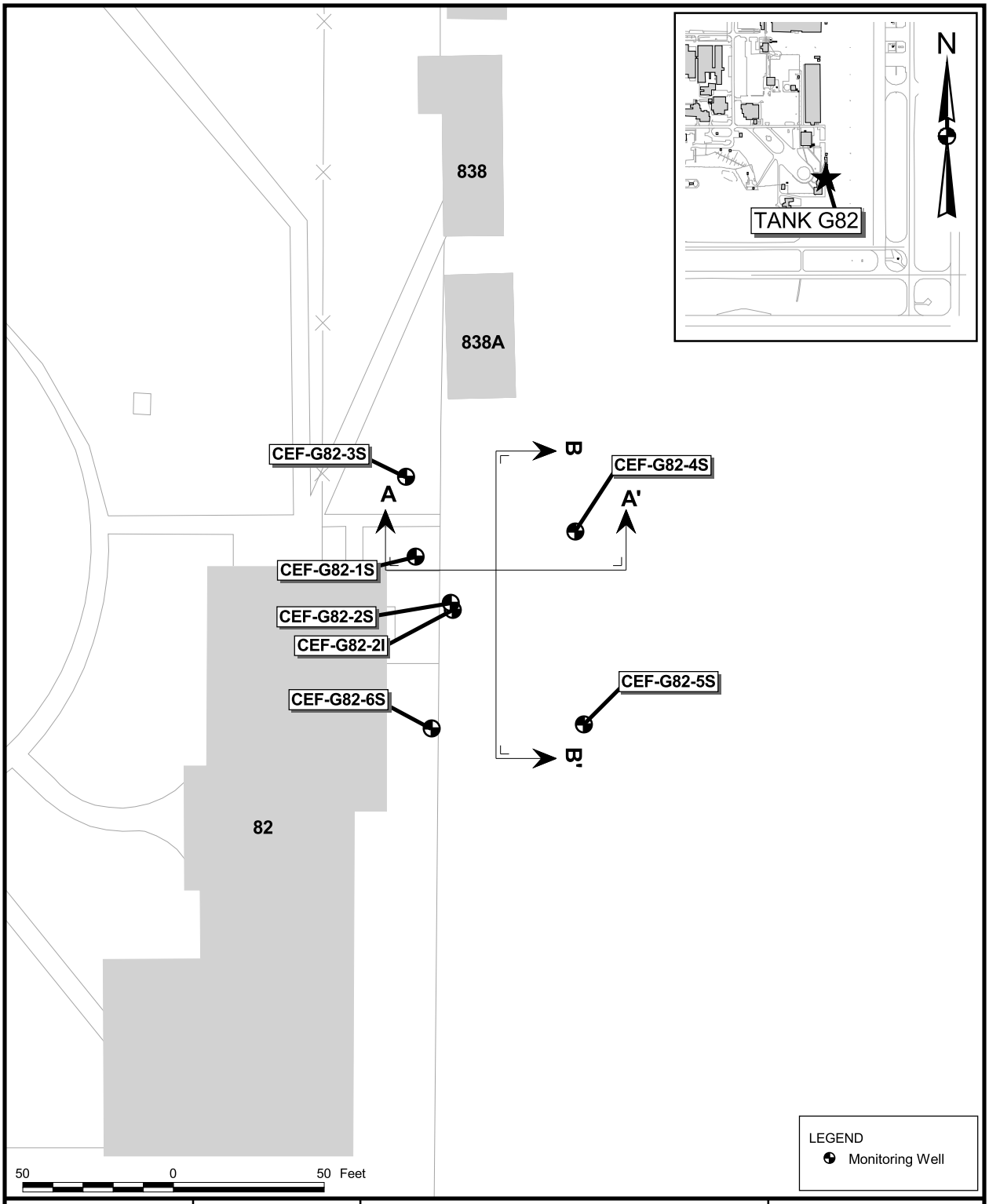

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CHECKED BY	DATE		APPROVED BY DATE
COST/SCHEDULE-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 10B-1 / REV 0

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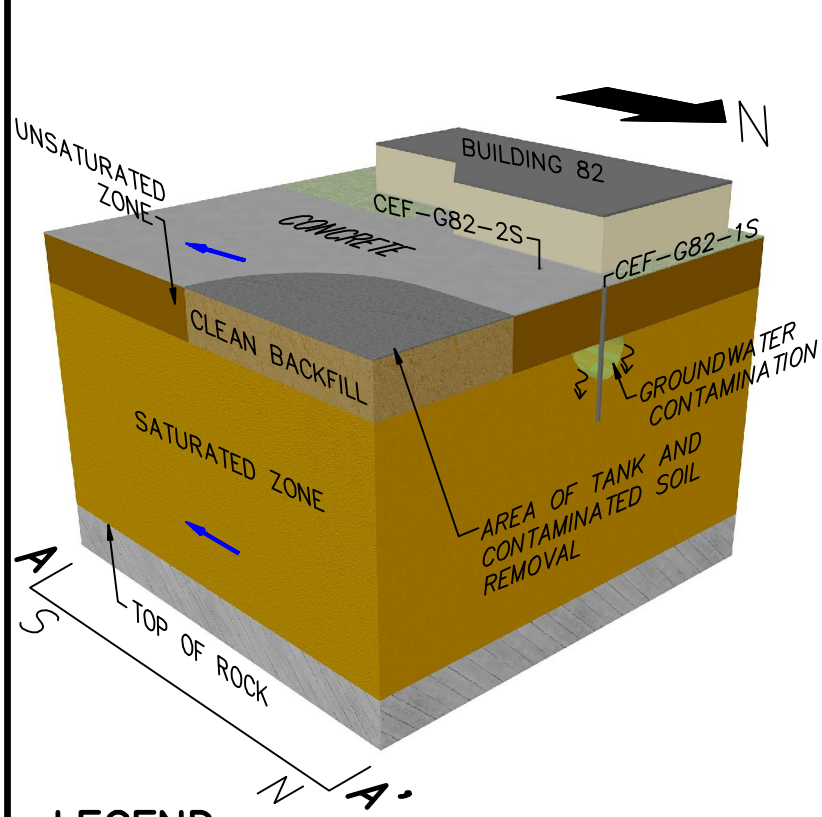

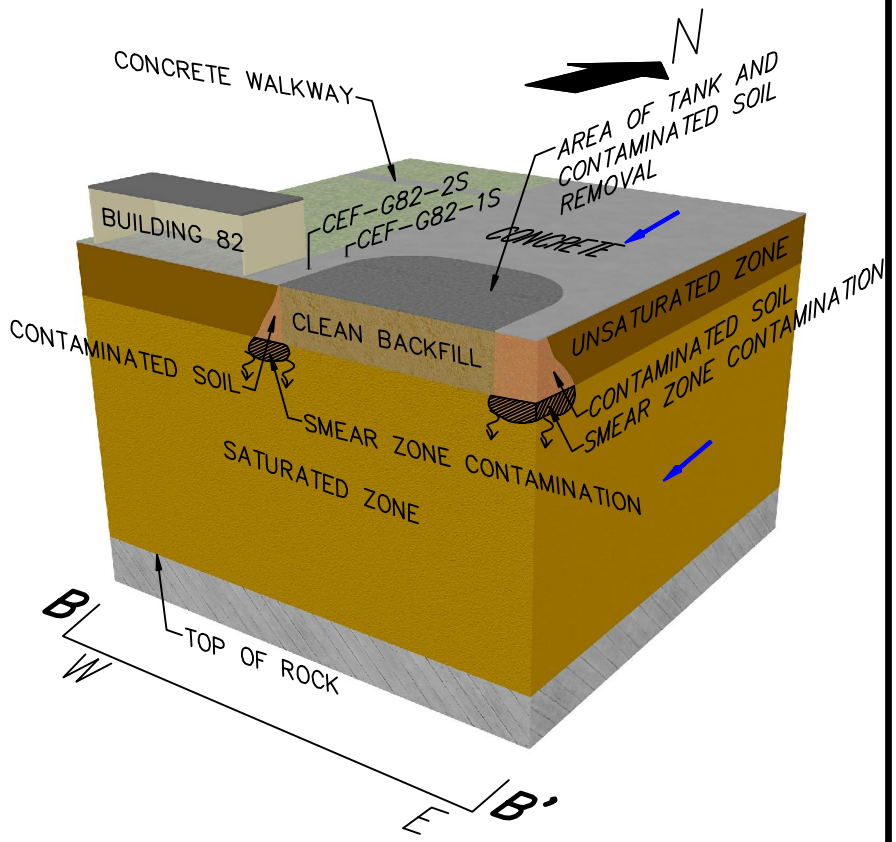

LEGEND

GRASS

RAINWATER INFILTRATION

TOP OF WATER TABLE

DIRECTION OF GROUNDWATER AND SURFACE WATER FLOW

DRAWN BY BH	DATE 12/16/09
CHECKED BY BP	DATE 12/16/09
REVISED BY ---	DATE ---
SCALE NOT TO SCALE	

NAVFAC

CONCEPTUAL SITE MODEL
BUILDING 82
NAS CECIL FIELD
JACKSONVILLE, FLORIDA

CONTRACT NO. 2267	
OWNER NO.	
APPROVED BY ---	DATE
DRAWING NO. FIGURE 10B-2	REV. 0

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COST/SCHEDULE-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 10C-1 / REV 0

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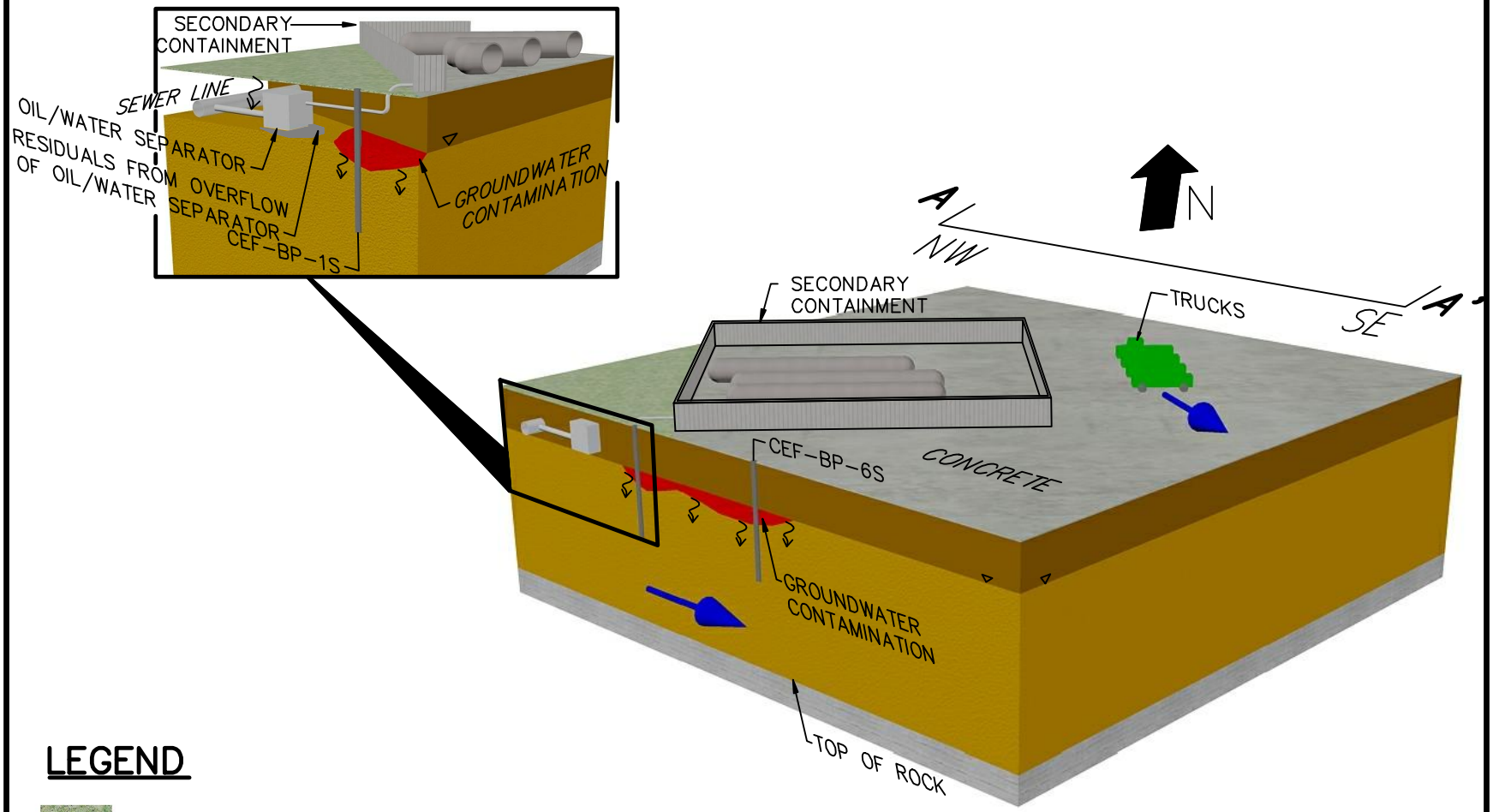

LEGEND

GRASS

RAINWATER INFILTRATION

TOP OF WATER TABLE

DIRECTION OF GROUNDWATER AND SURFACE WATER FLOW

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CHECKED BY BP	DATE 12/11/09	
REVISED BY ---	DATE ---	
SCALE NOT TO SCALE		

NAVFAC

CONCEPTUAL SITE MODEL
BP WELLS
NAS CECIL FIELD
JACKSONVILLE, FLORIDA

CONTRACT NO. 2267	
OWNER NO.	
APPROVED BY ---	DATE
DRAWING NO. FIGURE 10C-2	REV. 0

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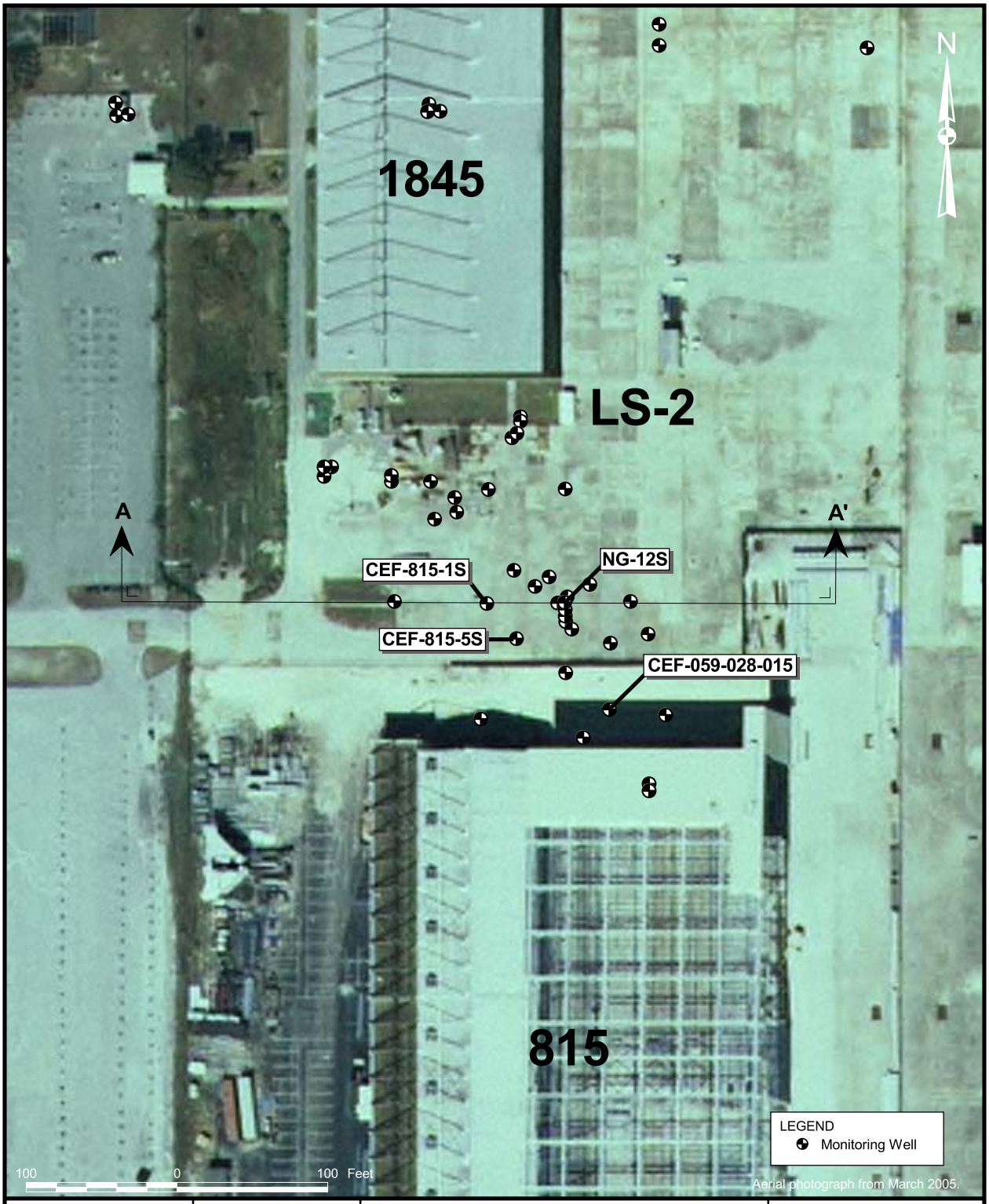

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CHECKED BY	DATE		APPROVED BY DATE
COST/SCHEDULE-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 10D-1 / REV 0

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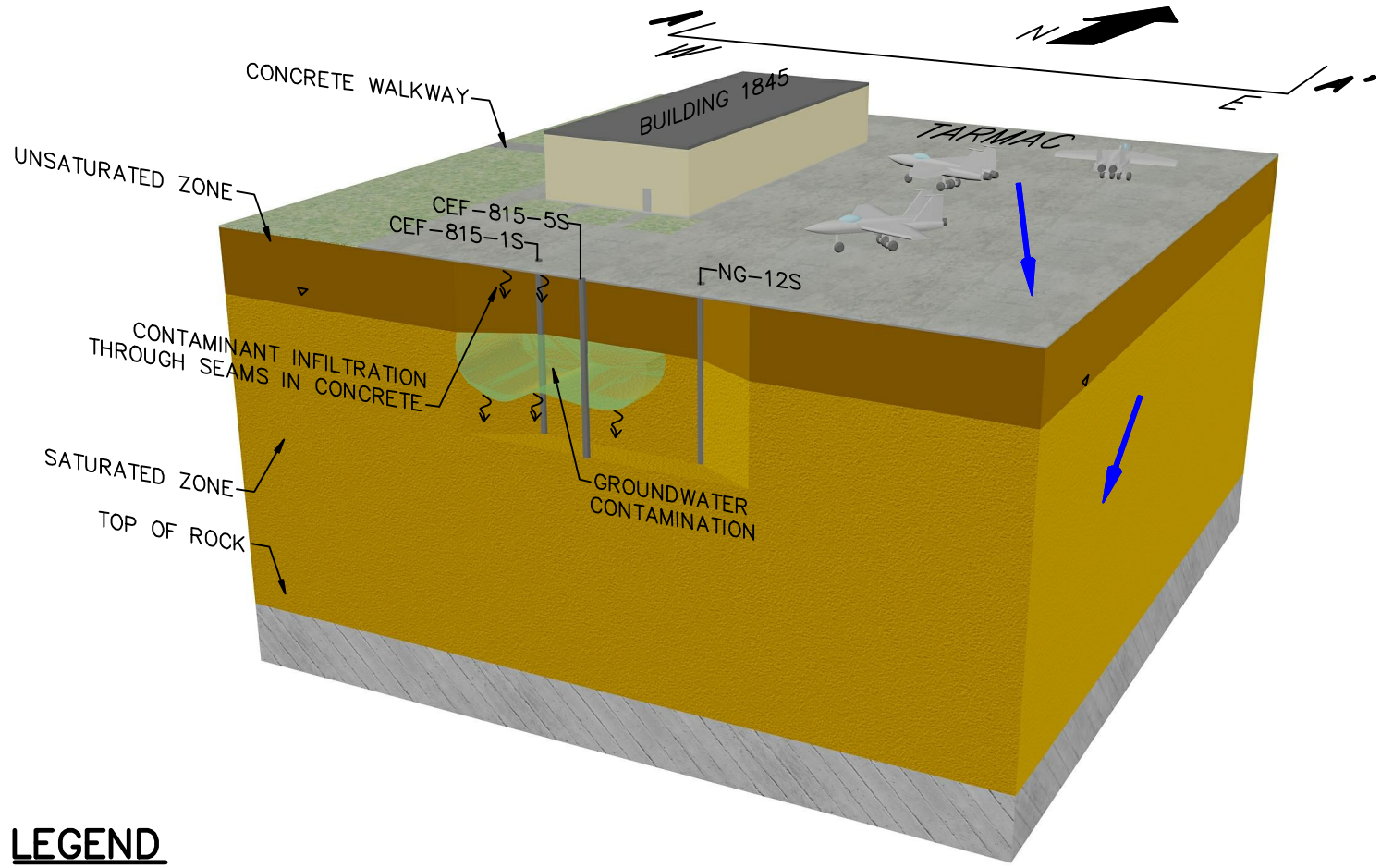

LEGEND

GRASS

RAINWATER INFILTRATION

TOP OF WATER TABLE

DIRECTION OF GROUNDWATER AND SURFACE WATER FLOW

DRAWN BY	DATE
BH	12/16/09
CHECKED BY	DATE
BP	12/16/09
REVISED BY	DATE
---	---
SCALE	
NOT TO SCALE	

NAVFAC

CONCEPTUAL SITE MODEL
815 WASH RACK
NAS CECIL FIELD
JACKSONVILLE, FLORIDA

CONTRACT NO.	
2267	
OWNER NO.	
APPROVED BY	DATE

DRAWING NO.	REV.
FIGURE 10D-2	0

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APPENDIX A

FIELD DOCUMENTATION FORMS and STANDARD OPERATING PROCEDURES

FIELD DOCUMENTATION FORMS

Tetra Tech NUS, Inc.

CONTAINER SAMPLE & INSPECTION SHEET

Page_____ of _____

Project Site Name: _____
Project Number: _____
Site Identification: _____
Container Number(s): _____
Sample Type: [] Grab
[] Composite

Sample ID No. _____
Sampled By: _____
C.O.C. No.: _____
Concentration: [] High
[] Medium
[] Low

CONTAINER SOURCE

DRUM:
[] Bung Top
[] Lever Lock
[] Bolted Ring
[] Other _____

TANK:
[] Plastic
[] Metal
[] Other _____

OTHER: _____

CONTAINER DESCRIPTION

COLOR: _____

CONDITION: _____

MARKINGS: _____

VOL. OF CONTENTS: _____

OTHER: _____

CONTAINER DISPOSITION

SAMPLED: _____

OPENED BUT NOT SAMPLED:
Reason _____
_____

NOT OPENED:
Reason _____
_____

CONTENTS DESCRIPTION

SINGLE PHASED: _____
_____

MULTIPHASE :

	Layer 1	Layer 2	Layer 3
Phase (Sol. or Liq.)	_____	_____	_____
Color	_____	_____	_____
Viscosity	L, M or H	L, M or H	L, M orH
% of Total Volume	_____	_____	_____

MONITOR READING:

SAMPLE and /or INSPECTION DATE & TIME:
_____HRS.
METHOD:_____

SAMPLER(S) and / or INSPECTOR(S) SIGNATURE:

ANALYSIS:

Tetra Tech NUS, Inc.

DAILY ACTIVITIES RECORD

PROJECT NAME: _____ **PROJECT NUMBER:** _____

CLIENT: _____ **LOCATION:** _____

DATE: _____ **ARRIVAL TIME:** _____

Tt NUS PERSONNEL: _____ **DEPARTURE TIME:** _____

CONTRACTOR: _____ **DRILLER:** _____

ITEM	QUANTITY ESTIMATE	QUANTITY TODAY	PREVIOUS TOTAL QUANTITY	CUMULATIVE QUANTITY TO DATE

COMMENTS: _____

_____

_____

_____

APPROVED BY:

_____ _____

Tt NUS REPRESENTATIVE DRILLER

DATE: _____

Tetra Tech NUS, Inc.

EQUIPMENT CALIBRATION LOG

PROJECT NAME : _____ INSTRUMENT NAME/MODEL: _____

SITE NAME: _____ MANUFACTURER: _____

PROJECT No.: _____ SERIAL NUMBER: _____

Date of Calibration	Instrument I.D. Number	Person Performing Calibration	Instrument Settings		Instrument Readings		Calibration Standard (Lot No.)	Remarks and Comments
			Pre-calibration	Post-calibration	Pre-calibration	Post-calibration		

Tetra Tech NUS, Inc.

GROUNDWATER LEVEL MEASUREMENT SHEET

Project Name: _____ **Project No.:** _____

Location: _____ **Personnel:** _____

Weather Conditions: _____ **Measuring Device:** _____

Tidally Influenced: Yes ____ No ____ **Remarks:** _____

Well or Piezometer Number	Date	Time	Elevation of Reference Point (feet)*	Total Well Depth (feet)*	Water Level Indicator Reading (feet)*	Thickness of Free Product (feet)*	Groundwater Elevation (feet)*	Comments

* All measurements to the nearest 0.01 foot

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: _____
Project No.: _____

[] Domestic Well Data
[] Monitoring Well Data
[] Other Well Type: _____
[] QA Sample Type: _____

Sample ID No.: _____
Sample Location: _____
Sampled By: _____
C.O.C. No.: _____
Type of Sample:
[] Low Concentration
[] High Concentration

SAMPLING DATA:

Date:	Color	pH	S.C.	Temp.	Turbidity	DO	Salinity	Other
Time:	(Visual)	(S.U.)	(mS/cm)	(^{0}C)	(NTU)	(mg/l)	(%)	
Method:								

PURGE DATA:

Date:	Volume	pH	S.C.	Temp.	Turbidity	DO	Salinity	Other
Method:								
Monitor Reading (ppm):								
Well Casing Diameter & Material								
Type:								
Total Well Depth (TD):								
Static Water Level (WL):								
One Casing Volume(gal/L):								
Start Purge (hrs):								
End Purge (hrs):								
Total Purge Time (min):								
Total Vol. Purged (gal/L):								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected

OBSERVATIONS / NOTES:

Circle if Applicable:

MS/MSD	Duplicate ID No.:

Signature(s):

FIELD STANDARD OPERATING PROCEDURES

TABLE OF CONTENTS

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3.0 GLOSSARY **2**

4.0 RESPONSIBILITIES **2**

5.0 PROCEDURES **2**

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5.6 EXAMPLES OF FIELD QA/QC SAMPLE NOMENCLATURE 6

6.0 DEVIATIONS **6**

1.0 PURPOSE

The purpose of this document is to specify a consistent sample nomenclature system that will facilitate subsequent data management in a cost-effective manner. The sample nomenclature system has been devised such that the following objectives can be attained:

- Sorting of data by matrix.
- Sorting of data by depth.
- Maintenance of consistency (field, laboratory, and data base sample numbers).
- Accommodation of all project-specific requirements.
- Accommodation of laboratory sample number length constraints (maximum of 20 characters).

2.0 SCOPE

The methods described in this procedure shall be used consistently for all projects requiring electronic data.

3.0 GLOSSARY

None.

4.0 RESPONSIBILITIES

Program Manager - It shall be the responsibility of the Program Manager (or designee) to inform contract-specific Project Managers of the existence and requirements of this Standard Operating Procedure.

Project Manager - It shall be the responsibility of the Project Manager to determine the applicability of this Standard Operating Procedure based on: (1) program-specific requirements, and (2) project size and objectives. It shall be the responsibility of the Project Manager (or designee) to ensure that the sample nomenclature is thoroughly specified in the relevant project planning document (e.g., sampling and analysis plan) and is consistent with this Standard Operating Procedure if relevant. It shall be the responsibility of the project manager to ensure that the Field Operations Leader is familiar with the sample nomenclature system.

Field Operations Leader - It shall be the responsibility of the Field Operations Leader to ensure that all field technicians or sampling personnel are thoroughly familiar with this Standard Operating Procedure and the project-specific sample nomenclature system. It shall be the responsibility of the Field Operations Leader to ensure that the sample nomenclature system is used during all project-specific sampling efforts.

5.0 PROCEDURES

5.1 Introduction

The sample identification (ID) system can consist of as few as 8 but not more than 20 distinct alpha-numeric characters. The sample ID will be provided to the laboratory on the sample labels and chain-of-custody forms. The basic sample ID provided to the lab has three segments and shall be as follows where "A" indicates "alpha," and "N" indicates "numeric":

A or N 3- or 4-Characters	AAA 2- or 3-Characters	A or N 3- to 6-Characters
Site Identifier	Sample Type	Sample Location

Additional segments may be added as needed. For example:

(1) Soil and Sediment Sample ID

A or N 3- or 4-Characters	AAA 2- or 3-Characters	A or N 3- to 6-Characters	NNNN 4-Characters
Site Identifier	Sample Type	Sample Location	Sample Depth

(2) Aqueous (groundwater or surface water) Sample ID

A or N 3- or 4-Characters	AAA 2- or 3-Characters	A or N 3- to 6-Characters	NN 2-Characters	-A
Site Identifier	Sample type	Sample Location	Round Number	Filtered Sample only

(3) Biota Sample ID

A or N 3- or 4-Characters	AAA 2- or 3-Characters	A or N 3- to 6-Characters	AA 2-Characters	NNN 3-Characters
Site Identifier	Sample Type	Sample Location	Species Identifier	Sample Group Number

5.2 Sample Identification Field Requirements

The various fields in the sample ID will include but are not limited to the following:

- Site Identifier
- Sample Type
- Sample Location
- Sample Depth
- Sampling Round Number
- Filtered
- Species Identifier
- Sample Group Number

The site identifier must be a three- or four-character field (numeric characters, alpha characters, or a mixture of alpha and numeric characters may be used). A site number is necessary since many facilities/sites have multiple individual sites, SWMUs, operable units, etc. Several examples are presented in Section 5.3 of this SOP.

The sample type must be a two- or three-character alpha field. Suggested codes are provided in Section 5.3 of this SOP.

The sample location must be at least a three-character field but may have up to six-characters (alpha, numeric, or a mixture). The six-characters may be useful in identifying a monitoring well to be sampled or describing a grid location.

The sample depth field is used to note the depth below ground surface (bgs) at which a soil or sediment sample is collected. The first two numbers of the four-number code specify the top interval, and the third and fourth specify the bottom interval in feet bgs of the sample. If the sample depth is equal to or greater than 100, then only the top interval would be represented and the sampling depth would be truncated to

three-characters. The depths will be noted in whole numbers only; further detail, if needed, will be recorded on the sample log sheet, boring log, logbook, etc.

A two-digit round number will be used to track the number of aqueous samples taken from a particular aqueous sample location. The first sample collected from a location will be assigned the round identifier 01, the second 02, etc. This applies to both existing and proposed monitoring wells and surface water locations.

Aqueous samples that are field filtered (dissolved analysis) will be identified with an "-F" in the last field segment. No entry in this segment signifies an unfiltered (total) sample.

The species identifier must be a two-character alpha field. Several suggested codes are provided in Section 5.3 of this SOP.

The three digit sample group number will be used to track the number of biota sample groups (a particular group size may be determined by sample technique, media type, the number of individual caught, weight issues, time, etc.) by species and location. The first sample group of a particular species collected from a given location will be assigned the sample group number 001 and the second sample group of the same species collected from the same location will be assigned the sample group number 002.

5.3 Example Sample Field Designations

Examples of each of the fields are as follows:

Site Identifier - Examples of site numbers/designations are as follows:

A01 - Area of Concern Number 1
125 - Solid Waste Management Unit Number 125
000 - Base or Facility Wide Sample (e.g., upgradient well)
BBG - Base Background

The examples cited are only suggestions. Each Project Manager (or designee) must designate appropriate (and consistent) site designations for their individual project.

Sample Type - Examples of sample types are as follows:

AH - Ash Sample
AS - Air Sample
BM - Building Material Sample
BSB - Biota Sample Full Body
BSF - Biota Sample Fillet
CP - Composite Sample
CS - Chip Sample
DS - Drum Sample
DU - Dust Sample
FP - Free Product
IDW - Investigation Derived Waste Sample
LT - Leachate Sample
MW - Monitoring Well Groundwater Sample
OF - Outfall Sample
RW - Residential Well Sample
SB - Soil Boring Sample
SD - Sediment Sample
SC - Scrape Sample

SG - Soil Gas Sample
SL - Sludge Sample
SP - Seep Sample
SS - Surface Soil Sample
ST - Storm Sewer Water Sample
SW - Surface Water Sample
TP - Test Pit Sample
TW - Temporary Well Sample
WC - Well Construction Material Sample
WP - Wipe Sample
WS - Waste/Solid Sample
WW - Wastewater Sample

Sample Location - Examples of the location field are as follows:

001 - Monitoring Well 1
N32E92 - Grid location 32 North and 92 East
D096 - Investigation derived waste drum number 96

Species Identifier - Examples of species identifier are as follows:

BC - Blue Crab
GB - Blue Gill
CO - Corn
SB - Soybean

5.4 Examples of Sample Nomenclature

The first round monitoring well groundwater sample collected from existing monitoring well 001 at SWMU 16 for a filtered sample would be designated as 016MW00101-F.

The second round monitoring well groundwater sample collected from existing monitoring well C20P2 at Site 23 for an unfiltered sample would be designated as 023MWC20P202.

The second surface water sample collected from point 01 at SWMU 130 for an unfiltered sample would be designated as 130SW00102.

A surface soil sample collected from grid location 32 North and 92 East at Site 32 at the 0- to 2-foot interval would be designated as 032SSN32E920002.

A subsurface soil sample from soil boring 03 at SWMU 32 at an interval of 4 to 5 feet bgs would be designated as 032SB0030405.

A sediment sample collected at SWMU 19 from 0 to 6 inches at location 14 would be designated as 019SD0140001. The sample data sheet would reflect the precise depth at which this sample was collected.

During biota sampling for full body analysis the first time a minnow trap was checked at grid location A25 of SWMU 1415 three small blue gills were captured, collected and designated with the sample ID of 1415BSBA25BG001. The second time blue gill were collected at the same location (grid location A25 at SWMU 1415) the sample ID designation given was 1415BSBA25BG002.

Note: No dash (-) or spacing is used between the segments with the exception of the filtered segment. The "F" used for a filtered aqueous sample is preceded by a dash "-F".

5.5 Field Quality Assurance/Quality Control (QA/QC) Sample Nomenclature)

Field QA/QC will be designated using a different coding system. The QC code will consist of a three- to four-segment alpha-numeric code that identifies the sample QC type, the date the sample was collected, and the number of this type of QC sample collected on that date.

AA	NNNNNN	NN	-F
QC Type	Date	Sequence Number (per day)	Filtered (aqueous only, if needed)

The QC types are identified as:

TB = Trip Blank
RB = Rinsate Blank (Equipment Blank)
FD = Field Duplicate
AB = Ambient Conditions Blank
WB = Source Water Blank

The sampling time recorded on the Chain-of-Custody Form, labels, and tags for duplicate samples will be 0000 so that the samples are "blind" to the laboratory. Notes detailing the sample number, time, date, and type will be recorded on the routine sample log sheets and will document the location of the duplicate sample (sample log sheets are not provided to the laboratory). Documentation for all other QC types (TB, RB, AB, and WB) will be recorded on the QC Sample Log sheet (see SOP on Field Documentation).

5.6 Examples of Field QA/QC Sample Nomenclature

The first duplicate of the day for a filtered ground water sample collected on June 3, 2000 would be designated as FD06030001-F.

The third duplicate of the day taken of a subsurface soil sample collected on November 17, 2003 would be designated as FD11170303.

The first trip blank associated with samples collected on October 12, 2000 would be designated as TB10120001.

The only rinsate blank collected on November 17, 2001 would be designated as RB11170101.

6.0 DEVIATIONS

Any deviation from this SOP must be addressed in detail in the site specific planning documents.

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1.0 PURPOSE

The purpose of this procedure is to provide general reference information regarding the sampling of groundwater wells.

2.0 SCOPE

This procedure provides information on proper sampling equipment, onsite water quality testing, and techniques for groundwater sampling. Review of the information contained herein will facilitate planning of the field sampling effort by describing standard sampling techniques. The techniques described shall be followed whenever applicable, noting that site-specific conditions or project-specific plans may require modifications to methodology.

3.0 GLOSSARY

Conductivity – Conductivity is a numerical expression of the ability of an aqueous solution to carry an electric current. This ability depends on the presence of ions, their total concentration, mobility, valence, and relative concentrations, and on temperature of measure. Conductivity is highly dependent on temperature and should be reported at a particular temperature, i.e., 20.2 mS/cm at 14°C.

Dissolved Oxygen (DO) – DO levels in natural and wastewater depend on the physical, chemical, and biochemical activities in the water sample.

Oxidation-Reduction Potential (ORP) - A measure of the activity ratio of oxidizing and reducing species as determined by the electromotive force developed by a noble metal electrode, immersed in water, as referenced against a standard hydrogen electrode.

pH - The negative logarithm (base 10) of the hydrogen ion activity. The hydrogen ion activity is related to the hydrogen ion concentration, and, in a relatively weak solution, the two are nearly equal. Thus, for all practical purposes, pH is a measure of the hydrogen ion concentration.

pH Paper - Indicator paper that turns different colors depending on the pH of the solution to which it is exposed. Comparison with color standards supplied by the manufacturer will then give an indication of the solution's pH.

Salinity – The measurement of dissolved salts in a given mass of solution. Note: most field meters determined salinity automatically from conductivity and temperature. The displayed value will be displayed in either parts per thousand (ppt) or % (e.g., 35 ppt will equal 3.5%).

Turbidity – Turbidity in water is caused by suspended matter, such as clay, silt, fine organic and inorganic matter. Turbidity is an expression of the optical property that causes light to be scattered and absorbed rather than transmitted in a straight line through the sample.

4.0 RESPONSIBILITIES

Project Hydrogeologist - Responsible for selecting and detailing the specific groundwater sampling techniques, onsite water quality testing (type, frequency, and location), and equipment to be used, and providing detailed input in this regard to the project plan documents. The project hydrogeologist is also responsible for properly briefing and overseeing the performance of the site sampling personnel.

Project Geologist/Field Sample Technician - is primarily responsible for the proper acquisition of the groundwater samples. He/she is also responsible for the actual analyses of onsite water quality samples, as well as instrument calibration, care, and maintenance. When appropriate, such responsibilities may be performed by other qualified personnel (e.g., field technicians).

5.0 PROCEDURES

5.1 General

To be useful and accurate, a groundwater sample must be representative of the particular zone of the water being sampled. The physical, chemical, and bacteriological integrity of the sample must be maintained from the time of sampling to the time of analysis in order to keep any changes in water quality parameters to a minimum.

Methods for withdrawing samples from completed wells include the use of pumps, compressed air, bailers, and various types of samplers. The primary considerations in obtaining a representative sample of the groundwater are to avoid collection of stagnant (standing) water in the well and to avoid physical or chemical alteration of the water due to sampling techniques. In a non-pumping well, there will be little or no vertical mixing of water in the well pipe or casing, and stratification will occur. The well water in the screened section will mix with the groundwater due to normal flow patterns, but the well water above the screened section will remain isolated and become stagnant. To safeguard against collecting non-representative stagnant water in a sample, the following approach shall be followed prior to sample acquisition:

1. All monitoring wells shall be purged prior to obtaining a sample. Evacuation of three to five volumes is recommended prior to sampling. In a high-yielding groundwater formation and where there is no stagnant water in the well above the screened section, extensive evacuation prior to sample withdrawal is not as critical.

2. For wells that can be purged dry, the well shall be evacuated and allowed to recover to 75% full capacity prior to sample acquisition. If the recovery rate is fairly rapid, evacuation of more than one volume of water is required.

3. For high-yielding monitoring wells which cannot be evacuated to dryness, there is no absolute safeguard against contaminating the sample with stagnant water. One of the following techniques shall be used to minimize this possibility:

   - A submersible pump or the intake line of a surface pump or bailer shall be placed just below the water surface when removing the stagnant water and lowered as the water level drops. Three to five volumes of water shall be removed to provide reasonable assurance that all stagnant water has been evacuated. Once this is accomplished, a bailer or other approved device may be used to collect the sample for analysis.

   - The intake line of the sampling pump (or the submersible pump itself) unless otherwise directed shall be placed near the center of the screened section, and approximately one casing volume of water shall be pumped from the well at a low purge rate, equal to the well's recovery rate (low flow sampling).

Stratification of contaminants may exist in the aquifer. Concentration gradients as a result of mixing and dispersion processes, layers of variable permeability, and the presence of separate-phase product (i.e.,

floating hydrocarbons) may cause stratification. Excessive pumping or improper sampling methods can dilute or increase the contaminant concentrations in the recovered sample compared to what is representative of the integrated water column as it naturally occurs at that point, thus the result is the collection of a non-representative sample.

5.2 Sampling, Monitoring, and Evacuation Equipment

Sample containers shall conform with the guidelines expressed in SOP SA-6.1.

The following equipment shall be on hand when sampling groundwater wells (reference SOPs SA-6.1 and SA-7.1):

- Sample packaging and shipping equipment - Coolers for sample shipping and cooling, chemical preservatives, appropriate sampling containers and filler, ice, labels and chain-of-custody documents.
- Field tools and instrumentation - Multi-parameters water quality meter capable of measuring ORP, pH, temperature, DO, specific conductance, turbidity and salinity or individual meters (as applicable), pH paper, camera and film (if appropriate), appropriate keys (for locked wells), water level indicator.
- Pumps
  - Shallow-well pumps: Centrifugal, bladder, suction, or peristaltic pumps with droplines, air-lift apparatus (compressor and tubing) where applicable.
  - Deep-well pumps: Submersible pump and electrical power-generating unit, or bladder pumps where applicable.
- Other sampling equipment - Bailers and inert line with tripod-pulley assembly (if necessary).
- Pails - Plastic, graduated.
- Decontamination solutions - Deionized water, potable water, laboratory detergents, 10% nitric acid solution (as required), and analytical-grade solvent (e.g., pesticide-grade isopropanol), as required.

Ideally, sample withdrawal equipment shall be completely inert, economical, easily cleaned, cleaned prior to use, reusable, able to operate at remote sites in the absence of power sources, and capable of delivering variable rates for well purging and sample collection.

5.3 Calculations of Well Volume

To insure that the proper volume of water has been removed from the well prior to sampling it is first necessary to know the volume of standing water in the well pipe. This volume can be easily calculated by the following method. Calculations shall be entered in the site logbook or field notebook or on a sample log sheet form (see SOP SA-6.3):

- Obtain all available information on well construction (location, casing, screens, etc.).
- Determine well or inner casing diameter.
- Measure and record static water level (depth below ground level or top of casing reference point).
- Determine depth of well by sounding using a clean, decontaminated, weighted tape measure.

- Calculate number of linear feet of static water (total depth or length of well pipe minus the depth to static water level).

- Calculate one static well volume in gallons $V = (0.163)(T)(r^2)1$

where:	V	=	Static volume of well in gallons.
	T=		Thickness of water table in the well measured in feet (i.e., linear feet of static water).
	r	=	Inside radius of well casing in inches.
	0.163	=	A constant conversion factor which compensates for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and pi.

- Per evacuation volumes discussed above, determine the minimum amount to be evacuated before sampling.

5.4 Evacuation of Static Water (Purging)

5.4.1 General

The amount of purging a well shall receive prior to sample collection will depend on the intent of the monitoring program and the hydrogeologic conditions. Programs to determine overall quality of water resources may require long pumping periods to obtain a sample that is representative of a large volume of that aquifer. The pumped volume may be specified prior to sampling so that the sample can be a composite of a known volume of the aquifer. Alternately the well can be pumped until the parameters such as temperature, specific conductance, pH, and turbidity (as applicable), have stabilized. Onsite measurements of these parameters shall be recorded in the site logbook, field notebook, or on standardized data sheets.

5.4.2 Evacuation Devices

The following discussion is limited to those devices commonly used at hazardous waste sites. Attachment A provides guidance on the proper evacuation device to use for given sampling situations. Note that all of these techniques involve equipment which is portable and readily available.

Bailers

Bailers are the simplest evacuation devices used and have many advantages. They generally consist of a length of pipe with a sealed bottom (bucket-type bailer) or, as is more useful and favored, with a ball check-valve at the bottom. An inert line is used to lower the bailer and retrieve the sample.

Advantages of bailers include:

- Few limitations on size and materials used for bailers.
- No external power source needed.
- Bailers are inexpensive, and can be dedicated and hung in a well to reduce the chances of cross-contamination.
- Bailers are relatively easy to decontaminate.

Limitations on the use of bailers include the following:

- It is time consuming to remove stagnant water using a bailer.
- Transfer of sample may cause aeration.
- Use of bailers is physically demanding, especially in warm temperatures at protection levels above Level D.

Suction Pumps

There are many different types of inexpensive suction pumps including centrifugal, diaphragm, and peristaltic pumps. Centrifugal and diaphragm pumps can be used for well evacuation at a fast pumping rate and for sampling at a low pumping rate. The peristaltic pump is a low volume pump that uses rollers to squeeze a flexible tubing, thereby creating suction. This tubing can be dedicated to a well to prevent cross contamination.

These pumps are all portable, inexpensive and readily available. However, because they are based on suction, their use is restricted to areas with water levels within 20 to 25 feet of the ground surface. A significant limitation is that the vacuum created by these pumps can cause significant loss of dissolved gases and volatile organics.

Air-Lift Samplers

This group of pump samplers uses gas pressure either in the annulus of the well or in a venturi to force the water up a sampling tube. These pumps are also relatively inexpensive. Air (or gas)-lift samplers are more suitable for well development than for sampling because the samples may be aerated, leading to pH changes and subsequent trace metal precipitation, or loss of volatile organics.

Submersible Pumps

Submersible pumps take in water and push the sample up a sample tube to the surface. The power sources for these samplers may be compressed gas or electricity. The operation principles vary and the displacement of the sample can be by an inflatable bladder, sliding piston, gas bubble, or impeller. Pumps are available for 2-inch-diameter wells and larger. These pumps can lift water from considerable depths (several hundred feet).

Limitations of this class of pumps include:

- They may have low delivery rates.
- Many models of these pumps are expensive.
- Compressed gas or electric power is needed.
- Sediment in water may cause clogging of the valves or eroding the impellers with some of these pumps.
- Decontamination of internal components can be difficult and time-consuming.

5.5 Onsite Water Quality Testing

This section describes the procedures and equipment required to measure the following parameters of an aqueous sample in the field:

- pH
- Specific Conductance
- Temperature
- Dissolved Oxygen (DO)
- Oxidation-Reduction Potential (ORP)

- Turbidity
- Salinity

This section is applicable for use in an onsite groundwater quality monitoring program to be conducted at a hazardous or nonhazardous site. The procedures and equipment described are applicable to groundwater samples and are not, in general, subject to solution interferences from color, turbidity, and colloidal material or suspended matter.

This section provides general information for measuring the parameters listed above with instruments and techniques in common use. Since instruments from different manufacturers may vary, review of the manufacturer's literature pertaining to the use of a specific instrument is required before use. Most meters used to measure field parameters require calibration on a daily basis. Refer to SOP 6.3 for example equipment calibration log.

5.5.1 Measurement of pH

5.5.1.1 General

Measurement of pH is one of the most important and frequently used tests in water chemistry. Practically every phase of water supply and wastewater treatment such as acid-base neutralization, water softening, and corrosion control is pH dependent. Likewise, the pH of leachate can be correlated with other chemical analyses to determine the probable source of contamination. It is therefore important that reasonably accurate pH measurements be taken.

Two methods are given for pH measurement: the pH meter and pH indicator paper. The indicator paper is used when only a rough estimate of the pH is required, and the pH meter when a more accurate measurement is needed. The response of a pH meter can be affected to a slight degree by high levels of colloidal or suspended solids, but the effect is usually small and generally of little significance. Consequently, specific methods to overcome this interference are not described. The response of pH paper is unaffected by solution interferences from color, turbidity, colloidal or suspended materials unless extremely high levels capable of coating or masking the paper are encountered. In such cases, use of a pH meter is recommended.

5.5.1.2 Principles of Equipment Operation

Use of pH papers for pH measurement relies on a chemical reaction caused by the acidity or alkalinity of the solution created by the addition of the water sample reacting with the indicator compound on the paper. Various types of pH papers are available, including litmus (for general acidity or alkalinity determination) and specific pH range hydrion paper.

Use of a pH meter relies on the same principle as other ion-specific electrodes. Measurement relies on establishment of a potential difference across a glass or other type of membrane in response to (in this instance, hydrogen) ion concentration across that membrane. The membrane is conductive to ionic species and, in combination with a standard or reference electrode, a potential difference proportional to the ion concentration is generated and measured.

5.5.1.3 Equipment

The following equipment is needed for taking pH measurements:

- Stand-alone portable pH meter, or combination meter (e.g., Horiba U-10), or combination meters equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).

- Combination electrode with polymer body to fit the above meter (alternately a pH electrode and a reference electrode can be used if the pH meter is equipped with suitable electrode inputs).
- Buffer solutions, as specified by the manufacturer.
- pH indicator paper, to cover the pH range 2 through 12.
- Manufacturer's operation manual.

5.5.1.4 Measurement Techniques for Field Determination of pH

pH Meter

The following procedure is used for measuring pH with a pH meter (meter standardization is according to manufacturer's instructions):

- Inspect the instrument and batteries prior to initiation of the field effort.
- Check the integrity of the buffer solutions used for field calibration. Buffer solutions need to be changed often as a result of degradation upon exposure to the atmosphere.
- If applicable, make sure all electrolyte solutions within the electrode(s) are at their proper levels and that no air bubbles are present within the electrode(s).
- Calibrate on a daily use basis (or as recommended by manufacturer) following manufacturer's instructions. Record calibration data on an equipment calibration log sheet.
- Immerse the electrode(s) in the sample. Stabilization may take several seconds to minutes. If the pH continues to drift, the sample temperature may not be stable, a physical reaction (e.g., degassing) may be taking place in the sample, or the meter or electrode may be malfunctioning. This must be clearly noted in the logbook.
- Read and record the pH of the sample. pH shall be recorded to the nearest 0.01 pH unit. Also record the sample temperature.
- Rinse the electrode(s) with deionized water.
- Store the electrode(s) in an appropriate manner when not in use.

Any visual observation of conditions which may interfere with pH measurement, such as oily materials, or turbidity, shall be noted.

pH Paper

Use of pH paper is very simple and requires no sample preparation, standardization, etc. pH paper is available in several ranges, including wide-range (indicating approximately pH 1 to 12), mid-range (approximately pH 0 to 6, 6 to 9, 8 to 14) and narrow-range (many available, with ranges as narrow as 1.5 pH units). The appropriate range of pH paper shall be selected. If the pH is unknown the investigation shall start with wide-range paper and proceed with successively narrower range paper until the sample pH is adequately determined.

5.5.2 Measurement of Specific Conductance

5.5.2.1 General

Conductance provides a measure of dissolved ionic species in water and can be used to identify the direction and extent of migration of contaminants in groundwater or surface water. It can also be used as a measure of subsurface biodegradation or to indicate alternate sources of groundwater contamination.

Conductivity is a numerical expression of the ability of a water sample to carry an electric current. This value depends on the total concentration of the ionized substances dissolved in the water and the temperature at which the measurement is made. The mobility of each of the various dissolved ions, their valences, and their actual and relative concentrations affect conductivity.

It is important to obtain a specific conductance measurement soon after taking a sample, since temperature changes, precipitation reactions, and absorption of carbon dioxide from the air all affect the specific conductance. Most conductivity meters in use today display specific conductance (SC); units of milliSiemens per centimeter, which is the conductivity normalized to temperature @ 25°C. This format (SC) is the required units recorded on the groundwater sample log field form (Attachment B).

5.5.2.2 Principles of Equipment Operation

An aqueous system containing ions will conduct an electric current. In a direct-current field, the positive ions migrate toward the negative electrode, while the negatively charged ions migrate toward the positive electrode. Most inorganic acids, bases and salts (such as hydrochloric acid, sodium carbonate, or sodium chloride, respectively) are relatively good conductors. Conversely, organic compounds such as sucrose or benzene, which do not dissociate in aqueous solution, conduct a current very poorly, if at all.

A conductance cell and a Wheatstone Bridge (for the measurement of potential difference) may be used for measurement of electrical resistance. The ratio of current applied to voltage across the cell may also be used as a measure of conductance. The core element of the apparatus is the conductivity cell containing the solution of interest. Depending on ionic strength of the aqueous solution to be tested, a potential difference is developed across the cell which can be converted directly or indirectly (depending on instrument type) to a measurement of specific conductance.

5.5.2.3 Equipment

The following equipment is needed for taking specific conductance (SC) measurements:

- Stand alone portable conductivity meter, or combination meter (e.g., Horiba U-10), or combination meters equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).
- Calibration solution, as specified by the manufacturer.
- Manufacturer's operation manual.

A variety of conductivity meters are available which may also be used to monitor salinity and temperature. Probe types and cable lengths vary, so equipment must be obtained to meet the specific requirement of the sampling program.

5.5.2.4 Measurement Techniques for Specific Conductance

The steps involved in taking specific conductance measurements are listed below (standardization is according to manufacturer's instructions):

- Check batteries and calibrate instrument before going into the field.
- Calibrate on a daily use basis (or as recommended by manufacturer), according to the manufacturer's instructions and record all pertinent information on an equipment calibration log sheet. Potassium chloride solutions with a SC closest to the values expected in the field shall be used for calibration.
- Rinse the cell with one or more portions of the sample to be tested or with deionized water.
- Immerse the electrode in the sample and measure the conductivity.
- Read and record the results in a field logbook or sample log sheet.
- Rinse the electrode with deionized water.

If the specific conductance measurements become erratic, recalibrate the instrument and see the manufacturer's instructions for details.

5.5.3 Measurement of Temperature

5.5.3.1 General

In combination with other parameters, temperature can be a useful indicator of the likelihood of biological action in a water sample. It can also be used to trace the flow direction of contaminated groundwater. Temperature measurements shall be taken in-situ, or as quickly as possible in the field. Collected water samples may rapidly equilibrate with the temperature of their surroundings.

5.5.3.2 Equipment

Temperature measurements may be taken with alcohol-toluene, mercury filled, dial-type thermometers or combination meters equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).. In addition, various meters such as specific conductance or dissolved oxygen meters, which have temperature measurement capabilities, may also be used. Using such instrumentation along with suitable probes and cables, in-situ measurements of temperature at great depths can be performed.

5.5.3.3 Measurement Techniques for Water Temperature

If a thermometer is used to determine the temperature for a water sample:

- Immerse the thermometer in the sample until temperature equilibrium is obtained (1-3 minutes). To avoid the possibility of cross-contamination, the thermometer shall not be inserted into samples which will undergo subsequent chemical analysis.
- Record values in a field logbook or sample log sheet.

If a temperature meter or probe is used, the instrument shall be calibrated according to manufacturer's recommendations.

5.5.4 Measurement of Dissolved Oxygen

5.5.4.1 General

Dissolved oxygen (DO) levels in natural water and wastewater depend on the physical, chemical and biochemical activities in the water body. Conversely, the growth of many aquatic organisms as well as the rate of corrosivity, are dependent on the dissolved oxygen concentration. Thus, analysis for dissolved oxygen is a key test in water pollution and waste treatment process control. If at all possible, DO measurements shall be taken in-situ, since concentration may show a large change in a short time if the sample is not adequately preserved.

The monitoring method discussed herein is limited to the use of dissolved oxygen meters only. Chemical methods of analysis (i.e., Winkler methods) are available, but require more equipment and greater sample manipulation. Furthermore, DO meters, using a membrane electrode, are suitable for highly polluted waters, because the probe is completely submersible, and is not susceptible to interference caused by color, turbidity, colloidal material or suspended matter.

5.5.4.2 Principles of Equipment Operation

Dissolved oxygen probes are normally electrochemical cells that have two solid metal electrodes of different nobility immersed in an electrolyte. The electrolyte is retained by an oxygen-permeable membrane. The metal of highest nobility (the cathode) is positioned at the membrane. When a suitable potential exists between the two metals, reduction of oxygen to hydroxide ion (OH^-) occurs at the cathode surface. An electrical current is developed that is directly proportional to the rate of arrival of oxygen molecules at the cathode.

Since the current produced in the probe is directly proportional to the rate of arrival of oxygen at the cathode, it is important that a fresh supply of sample always be in contact with the membrane. Otherwise, the oxygen in the aqueous layer along the membrane is quickly depleted and false low readings are obtained. It is therefore necessary to stir the sample (or the probe) constantly to maintain fresh solution near the membrane interface. Stirring, however, shall not be so vigorous that additional oxygen is introduced through the air-water interface at the sample surface. To avoid this possibility, some probes are equipped with stirrers to agitate the solution near the probe, while leaving the surface of the solution undisturbed.

Dissolved oxygen probes are relatively unaffected by interferences. Interferences that can occur are reactions with oxidizing gases (such as chlorine) or with gases such as hydrogen sulfide, which are not easily depolarized from the indicating electrode. If a gaseous interference is suspected, it shall be noted in the field log book and checked if possible. Temperature variations can also cause interference because probes exhibit temperature sensitivity. Automatic temperature compensation is normally provided by the manufacturer.

5.5.4.3 Equipment

The following equipment is needed to measure dissolved oxygen concentration:

- Stand alone portable dissolved oxygen meter, or combination meter (e.g., Horiba U-10), or combination meters equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).
- Sufficient cable to allow the probe to contact the sample.
- Manufacturer's operation manual.

5.5.4.4 Measurement Techniques for Dissolved Oxygen Determination

Probes differ as to specifics of use. Follow the manufacturer's instructions to obtain an accurate reading. The following general steps shall be used to measure the dissolved oxygen concentration:

- The equipment shall be calibrated and have its batteries checked before going to the field.
- The probe shall be conditioned in a water sample for as long a period as practical before use in the field. Long periods of dry storage followed by short periods of use in the field may result in inaccurate readings.
- The instrument shall be calibrated in the field according to manufacturer's recommendations or in a freshly air-saturated water sample of known temperature.
- Record all pertinent information on an equipment calibration sheet.
- Rinse the probe with deionized water.
- Immerse the probe in the sample. Be sure to provide for sufficient flow past the membrane by stirring the sample. Probes without stirrers placed in wells can be moved up and down.
- Record the dissolved oxygen content and temperature of the sample in a field logbook or sample log sheet.
- Rinse the probe with deionized water.
- Recalibrate the probe when the membrane is replaced, or as needed. Follow the manufacturer's instructions.

Note that in-situ placement of the probe is preferable, since sample handling is not involved. This however, may not always be practical.

Special care shall be taken during sample collection to avoid turbulence which can lead to increased oxygen solubilization and positive test interferences.

5.5.5 Measurement of Oxidation-Reduction Potential

5.5.5.1 General

The oxidation-reduction potential (ORP) provides a measure of the tendency of organic or inorganic compounds to exist in an oxidized state. The ORP parameter therefore provides evidence of the likelihood of anaerobic degradation of biodegradable organics or the ratio of activities of oxidized to reduced species in the sample.

5.5.5.2 Principles of Equipment Operation

When an inert metal electrode, such as platinum, is immersed in a solution, a potential is developed at that electrode depending on the ions present in the solution. If a reference electrode is placed in the same solution, an ORP electrode pair is established. This electrode pair allows the potential difference between the two electrodes to be measured and is dependent on the concentration of the ions in solution. By this measurement, the ability to oxidize or reduce species in solution may be determined. Supplemental

measurements, such as dissolved oxygen, may be correlated with ORP to provide a knowledge of the quality of the solution, water, or wastewater.

5.5.5.3 Equipment

The following equipment is needed for measuring the oxidation-reduction potential of a solution:

- Combination meters with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).
- Reference solution as specified by the manufacturer.
- Manufacturer's operation manual.

5.5.5.4 Measurement Techniques for Oxidation-Reduction Potential

The following procedure is used for measuring oxidation-reduction potential:

- The equipment shall be checked using the manufacturer's recommended reference solution and have its batteries checked before going to the field.

- Thoroughly rinse the electrode with deionized water.

- If the probe does not respond properly to the recommended reference solution, then verify the sensitivity of the electrodes by noting the change in millivolt reading when the pH of a test solution is altered. The ORP will increase when the pH of a test solution decreases, and the ORP will decrease if the test solution pH is increased. Place the sample in a clean container and agitate the sample. Insert the electrodes and note the ORP drops sharply when the caustic is added (i.e., pH is raised) thus indicating the electrodes are sensitive and operating properly. If the ORP increases sharply when the caustic is added, the polarity is reversed and must be corrected in accordance with the manufacturer's instructions or the probe should be replaced.

- Record all pertinent information on an equipment calibration log sheet.

5.5.6 Measurement of Turbidity

5.5.6.1 General

Turbidity is an expression of the optical property that causes light to be scattered and absorbed rather than transmitted in a straight line through the sample. Turbidity in water is caused by suspended matter, such as clay, silt, finely divided organic and inorganic matter, soluble colored organic compounds, and microscopic organisms, including plankton.

It is important to obtain a turbidity reading immediately after taking a sample, since irreversible changes in turbidity may occur if the sample is stored too long.

5.5.6.2 Principles of Equipment Operation

Turbidity is measured by the Nephelometric Method. This method is based on a comparison of the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension under the same conditions. The higher the scattered light intensity, the higher the turbidity.

Formazin polymer is used as the reference turbidity standard suspension because of its ease of preparation combined with a higher reproducibility of its light-scattering properties than clay or turbid

natural water. The turbidity of a specified concentration of formazin suspension is defined as 40 nephelometric units. This same suspension has an approximate turbidity of 40 Jackson units when measured on the candle turbidmeter. Therefore, nephelometric turbidity units (NTU) based on the formazin preparation will approximate units derived from the candle turbidimeter but will not be identical to them.

5.5.6.3 Equipment

The following equipment is needed for turbidity measurement:

- Light meter (e.g., LaMotte 2020) which calibrates easily using test cells with standards of 0.0 NTUs, and 10 NTUs, or combination meter (e.g., Horiba U-10), or combination meter equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).
- Calibration solution, as specified by the manufacturer.
- Manufacturer's operation manual.

5.5.6.4 Measurement Techniques for Turbidity

The steps involved in taking turbidity measurements utilizing an electrode (e) or light meter (l) are listed below (standardization is according to manufacturer's instructions):

- Check batteries and calibrate instrument before going into the field.
- Check the expiration date (etc.) of the solutions used for field calibration.
- Calibrate on a daily use basis, according to the manufacturer's instructions and record all pertinent information on an equipment calibration log sheet.
- Rinse the electrode with one or more portions of the sample to be tested or with deionized water (applies to "e").
- Fill the light meters glass test cell with ~5 ml of sample, screw on cap, wipe off glass, place test cell in light meter and close the lid (applies to "l").
- Immerse the electrode in the sample and measure the turbidity (applies to "e").
- The reading must be taken immediately as suspended solids will settle over time resulting in a lower, inaccurate turbidity reading.
- Read and record the results in a field logbook or sample log sheet. Include a physical description of the sample, including color, qualitative estimate of turbidity, etc.
- Rinse the electrode or test cell with deionized water.

5.5.7 Measurement of Salinity

5.5.7.1 General

Salinity is a unitless property of industrial and natural waters. It is the measurement of dissolved salts in a given mass of solution. Note: Most field meters determined salinity automatically from conductivity and

temperature. The displayed value will be displayed in either parts per thousand (ppt) or % (e.g., 35 ppt will equal 3.5%).

5.5.7.2 Principles of Equipment Operation

Salinity is determined automatically from the meter's conductivity and temperature readings according to algorithms (found in *Standard methods for the Examination of Water and Wastewater*). Depending on the meter, the results are displayed in either ppt or %. The salinity measurements are carried out in reference to the conductivity of standard seawater (*corrected to S = 35*).

5.5.7.3 Equipment

The following equipment is needed for Salinity measurements:

- Multi-parameter water quality meter capable of measuring conductive, temperature and converting them to salinity (e.g., Horiba U-10 or YSI 600 series).
- Calibration Solution, as specified by the manufacturer.
- Manufacturer's operation manual.

5.5.7.4 Measurement Techniques for Salinity

The steps involved in taking Salinity measurements are listed below (standardization is according to manufacturer's instructions):

- Check batteries and calibrate before going into the field.
- Check the expiration date (etc.) of the solutions used for field calibration.
- Calibrate on a daily use basis, according to the manufacturer's instructions and record all pertinent information on an equipment calibration log sheet.
- Rinse the cell with the sample to be tested.
- Immerse the multi-probe in the sample and measure the salinity. Read and record the results in a field logbook or sample log sheet.
- Rinse the probes with deionized water.

5.6 Sampling

5.6.1 Sampling Plan

The sampling approach consisting of the following, shall be developed as part of the project plan documents which are approved prior to beginning work in the field:

- Background and objectives of sampling.
- Brief description of area and waste characterization.
- Identification of sampling locations, with map or sketch, and applicable well construction data (well size, depth, screened interval, reference elevation).

- Intended number, sequence volumes, and types of samples. If the relative degrees of contamination between wells is unknown or insignificant, a sampling sequence which facilitates sampling logistics may be followed. Where some wells are known or strongly suspected of being highly contaminated, these shall be sampled last to reduce the risk of cross-contamination between wells as a result of the sampling procedures.

- Sample preservation requirements.

- Work schedule.

- List of team members.

- List of observers and contacts.

- Other information, such as the necessity for a warrant or permission of entry, requirement for split samples, access problems, location of keys, etc.

5.6.2 Sampling Methods

The collection of a groundwater sample consists of the following steps:

1. The site Health & Safety Officer (or designee) will first open the well cap and use volatile organic detection equipment (PID or FID) on the escaping gases at the well head to determine the need for respiratory protection.

2. When proper respiratory protection has been donned, sound the well for total depth and water level (using clean equipment) and record these data on a groundwater sampling log sheet (see Attachment B); then calculate the fluid volume in the well pipe (as previously described in this SOP).

3. Calculate well volume to be removed as stated in Section 5.3.

4. Select the appropriate purging equipment (see Attachment A). If an electric submersible pump with packer is chosen, go to Step 10.

5. Lower the purging equipment or intake into the well to a short distance below the water level and begin water removal. Collect the purged water and dispose of it in an acceptable manner (as applicable). Lower the purging device, as required, to maintain submergence.

6. Measure the rate of discharge frequently. A graduated bucket or cylinder and stopwatch are most commonly used.

7. Observe the peristaltic pump intake for degassing "bubbles." If bubbles are abundant and the intake is fully submerged, this pump is not suitable for collecting samples for volatile organics.

8. Purge a minimum of three to five casing volumes before sampling. In low-permeability strata (i.e., if the well is pumped to dryness), one volume will suffice. Purged water shall be collected in a designated container and disposed in an acceptable manner.

9. If sampling using a pump, lower the pump intake to midscreen (or the middle of the open section in uncased wells) and collect the sample. If sampling with a bailer, lower the bailer to just below the water surface.

10. (For pump and packer assembly only). Lower the assembly into the well so that the packer is positioned just above the screen or open section. Inflate the packer. Purge a volume equal to at least twice the screened interval (or unscreened open section volume below the packer) before sampling. Packers shall always be tested in a casing section above ground to determine proper inflation pressures for good sealing.

11. In the event that recovery time of the well is very slow (e.g., 24 hours or greater), sample collection can be delayed until the following day. If the well has been purged early in the morning, sufficient water may be standing in the well by the day's end to permit sample collection. If the well is incapable of producing a sufficient volume of sample at any time, take the largest quantity available and record this occurrence in the site logbook.

12. Fill sample containers (preserve and label as described in SOP SA-6.1).

13. Replace the well cap and lock as appropriate. Make sure the well is readily identifiable as the source of the samples.

14. Process sample containers as described in SOP SA-6.1.

15. Decontaminate equipment as described in SOP SA-7.1.

5.7 Low Flow Purging and Sampling

5.7.1 Scope & Application

Low flow purging and sampling techniques are sometimes required for groundwater sampling activities. The purpose of low flow purging and sampling is to collect groundwater samples that contain "representative" amounts of mobile organic and inorganic constituents in the vicinity of the selected open well interval, at or near natural flow conditions. The minimum stress procedure emphasizes negligible water level drawdown and low pumping rates in order to collect samples with minimal alterations in water chemistry. This procedure is designed primarily to be used in wells with a casing diameter of 1 inch or more and a saturated screen, or open interval, length of ten feet or less. Samples obtained are suitable for analyses of common types of groundwater contaminants (volatile and semi-volatile organic compounds, pesticides, PCBs, metals and other inorganic ions [cyanide, chloride, sulfate, etc.]). This procedure is not designed to collect non-aqueous phase liquids samples from wells containing light or dense non-aqueous phase liquids (LNAPLs or DNAPLs), using the low flow pumps.

The procedure is flexible for various well construction types and groundwater yields. The goal of the procedure is to obtain a turbidity level of less than 10 NTU and to achieve a water level drawdown of less than 0.3 feet during purging and sampling. If these goals cannot be achieved, sample collection can take place provided the remaining criteria in this procedure are met.

5.7.2 Equipment

The following equipment is required (as applicable) for low flow purging and sampling:

- Adjustable rate, submersible pump (e.g., centrifugal or bladder pump constructed of stainless steel or Teflon).
- Disposable clear plastic bottom filling bailers may be used to check for and obtain samples of LNAPLs or DNAPLs.

- Tubing - Teflon, Teflon-lined polyethylene, polyethylene, PVC, Tygon, or stainless steel tubing can be used to collect samples for analysis, depending on the analyses to be performed and regulatory requirements.
- Water level measuring device, 0.01 foot accuracy, (electronic devices are preferred for tracking water level drawdown during all pumping operations).
- Interface probe, if needed.
- Flow measurement supplies.
- Power source (generator, nitrogen tank, etc.). If a gasoline generator is used, it must be located downwind and at a safe distance from the well so that the exhaust fumes do not contaminate the samples.
- Indicator parameter monitoring instruments - pH, turbidity, specific conductance, and temperature. Use of a flow-through cell is recommended. Optional Indicators - ORP, salinity, and dissolved oxygen, flow-through cell is required. Standards to perform field calibration of instruments.
- Decontamination supplies.
- Logbook(s), and other forms (see Attachments B and C).
- Sample Bottles.
- Sample preservation supplies (as required by the analytical methods).
- Sample tags and/or labels.
- Well construction data, location map, field data from last sampling event (if available).
- Field Sampling Plan.
- PID or FID instrument for measuring VOCs (volatile organic compounds).

5.7.3 Purging and Sampling Procedure

Open monitoring well, measure head space gases using PID/FID. If there is an indication of off gassing when opening the well, wait 3-5 minutes to permit water level an opportunity to reach equilibrium.

Measure and record the water level immediately prior to placing the pump in the well.

Lower pump or tubing slowly into the well so that the pump intake is located at the center of the saturated screen length of the well. If possible keep the pump intake at least two feet above the bottom of the well, to minimize mobilization of sediment that may be present in the bottom of the well. Collection of turbidity-free water samples may be difficult if there is three feet or less of standing water in the well.

Start with the initial pump rate set at approximately 0.1 liters/minute. Use a graduated cylinder and stopwatch to measure the pumping rate. Adjust pumping rates as necessary to prevent drawdown from exceeding 0.3 feet during purging. If no drawdown is noted, the pump rate may be increased (to a max of 0.4 liters/minute) to expedite the purging and sampling event. The pump rate will be reduced if turbidity is greater than 10 NTUs after all other field parameters have stabilized. If groundwater is drawn down below

the top of the well screen, purging will cease or the well will be pumped to dryness and the well will be allowed to recover before purging continues. Slow recovering wells will be identified and purged at the beginning of the workday. If possible, samples will be colleted from these wells within the same workday and no later than 24 hours after the start of purging.

Measure the well water level using the water level meter every 5 to 10 minutes. Record the well water level on the Low-Flow Purge Data Form (Attachment C).

Record on the Low-Flow Purge Data Form every 5 to 10 minutes the water quality parameters (pH, specific conductance, temperature, turbidity, oxidation-reduction potential, dissolved oxygen and salinity or as specified by the approved site specific work plan) measured by the water quality meter and turbidity meter. If the cell needs to be cleaned during purging operations, continue pumping (allow the pump to discharge into a container) and disconnect the cell. Rinse the cell with distilled/deionized water. After cleaning is completed, reconnect the flow-through cell and continue purging. Document the cell cleaning on the Low-Flow Purge Data Form.

Measure the flow rate using a graduated cylinder. Remeasure the flow rate any time the pump rate is adjusted.

During purging, check for the presence of bubbles in the flow-through cell. The presence of bubbles is an indication that connections are not tight. If bubbles are observed, check for loose connections.

After stabilization is achieved, sampling can begin when a minimum of two saturated screen volumes have been removed and three consecutive readings, taken at 5 to 10 minute intervals, are within the following limits:

- pH ±0.2 standard units
- Specific conductance ±10%
- Temperature ±10%
- Turbidity less than 10 NTUs
- Dissolved oxygen ±10%

If the above conditions have still not been met after the well has been purged for 4 hours, purging will be considered complete and sampling can begin. Record the final well stabilization parameters from the Low-Flow Purge Data Form onto the Groundwater Sample Log Form.

VOC samples are preferably collected first, directly into pre-preserved sample containers. Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

If the water column in the pump tubing collapses (water does not completely fill the tubing) before exiting the tubing, use one of the following procedures to collect VOC samples: (1) Collect the non-VOCs samples first, then increase the flow rate incrementally until the water column completely fills the tubing, collect the sample and record the new flow rate; (2) reduce the diameter of the existing tubing until the water column fills the tubing either by adding a connector (Teflon or stainless steel), or clamp which should reduce the flow rate by constricting the end of the tubing; (3) insert a narrow diameter Teflon tube into the pump's tubing so that the end of the tubing is in the water column and the other end of the tubing protrudes beyond the pump's tubing, collect sample from the narrow diameter tubing.

Prepare samples for shipping as per SOP SA-6.1.

6.0 REFERENCES

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ATTACHMENT A

PURGING EQUIPMENT SELECTION

Diameter Casing		Bailer	Peristaltic Pump	Vacuum Pump	Air-lift	Diaphragm "Trash" Pump	Submersible Diaphragm Pump	Submersible Electric Pump	Submersible Electric Pump w/Packer
1.25-Inch	Water level <25 feet	X	X	X	X	X			
	Water Level >25 feet	X			X				
2-Inch	Water level <25 feet	X	X	X	X	X	X		
	Water Level >25 feet	X			X		X		
4-Inch	Water level <25 feet	X	X	X	X	X	X	X	X
	Water Level >25 feet	X			X		X	X	X
6-Inch	Water level <25 feet				X	X		X	X
	Water Level >25 feet				X			X	X
8-Inch	Water level <25 feet				X	X		X	X
	Water Level >25 feet				X			X	X

ATTACHMENT A

PURGING EQUIPMENT SELECTION

PAGE 2

Manufacturer	Model Name/Number	Principle of Operation	Maximum Outside Diameter/Length (Inches)	Construction Materials (w/Lines and Tubing)	Lift Range (ft)	Delivery Rates or Volumes	1982 Price (Dollars)	Comments
BarCad Systems, Inc.	BarCad Sampler	Dedicated; gas drive (positive displacement)	1.5/16	PE, brass, nylon, aluminum oxide	0-150 with std. tubing	1 liter for each 10-15 feet of submergence	$220-350	Requires compressed gas; custom sizes and materials available; acts as piezometer.
Cole-Parmer Inst. Co.	Master Flex 7570 Portable Sampling Pump	Portable; peristaltic (suction)	<1.0/NA	(not submersible) Tygon®, silicone Viton®	0-30	670 mL/min with 7015-20 pump head	$500-600	AC/DC; variable speed control available; other models may have different flow rates.
ECO Pump Corp.	SAMPLifier	Portable; venturi	<1.5 or <2.0/NA	PP, PE, PVC, SS, Teflon®, Tefzel®	0-100	0-500 mL/min depending on lift	$400-700	AC, DC, or gasoline-driven motors available; must be primed.
Geltek Corp.	Bailer 219-4	Portable; grab (positive displacement)	1.66/38	Teflon®	No limit	1,075 mL	$120-135	Other sizes available.
GeoEngineering, Inc.	GEO-MONITOR	Dedicated; gas drive (positive displacement)	1.5/16	PE, PP, PVC, Viton®	Probably 0-150	Approximately 1 liter for each 10 feet of submergence	$185	Acts as piezometer; requires compressed gas.
Industrial and Environmental Analysts, Inc. (IEA)	Aquarius	Portable; bladder (positive displacement)	1.75/43	SS, Teflon®, Viton®	0-250	0-2,800 mL/min	$1,500-3,000	Requires compressed gas; other models available; AC, DC, manual operation possible.
IEA	Syringe Sampler	Portable; grab (positive displacement)	1.75/43	SS, Teflon®	No limit	850 mL sample volume	$1,100	Requires vacuum and/or pressure from hand pump.
Instrument Specialties Co. (ISCO)	Model 2600 Well Sampler	Portable; bladder (positive displacement)	1.75/50	PC, silicone, Teflon®, PP, PE, Detrin®, acetal	0-150	0-7,500 mL/min	$990	Requires compressed gas (40 psi minimum).
Keck Geophysical Instruments, Inc.	SP-81 Submersible Sampling Pump	Portable; helical rotor (positive displacement)	1.75/25	SS, Teflon®, PP, EPDM, Viton®	0-160	0-4,500 mL/min	$3,500	DC operated.
Leonard Mold and Die Works, Inc.	GeoFilter Small Diameter Well Pump (#0500)	Portable; bladder (positive displacement)	1.75/38	SS, Teflon®, PC, Neoprene®	0-400	0-3,500 mL/min	$1,400-1,500	Requires compressed gas (55 psi minimum); pneumatic or AC/DC control module.
Oil Recovery Systems, Inc.	Surface Sampler	Portable; grab (positive displacement)	1.75/12	acrylic, Detrin®	No limit	Approximately 250 mL	$125-160	Other materials and models available; for measuring thickness of "floating" contaminants.
Q.E.D. Environmental Systems, Inc.	Well Wizard® Monitoring System (P-100)	Dedicated; bladder (positive displacement)	1.66/36	PVC	0-230	0-2,000 mL/min	$300-400	Requires compressed gas; piezometric level indicator; other materials available.

ATTACHMENT A

PURGING EQUIPMENT SELECTION

PAGE 3

Manufacturer	Model Name/Number	Principle of Operation	Maximum Outside Diameter/Length (Inches)	Construction Materials (w/Lines and Tubing)	Lift Range (ft)	Delivery Rates or Volumes	1982 Price (Dollars)	Comments
Randolph Austin Co.	Model 500 Vari-Flow Pump	Portable; peristaltic (suction)	<0.5/NA	(Not submersible) Rubber, Tygon®, or Neoprene®	0-30	See comments	$1,200-1,300	Flow rate dependent on motor and tubing selected; AC operated; other models available.
Robert Bennett Co.	Model 180	Portable; piston (positive displacement)	1.8/22	SS, Teflon®, Delrin® PP, Viton®, acrylic, PE	0-500	0-1,800 mL/min	$2,600-2,700	Requires compressed gas; water level indicator and flow meter; custom models available.
Slope Indicator Co. (SINCO)	Model 514124 Pneumatic Water Sampler	Portable; gas drive (positive displacement)	1.9/18	PVC, nylon	0-1,100	250 mL/flushing cycle	$250-350	Requires compressed gas; SS available; piezometer model available; dedicated model available.
Solinst Canada Ltd.	5W Water Sampler	Portable; grab (positive displacement)	1.9/27	PVC, brass, nylon, Neoprene®	0-330	500 mL	$1,300-1,800	Requires compressed gas; custom models available.
TIMCO Mfg. Co., Inc.	Std. Bailer	Portable; grab (positive displacement)	1.66/Custom	PVC, PP	No limit	250 mL/ft of bailer	$20-60	Other sizes, materials, models available; optional bottom-emptying device available; no solvents used.
TIMCO	Air or Gas Lift Sampler	Portable; gas drive (positive displacement)	1.66/30	PVC, Tygon®, Teflon®	0-150	350 mL/flushing cycle	$100-200	Requires compressed gas; other sizes, materials, models available; no solvents used.
Tole Devices Co.	Sampling Pump	Portable; bladder (positive displacement)	1.38/48	SS, silicone, Delrin®, Tygon®	0-125	0-4,000 mL/min	$800-1,000	Compressed gas required; DC control module; custom built.

Construction Material Abbreviations:

- PE Polyethylene
- PP Polypropylene
- PVC Polyvinyl chloride
- SS Stainless steel
- PC Polycarbonate
- EPDM Ethylene-propylene diene (synthetic rubber)

Other Abbreviations:

- NA Not applicable
- AC Alternating current
- DC Direct current

NOTE: Other manufacturers market pumping devices which could be used for groundwater sampling, though not expressly designed for this purpose. The list is not meant to be all-inclusive and listing does not constitute endorsement for use. Information in the table is from sales literature and/or personal communication. No skimmer, scavenger-type, or high-capacity pumps are included.

Source: Barcelona et al., 1983.

ATTACHMENT B
GROUNDWATER SAMPLE LOG SHEET

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Page___ of ___

Project Site Name: _____
Project No.: _____

[ ] Domestic Well Data
[x] Monitoring Well Data
[ ] Other Well Type: _____
[ ] QA Sample Type: _____

Sample ID No.: _____
Sample Location: _____
Sampled By: _____
C.O.C. No.: _____
Type of Sample:
[X] Low Concentration
[ ] High Concentration

SAMPLING DATA:

Date:	Color	pH	S.C.	Temp.	Turbidity	DO	ORP	Other
Time:	Visual	Standard	mS/cm	Degrees C	NTU	mg/l	mV	NA
Method:								

PURGE DATA:

Date:	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	ORP	Other
Method:								
Monitor Reading (ppm):			SEE LOW FLOW PURGE DATA SHEET					
Well Casing Diameter & Material								
Type:								
Total Well Depth (TD):								
Static Water Level (WL):								
One Casing Volume(gal/L):								
Start Purge (hrs):								
End Purge (hrs):								
Total Purge Time (min):								
Total Vol. Purged (gal/L):								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected

OBSERVATIONS / NOTES:

Circle if Applicable:		Signature(s):
MS/MSD	Duplicate ID No.:	

ATTACHMENT C
LOW FLOW PURGE DATA SHEET

LOW FLOW PURGE DATA SHEET

PROJECT SITE NAME: _____ WELL ID.: _____
PROJECT NUMBER: _____ DATE: _____

Time (Hrs.)	Water Level (Ft. below TOC)	Flow (mL/Min.)	pH (S.U.)	S. Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celcius)	ORP mV	Salinity % or ppt	Comments

SIGNATURE(S): _____ PAGE___OF___

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1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide information on sample preservation, packaging, and shipping procedures to be used in handling environmental samples submitted for chemical constituent, biological, or geotechnical analysis. Sample chain-of-custody procedures and other aspects of field documentation are addressed in SOP SA-6.3. Sample identification is addressed in SOP CT-04.

2.0 SCOPE

This procedure describes the appropriate containers to be used for samples depending on the analyses to be performed, and the steps necessary to preserve the samples when shipped off site for chemical analysis.

3.0 GLOSSARY

Hazardous Material - A substance or material which has been determined by the Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and which has been so designated. Under 49 CFR, the term includes hazardous substances, hazardous wastes, marine pollutants, and elevated temperature materials, as well as materials designated as hazardous under the provisions of §172.101 and §172.102 and materials that meet the defining criteria for hazard classes and divisions in Part 173. With slight modifications, IATA has adopted DOT "hazardous materials" as IATA "Dangerous Goods."

Hazardous Waste - Any substance listed in 40 CFR, Subpart D (~~y~~261.30 et seq.), or otherwise characterized as ignitable, corrosive, reactive, or toxic (as defined by Toxicity Characteristic Leaching Procedure, TCLP, analysis) as specified under 40 CFR, Subpart C (~~y~~261.20 et seq.), that would be subject to manifest requirements specified in 40 CFR 262. Such substances are defined and regulated by EPA.

Marking - A descriptive name, identification number, instructions, cautions, weight, specification or UN marks, or combination thereof required on outer packaging of hazardous materials.

n.o.i - Not otherwise indicated (may be used interchangeably with n.o.s.).

n.o.s. - Not otherwise specified.

Packaging - A receptacle and any other components or materials necessary for compliance with the minimum packaging requirements of 49 CFR 174, including containers (other than freight containers or overpacks), portable tanks, cargo tanks, tank cars, and multi-unit tank-car tanks to perform a containment function in conformance with the minimum packaging requirements of 49 CFR 173.24(a) & (b).

Placard - Color-coded, pictorial sign which depicts the hazard class symbol and name and which is placed on the side of a vehicle transporting certain hazardous materials.

Common Preservatives:

- Hydrochloric Acid - HCl
- Sulfuric Acid - H_2SO_4
- Nitric Acid - HNO_3
- Sodium Hydroxide - NaOH

Other Preservatives

- Zinc Acetate
- Sodium Thiosulfate - $Na_2S_2O_3$

Normality (N) - Concentration of a solution expressed as equivalent per liter, an equivalent being the amount of a substance containing 1 gram-atom of replaceable hydrogen or its equivalent.

Reportable Quantity (RQ) - For the purposes of this SOP, means the quantity specified in column 3 of the Appendix to DOT 49 CFR §172.101 for any material identified in column 1 of the appendix. A spill greater than the amount specified must be reported to the National Response Center.

Sample - A sample is physical evidence collected from a facility or the environment, which is representative of conditions at the location and time of collection.

4.0 RESPONSIBILITIES

Field Operations Leader - Directly responsible for the bottling, preservation, labeling, packaging, shipping, and custody of samples up to and including release to the shipper.

Field Samplers - Responsible for initiating the Chain-of-Custody Record (per SOP SA-6.3), implementing the packaging and shipping requirements, and maintaining custody of samples until they are relinquished to another custodian or to the shipper.

5.0 PROCEDURES

Sample identification, labeling, documentation, and chain-of-custody are addressed by SOP SA-6.3.

5.1 Sample Containers

Different types of chemicals react differently with sample containers made of various materials. For example, trace metals adsorb more strongly to glass than to plastic, whereas many organic chemicals may dissolve various types of plastic containers. Attachments A and B show proper containers (as well as other information) per 40 CFR 136. In general, the sample container shall allow approximately 5-10 percent air space ("ullage") to allow for expansion/vaporization if the sample warms during transport. However, for collection of volatile organic compounds, head space shall be omitted. The analytical laboratory will generally provide certified-clean containers for samples to be analyzed for chemical constituents. Shelby tubes or other sample containers are generally provided by the driller for samples requiring geotechnical analysis. Sufficient lead time shall be allowed for a delivery of sample container orders. Therefore, it is critical to use the correct container to maintain the integrity of the sample prior to analysis.

Once opened, the container must be used at once for storage of a particular sample. Unused but opened containers are to be considered contaminated and must be discarded. Because of the potential for introduction of contamination, they cannot be reclosed and saved for later use. Likewise, any unused containers which appear contaminated upon receipt, or which are found to have loose caps or a missing Teflon liner (if required for the container), shall be discarded.

5.2 Sample Preservation

Many water and soil samples are unstable and therefore require preservation to prevent changes in either the concentration or the physical condition of the constituent(s) requiring analysis. Although complete and irreversible preservation of samples is not possible, preservation does retard the chemical and biological

changes that inevitably take place after the sample is collected. Preservation techniques are usually limited to pH control, chemical addition(s), and refrigeration/ freezing (certain biological samples only).

5.2.1 Overview

The preservation techniques to be used for various analytes are listed in Attachments A and B. Reagents required for sample preservation will either be added to the sample containers by the laboratory prior to their shipment to the field or be added in the field (in a clean environment). Only high purity reagents shall be used for preservation. In general, aqueous samples of low-concentration organics (or soil samples of low- or medium-concentration organics) are cooled to 4°C. Medium-concentration aqueous samples, high-hazard organic samples, and some gas samples are typically not preserved. Low-concentration aqueous samples for metals are acidified with HNO_3, whereas medium-concentration and high-hazard aqueous metal samples are not preserved. Low- or medium-concentration soil samples for metals are cooled to 4°C, whereas high-hazard samples are not cooled.

The following subsections describe the procedures for preparing and adding chemical preservatives. Attachments A and B indicate the specific analytes which require these preservatives.

The FOL is responsible for ensuring that an accurate Chemical Inventory is created and maintained for all hazardous chemicals brought to the work site (see Section 5 of the TtNUS Health and Safety Guidance Manual). Furthermore, the FOL must ensure that a corresponding Material Safety Data Sheet (MSDS) is collected for every substance entered on the site Chemical Inventory, and that all persons using/handling/ disposing of these substances review the appropriate MSDS for substances they will work with. The Chemical Inventory and the MSDSs must be maintained at each work site in a location and manner where they are readily-accessible to all personnel.

5.2.2 Preparation and Addition of Reagents

Addition of the following acids or bases may be specified for sample preservation; these reagents shall be analytical reagent (AR) grade or purer and shall be diluted to the required concentration with deionized water before field sampling commences. To avoid uncontrolled reactions, be sure to Add Acid to water (not vice versa). A dilutions guide is provided below.

Acid/Base	Dilution	Concentration	Estimated Amount Required for Preservation
Hydrochloric Acid (HCl)	1 part concentrated HCl: 1 part double-distilled, deionized water	6N	5-10 mL
Sulfuric Acid (H_2SO_4)	1 part concentrated H_2SO_4: 1 part double-distilled, deionized water	18N	2 - 5 mL
Nitric Acid (HNO_3)	Undiluted concentrated HNO_3	16N	2 - 5 mL
Sodium Hydroxide (NaOH)	400 grams solid NaOH dissolved in 870 mL double-distilled, deionized water; yields 1 liter of solution	10N	2 mL

The amounts required for preservation shown in the above table assumes proper preparation of the preservative and addition of the preservative to one liter of aqueous sample. This assumes that the sample is initially at pH 7, is poorly buffered, and does not contain particulate matter; as these conditions vary, more preservative may be required. Consequently, the final sample pH must be checked using narrow-range pH paper, as described in the generalized procedure detailed below:

- Pour off 5-10 mL of sample into a dedicated, clean container. Use some of this sample to check the initial sample pH using wide range (0-14) pH paper. Never dip the pH paper into the sample; always apply a drop of sample to the pH paper using a clean stirring rod or pipette.

- Add about one-half of the estimated preservative required to the original sample bottle. Cap and invert gently several times to mix. Check pH (as described above) using medium range pH paper (pH 0-6 or pH 7.5-14, as applicable).

- Cap sample bottle and seal securely.

Additional considerations are discussed below:

- To test if ascorbic acid must be used to remove oxidizing agents present in the sample before it can be properly preserved, place a drop of sample on KI-starch paper. A blue color indicates the need for ascorbic acid addition.

  If required, add a few crystals of ascorbic acid to the sample and retest with the KI-starch paper. Repeat until a drop of sample produces no color on the KI-starch paper. Then add an additional 0.6 grams of ascorbic acid per each liter of sample volume.

  Continue with proper base preservation of the sample as described above.

- Samples for sulfide analysis must be treated by the addition of 4 drops (0.2 mL) of 2N zinc acetate solution per 100 ml of sample.

  The 2N zinc acetate solution is made by dissolving 220 grams of zinc acetate in 870 mL of double-distilled, deionized water to make 1 liter of solution.

  The sample pH is then raised to 9 using the NaOH preservative.

- Sodium thiosulfate must be added to remove residual chlorine from a sample. To test the sample for residual chlorine use a field test kit specially made for this purpose.

  If residual chlorine is present, add 0.08 grams of sodium thiosulfate per liter of sample to remove the residual chlorine.

  Continue with proper acidification of the sample as described above.

For biological samples, 10% buffered formalin or isopropanol may also be required for preservation. Questions regarding preservation requirements should be resolved through communication with the laboratory before sampling begins.

5.3 Field Filtration

At times, field-filtration may be required to provide for the analysis of dissolved chemical constituents. Field-filtration must be performed prior to the preservation of samples as described above. General procedures for field filtration are described below:

- The sample shall be filtered through a non-metallic, 0.45-micron membrane filter, immediately after collection. The filtration system shall consist of dedicated filter canister, dedicated tubing, and a peristaltic pump with pressure or vacuum pumping squeeze action (since the sample is filtered by mechanical peristalsis, the sample travels only through the tubing).

- To perform filtration, thread the tubing through the peristaltic pump head. Attach the filter canister to the discharge end of the silicon tubing (note flow direction arrow); attach the aqueous sample container to the intake end of the silicon tubing. Turn the peristaltic pump on and perform filtration. Run approximately 100 ml of sample through the filter and discard prior to sample collection.

- Continue by preserving the filtrate (contained in the filter canister), as applicable and generally described above.

5.4 Sample Packaging and Shipping

Only employees who have successfully completed the TtNUS "Shipping Hazardous Materials" training course are authorized to package and ship hazardous substances. These trained individuals are responsible for performing shipping duties in accordance with this training.

Samples collected for shipment from a site shall be classified as either environmental or hazardous material samples. Samples from drums containing materials other than Investigative Derived Waste (IDW) and samples obtained from waste piles or bulk storage tanks are generally shipped as hazardous materials. A distinction must be made between the two types of samples in order to:

- Determine appropriate procedures for transportation of samples (if there is any doubt, a sample shall be considered hazardous and shipped accordingly.)

- Protect the health and safety of transport and laboratory personnel receiving the samples (special precautions are used by the shipper and at laboratories when hazardous materials are received.)

Detailed procedures for packaging environmental samples are outlined in the remainder of this section.

5.4.1 Environmental Samples

Environmental samples are packaged as follows:

- Place properly identified sample container, with lid securely fastened, in a plastic bag (e.g. Ziploc baggie), and seal the bag.

- Place sample in a cooler constructed of sturdy material which has been lined with a large, plastic bag (e.g. "garbage" bag). Drain plugs on coolers must be taped shut.

- Pack with enough cushioning materials such as bubble wrap (shoulders of bottles must be iced if required) to minimize the possibility of the container breaking.

- If cooling is required (see Attachments A and B), place ice around sample container shoulders, and on top of packing material (minimum of 8 pounds of ice for a medium-size cooler).

- Seal (i.e., tape or tie top in knot) large liner bag.

- The original (top, signed copy) of the COC form shall be placed inside a large Ziploc-type bag and taped inside the lid of the shipping cooler. If multiple coolers are sent but are included on one COC form, the COC form should be sent with the cooler containing the vials for VOC analysis. The COC form should then state how many coolers are included with that shipment.

- Close and seal outside of cooler as described in SOP SA-6.3. Signed custody seals must be used.

Coolers must be marked as containing "Environmental Samples." The appropriate side of the container must be marked "This End Up" and arrows placed appropriately. No DOT marking or labeling is required; there are no DOT restrictions on mode of transportation.

6.0 REFERENCES

American Public Health Association, 1981. Standard Methods for the Examination of Water and Wastewater, 15th Edition. APHA, Washington, D.C.

International Air Transport Association (latest issue). Dangerous Goods Regulations, Montreal, Quebec, Canada.

U.S. Department of Transportation (latest issue). Hazardous Materials Regulations, 49 CFR 171-177.

U.S. EPA, 1984. "Guidelines Establishing Test Procedures for the Analysis of Pollutants under Clean Water Act." Federal Register, Volume 49 (209), October 26, 1984, p. 43234.

U.S. EPA, 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020, U.S. EPA-EMSL, Cincinnati, Ohio.

ATTACHMENT A

GENERAL SAMPLE CONTAINER AND PRESERVATION REQUIREMENTS

Sample Type and Concentration			Container[1]	Sample Size	Preservation[2]	Holding Time[2]
WATER						
Organics (GC&GC/MS)	VOC	Low	Borosilicate glass	2 x 40 mL	Cool to 4°C HCl to ≤ 2	14 days[9]
	Extractables SVOCs and pesticide/PCBs)	(Low	Amber glass	2x2 L or 4x1 L	Cool to 4°C	7 days to extraction; 40 days after extraction
	Extractables SVOCs and pesticide/PCBs)	(Medium	Amber glass	2x2 L or 4x1 L	None	7 days to extraction; 40 days after extraction
Inorganics	Metals	Low	High-density polyethylene	1 L	HNO_3 to pH ≤2	6 months (Hg-28 days)
		Medium	Wide-mouth glass	16 oz.	None	6 months
	Cyanide	Low	High-density polyethylene	1 L	NaOH to pH>12	14 days
	Cyanide	Medium	Wide-mouth glass	16 oz.	None	14 days
Organic/ Inorganic	High Hazard		Wide-mouth glass	8 oz.	None	14 days
SOIL						
Organics (GC&GC/MS)	VOC		EnCore Sampler	(3) 5 g Samplers	Cool to 4°C	48 hours to lab preservation
	Extractables SVOCs and pesticides/PCBs)	(Low	Wide-mouth glass	8 oz.	Cool to 4°C	14 days to extraction; 40 days after extraction
	Extractables SVOCs and pesticides/PCBs)	(Medium	Wide-mouth glass	8 oz.	Cool to 4°C	14 days to extraction; 40 days after extraction
Inorganics	Low/Medium		Wide-mouth glass	8 oz.	Cool to 4°C	6 months (Hg - 28 days) Cyanide (14 days)
Organic/Inorganic	High Hazard		Wide-mouth glass	8 oz.	None	NA
Dioxin/Furan	All		Wide-mouth glass	4 oz.	None	35 days until extraction; 40 days after extraction
TCLP	All		Wide-mouth glass	8 oz.	None	7 days until preparation; analysis as per fraction
AIR						
Volatile Organics	Low/Medium		Charcoal tube -- 7 cm long, 6 mm OD, 4 mm ID	100 L air	Cool to 4°C	5 days recommended

1 All glass containers should have Teflon cap liners or septa.
2 See Attachment E. Preservation and maximum holding time allowances per 40 CFR 136.

ATTACHMENT B

ADDITIONAL REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES

Parameter Number/Name	Container[1]	Preservation[2][3]	Maximum Holding Time[4]
INORGANIC TESTS:			
Acidity	P, G	Cool, 4°C	14 days
Alkalinity	P, G	Cool, 4°C	14 days
Ammonia - Nitrogen	P, G	Cool, 4°C; H_2SO_4 to pH 2	28 days
Biochemical Oxygen Demand (BOD)	P, G	Cool, 4°C	48 hours
Bromide	P, G	None required	28 days
Chemical Oxygen Demand (COD)	P, G	Cool, 4°C; H_2SO_4 to pH 2	28 days
Chloride	P, G	None required	28 days
Chlorine, Total Residual	P, G	None required	Analyze immediately
Color	P, G	Cool, 4°C	48 hours
Cyanide, Total and Amenable to Chlorination	P, G	Cool, 4°C; NaOH to pH 12; 0.6 g ascorbic acid[5]	14 days[6]
Fluoride	P	None required	28 days
Hardness	P, G	HNO_3 to pH 2; H_2SO_4 to pH 2	6 months
Total Kjeldahl and Organic Nitrogen	P, G	Cool, 4°C; H_2SO_4 to pH 2	28 days
Nitrate - Nitrogen	P, G	None required	48 hours
Nitrate-Nitrite - Nitrogen	P, G	Cool, 4°C; H_2SO_4 to pH 2	28 days
Nitrite - Nitrogen	P, G	Cool, 4°C	48 hours
Oil & Grease	G	Cool, 4°C; H_2SO_4 to pH 2	28 days
Total Organic Carbon (TOC)	P, G	Cool, 4°C; HCl or H_2SO_4 to pH 2	28 days
Orthophosphate	P, G	Filter immediately; Cool, 4°C	48 hours
Oxygen, Dissolved-Probe	G Bottle & top	None required	Analyze immediately
Oxygen, Dissolved-Winkler	G Bottle & top	Fix on site and store in dark	8 hours
Phenols	G	Cool, 4°C; H_2SO_4 to pH 2	28 days
Phosphorus, Total	P, G	Cool, 4°C; H_2SO_4 to pH 2	28 days
Residue, Total	P, G	Cool, 4°C	7 days
Residue, Filterable (TDS)	P, G	Cool, 4°C	7 days
Residue, Nonfilterable (TSS)	P, G	Cool, 4°C	7 days
Residue, Settleable	P, G	Cool, 4°C	48 hours
Residue, Volatile (Ash Content)	P, G	Cool, 4°C	7 days
Silica	P	Cool, 4°C	28 days
Specific Conductance	P, G	Cool, 4°C	28 days
Sulfate	P, G	Cool, 4°C	28 days

ATTACHMENT B
ADDITIONAL REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES
PAGE TWO

Parameter Number/Name	Container[1]	Preservation[2][3]	Maximum Holding Time[4]
INORGANIC TESTS (Cont'd):			
Sulfide	P, G	Cool, 4°C; add zinc acetate plus sodium hydroxide to pH 9	7 days
Sulfite	P, G	None required	Analyze immediately
Turbidity	P, G	Cool, 4°C	48 hours
METALS:[7]			
Chromium VI (Hexachrome)	P, G	Cool, 4°C	24 hours
Mercury (Hg)	P, G	HNO_3 to pH 2	28 days
Metals, except Chromium VI and Mercury	P, G	HNO_3 to pH 2	6 months
ORGANIC TESTS:[8]			
Purgeable Halocarbons	G, Teflon-lined septum	Cool, 4°C; 0.008% $Na_2S_2O_3$[5]	14 days
Purgeable Aromatic Hydrocarbons	G, Teflon-lined septum	Cool, 4°C; 0.008% $Na_2S_2O_3$[5] HCl to pH 2 [9]	14 days
Acrolein and Acrylonitrile	G, Teflon-lined septum	Cool, 4°C; 0.008% $Na_2S_2O_3$[5] adjust pH to 4-5 [10]	14 days
Phenols[11]	G, Teflon-lined cap	Cool, 4°C; 0.008% $Na_2S_2O_3$[5]	7 days until extraction; 40 days after extraction
Benzidines[11], [12]	G, Teflon-lined cap	Cool, 4°C; 0.008% $Na_2S_2O_3$[5]	7 days until extraction[13]
Phthalate esters[11]	G, Teflon-lined cap	Cool, 4°C	7 days until extraction; 40 days after extraction
Nitrosamines[11], [14]	G, Teflon-lined cap	Cool, 4°C; store in dark; 0.008% $Na_2S_2O_3$[5]	7 days until extraction; 40 days after extraction
PCBs[11]	G, Teflon-lined cap	Cool, 4°C	7 days until extraction; 40 days after extraction
Nitroaromatics & Isophorone[11]	G, Teflon-lined cap	Cool, 4°C; 0.008% $Na_2S_2O_3$[5]; store in dark	7 days until extraction; 40 days after extraction
Polynuclear Aromatic Hydrocarbons (PAHs)[11],[14]	G, Teflon-lined cap	Cool, 4°C; 0.008% $Na_2S_2O_3$[5]; store in dark	7 days until extraction; 40 days after extraction
Haloethers[11]	G, Teflon-lined cap	Cool, 4°C; 0.008% $Na_2S_2O_3$[5]	7 days until extraction; 40 days after extraction
Dioxin/Furan (TCDD/TCDF)[11]	G, Teflon-lined cap	Cool, 4°C; 0.008% $Na_2S_2O_3$[5]	7 days until extraction; 40 days after extraction

ATTACHMENT B
ADDITIONAL REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES
PAGE THREE

(1) Polyethylene (P): generally 500 ml or Glass (G): generally 1L.
(2) Sample preservation should be performed immediately upon sample collection. For composite chemical samples each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.
(3) When any sample is to be shipped by common carrier or sent through the United States Mail, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172).
(4) Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid. Samples may be held for longer periods only if the permittee, or monitoring laboratory, has data on file to show that the specific types of samples under study are stable for the longer periods, and has received a variance from the Regional Administrator.
(5) Should only be used in the presence of residual chlorine.
(6) Maximum holding time is 24 hours when sulfide is present. Optionally, all samples may be tested with lead acetate paper before pH adjustments are made to determine if sulfide is present. If sulfide is present, it can be removed by the addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and then NaOH is added to pH 12.
(7) Samples should be filtered immediately on site before adding preservative for dissolved metals.
(8) Guidance applies to samples to be analyzed by GC, LC, or GC/MS for specific compounds.
(9) Sample receiving no pH adjustment must be analyzed within 7 days of sampling.
(10) The pH adjustment is not required if acrolein will not be measured. Samples for acrolein receiving no pH adjustment must be analyzed within 3 days of sampling.
(11) When the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding times should be observed for optimum safeguard of sample integrity. When the analytes of concern fall within two or more chemical categories, the sample may be preserved by cooling to 4°C, reducing residual chlorine with 0.008% sodium thiosulfate, storing in the dark, and adjusting the pH to 6-9; samples preserved in this manner may be held for 7 days before extraction and for 40 days after extraction. Exceptions to this optional preservation and holding time procedure are noted in footnote 5 (re: the requirement for thiosulfate reduction of residual chlorine) and footnotes 12, 13 (re: the analysis of benzidine).
(12) If 1,2-diphenylthydrazine is likely to be present, adjust the pH of the sample to 4.0±0.2 to prevent rearrangement to benzidine.
(13) Extracts may be stored up to 7 days before analysis if storage is conducted under an inert (oxidant-free) atmosphere.
(14) For the analysis of diphenylnitrosamine, add 0.008% $Na_2S_2O_3$ and adjust pH to 7-10 with NaOH within 24 hours of sampling.
(15) The pH adjustment may be performed upon receipt at the laboratory and may be omitted if the samples are extracted within 72 hours of collection. For the analysis of aldrin, add 0.008% $Na_2S_2O_3$.

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1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to identify and designate the field data record forms, logs and reports generally initiated and maintained for documenting Tetra Tech NUS field activities.

2.0 SCOPE

Documents presented within this procedure (or equivalents) shall be used for all Tetra Tech NUS field activities, as applicable. Other or additional documents may be required by specific client contracts or project planning documents.

3.0 GLOSSARY

None

4.0 RESPONSIBILITIES

Project Manager (PM) - The Project Manager is responsible for obtaining hardbound, controlled-distribution logbooks (from the appropriate source), as needed. In addition, the Project Manager is responsible for placing all field documentation used in site activities (i.e., records, field reports, sample data sheets, field notebooks, and the site logbook) in the project's central file upon the completion of field work.

Field Operations Leader (FOL) - The Field Operations Leader is responsible for ensuring that the site logbook, notebooks, and all appropriate and current forms and field reports illustrated in this guideline (and any additional forms required by the contract) are correctly used, accurately filled out, and completed in the required time-frame.

5.0 PROCEDURES

5.1 Site Logbook

5.1.1 General

The site logbook is a hard-bound, paginated, controlled-distribution record book in which all major onsite activities are documented. At a minimum, the following activities/events shall be recorded or referenced (daily) in the site logbook:

- All field personnel present
- Arrival/departure of site visitors
- Arrival/departure of equipment
- Start and/or completion of borehole, trench, monitoring well installation, etc.
- Daily onsite activities performed each day
- Sample pickup information
- Health and Safety issues (level of protection observed, etc.)
- Weather conditions

A site logbook shall be maintained for each project. The site logbook shall be initiated at the start of the first onsite activity (e.g., site visit or initial reconnaissance survey). Entries are to be made for every day that onsite activities take place which involve Tetra Tech NUS or subcontractor personnel. Upon completion of the fieldwork, the site logbook must become part of the project's central file.

The following information must be recorded on the cover of each site logbook:

- Project name
- Tetra Tech NUS project number
- Sequential book number
- Start date
- End date

Information recorded daily in the site logbook need not be duplicated in other field notebooks (see Section 5.2), but must summarize the contents of these other notebooks and refer to specific page locations in these notebooks for detailed information (where applicable). An example of a typical site logbook entry is shown in Attachment A.

If measurements are made at any location, the measurements and equipment used must either be recorded in the site logbook or reference must be made to the field notebook in which the measurements are recorded (see Attachment A).

All logbook, notebook, and log sheet entries shall be made in indelible ink (black pen is preferred). No erasures are permitted. If an incorrect entry is made, the data shall be crossed out with a single strike mark, and initialed and dated. At the completion of entries by any individual, the logbook pages used must be signed and dated. The site logbook must also be signed by the Field Operations Leader at the end of each day.

5.1.2 Photographs

When movies, slides, or photographs are taken of a site or any monitoring location, they must be numbered sequentially to correspond to logbook/notebook entries. The name of the photographer, date, time, site location, site description, and weather conditions must be entered in the logbook/notebook as the photographs are taken. A series entry may be used for rapid-sequence photographs. The photographer is not required to record the aperture settings and shutter speeds for photographs taken within the normal automatic exposure range. However, special lenses, films, filters, and other image-enhancement techniques must be noted in the logbook/notebook. If possible, such techniques shall be avoided, since they can adversely affect the accuracy of photographs. Chain-of-custody procedures depend upon the subject matter, type of film, and the processing it requires. Film used for aerial photography, confidential information, or criminal investigation require chain-of-custody procedures. Once processed, the slides of photographic prints shall be consecutively numbered and labeled according to the logbook/notebook descriptions. The site photographs and associated negatives must be docketed into the project's central file.

5.2 Field Notebooks

Key field team personnel may maintain a separate dedicated field notebook to document the pertinent field activities conducted directly under their supervision. For example, on large projects with multiple investigative sites and varying operating conditions, the Health and Safety Officer may elect to maintain a separate field notebook. Where several drill rigs are in operation simultaneously, each site geologist assigned to oversee a rig must maintain a field notebook.

5.3 Sample Forms

A summary of the forms illustrated in this procedure is shown as the listing of Attachments in the Table of Contents for this SOP. Forms may be altered or revised for project-specific needs contingent upon client

approval. Care must be taken to ensure that all essential information can be documented. Guidelines for completing these forms can be found in the related sampling SOP.

5.3.1 Sample Collection, Labeling, Shipment, Request for Analysis, and Field Test Results

5.3.1.1 Sample Log Sheet

Sample Log Sheets are used to record specified types of data while sampling. Attachments B-1 to B-4 are examples of Sample Log Sheets. The data recorded on these sheets are useful in describing the waste source and sample as well as pointing out any problems, difficulties, or irregularities encountered during sampling. A log sheet must be completed for each sample obtained, including field quality control (QC) samples.

5.3.1.2 Sample Label

A typical sample label is illustrated in Attachment B-5. Adhesive labels must be completed and applied to every sample container. Sample labels can usually be obtained from the appropriate Program source electronically generated in-house, or are supplied from the laboratory subcontractor.

5.3.1.3 Chain-of-Custody Record Form

The Chain-of-Custody (COC) Record is a multi-part form that is initiated as samples are acquired and accompanies a sample (or group of samples) as they are transferred from person to person. This form must be used for any samples collected for chemical or geotechnical analysis whether the analyses are performed on site or off site. One carbonless copy of the completed COC form is retained by the field crew, one copy is sent to the Project Manager, while the original is sent to the laboratory. The original (top, signed copy) of the COC form shall be placed inside a large Ziploc-type bag and taped inside the lid of the shipping cooler. If multiple coolers are sent but are included on one COC form, the COC form should be sent with the first cooler. The COC form should then state how many coolers are included with that shipment. An example of a Chain-of-Custody Record form is provided as Attachment B-6. Once the samples are received at the laboratory, the sample cooler and contents are checked and any problems are noted on the enclosed COC form (any discrepancies between the sample labels and COC form and any other problems that are noted are resolved through communication between the laboratory point-of-contact and the Tetra Tech NUS Project Manager). The COC form is signed and copied. The laboratory will retain the copy while the original becomes part of the samples' corresponding analytical data package.

5.3.1.4 Chain-of-Custody Seal

Attachment B-7 is an example of a custody seal. The Custody seal is an adhesive-backed label. It is part of a chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field and sealed in coolers for transport to the laboratory. The COC seals are signed and dated by the samplers and affixed across the opening edges of each cooler containing environmental samples. COC seals may be available from the laboratory; these seals may also be purchased from a supplier.

5.3.1.5 Field Analytical Log Sheets for Geochemical Parameters

Field Analytical Log Sheets (Attachment B-8) are used to record geochemical and/or natural attenuation field test results. Attachments B-8 (3-page form) should be used when applicable.

5.3.2 Hydrogeological and Geotechnical Forms

5.3.2.1 Groundwater Level Measurement Sheet

A groundwater level measurement sheet, shown in Attachment C-1 must be filled out for each round of water level measurements made at a site.

5.3.2.2 Data Sheet for Pumping Test

During the performance of a pumping test (or an in-situ hydraulic conductivity test), a large amount of data must be recorded, often within a short time period. The pumping test data sheet (Attachment C-2) facilitates this task by standardizing the data collection format, and allowing the time interval for collection to be laid out in advance.

5.3.2.3 Packer Test Report Form

A packer test report form shown in Attachment C-3 must be completed for each well upon which a packer test is conducted.

5.3.2.4 Summary Log of Boring

During the progress of each boring, a log of the materials encountered, operation and driving of casing, and location of samples must be kept. The Summary Log of Boring, or Boring Log, (Attachment C-4) is used for this purpose and must be completed for each soil boring performed. In addition, if volatile organics are monitored on cores, samples, cuttings from the borehole, or breathing zone, (using a PID or FID), these results must be entered on the boring log at the appropriate depth. The "Remarks" column can be used to subsequently enter the laboratory sample number, the concentration of key analytical results, or other pertinent information. This feature allows direct comparison of contaminant concentrations with soil characteristics.

5.3.2.5 Monitoring Well Construction Details Form

A Monitoring Well Construction Details Form must be completed for every monitoring well, piezometer, or temporary well point installed. This form contains specific information on length and type of well riser pipe and screen, backfill, filter pack, annular seal and grout characteristics, and surface seal characteristics. This information is important in evaluating the performance of the monitoring well, particularly in areas where water levels show temporal variation, or where there are multiple (immiscible) phases of contaminants. Depending on the type of monitoring well (in overburden or bedrock), different forms are used (see Attachments C-5 through C-9). Similar forms are used for flush-mount well completions.

5.3.2.6 Test Pit Log

When a test pit or trench is constructed for investigative or sampling purposes, a Test Pit Log (Attachment C-10) must be filled out by the responsible field geologist or sampling technician.

5.3.2.7 Miscellaneous Monitoring Well Forms

Monitoring Well Materials Certificate of Conformance (Attachment C-11) should be used as the project directs to document all materials utilized during each monitoring well installation.

The Monitoring Well Development Record (Attachment C-12) should be used as the project directs to document all well development activities.

5.3.3 Equipment Calibration and Maintenance Form

The calibration or standardization of monitoring, measuring or test equipment is necessary to assure the proper operation and response of the equipment, to document the accuracy, precision or sensitivity of the measurement, and determine if correction should be applied to the readings. Some items of equipment require frequent calibration, others infrequent. Some are calibrated by the manufacturer, others by the user.

Each instrument requiring calibration has its own Equipment Calibration Log (Attachment D) which documents that the manufacturer's instructions were followed for calibration of the equipment, including frequency and type of standard or calibration device. An Equipment Calibration Log must be maintained for each electronic measuring device used in the field; entries must be made for each day the equipment is used.

5.4 Field Reports

The primary means of recording onsite activities is the site logbook. Other field notebooks may also be maintained. These logbooks and notebooks (and supporting forms) contain detailed information required for data interpretation or documentation, but are not easily useful for tracking and reporting of progress. Furthermore, the field logbook/notebooks remain onsite for extended periods of time and are thus not accessible for timely review by project management.

5.4.1 Daily Activities Report

To provide timely oversight of onsite contractors, Daily Activities Reports are completed and submitted as described below.

5.4.1.1 Description

The Daily Activities Report (DAR) documents the activities and progress for each day's field work. This report must be filled out on a daily basis whenever there are drilling, test pitting, well construction, or other related activities occurring which involve subcontractor personnel. These sheets summarize the work performed and form the basis of payment to subcontractors (Attachment E is an example of a Daily Activities Report).

5.4.1.2 Responsibilities

It is the responsibility of the rig geologist to complete the DAR and obtain the driller's signature acknowledging that the times and quantities of material entered are correct.

5.4.1.3 Submittal and Approval

At the end of the shift, the rig geologist must submit the Daily Activities Report to the Field Operations Leader (FOL) for review and filing. The Daily Activities Report is not a formal report and thus requires no further approval. The DAR reports are retained by the FOL for use in preparing the site logbook and in preparing weekly status reports for submission to the Project Manager.

5.4.2 Weekly Status Reports

To facilitate timely review by project management, photocopies of logbook/notebook entries may be made for internal use.

It should be noted that in addition to the summaries described herein, other summary reports may also be contractually required. Attachment F is an example of a Field Trip Summary Report form.

6.0 ATTACHMENTS

Attachment A	TYPICAL SITE LOGBOOK ENTRY
Attachment B-1	EXAMPLE GROUNDWATER SAMPLE LOG SHEET
Attachment B-2	EXAMPLE SURFACE WATER SAMPLE LOG SHEET
Attachment B-3	EXAMPLE SOIL/SEDIMENT SAMPLE LOG SHEET
Attachment B-4	CONTAINER SAMPLE LOG SHEET FORM
Attachment B-5	SAMPLE LABEL
Attachment B-6	CHAIN-OF-CUSTODY RECORD FORM
Attachment B-7	CHAIN-OF-CUSTODY SEAL
Attachment B-8	FIELD ANALYTICAL LOG SHEET
Attachment C-1	EXAMPLE GROUNDWATER LEVEL MEASUREMENT SHEET
Attachment C-2	EXAMPLE PUMPING TEST DATA SHEET
Attachment C-3	PACKER TEST REPORT FORM
Attachment C-4	EXAMPLE BORING LOG
Attachment C-5	EXAMPLE OVERBURDEN MONITORING WELL SHEET
Attachment C-5A	EXAMPLE OVERBURDEN MONITORING WELL SHEET (FLUSHMOUNT)
Attachment C-6	EXAMPLE CONFINING LAYER MONITORING WELL SHEET
Attachment C-7	EXAMPLE BEDROCK MONITORING WELL SHEET - OPEN HOLE WELL
Attachment C-8	EXAMPLE BEDROCK MONITORING WELL SHEET - WELL INSTALLED IN BEDROCK
Attachment C-9	EXAMPLE BEDROCK MONITORING WELL SHEET - WELL INSTALLED IN BEDROCK (FLUSHMOUNT)
Attachment C-10	EXAMPLE TEST PIT LOG
Attachment C-11	MONITORING WELL MATERIALS CERTIFICATE OF CONFORMANCE
Attachment C-12	MONITORING WELL DEVELOPMENT RECORD
Attachment D	EXAMPLE EQUIPMENT CALIBRATION LOG
Attachment E	EXAMPLE DAILY ACTIVITIES RECORD
Attachment F	FIELD TRIP SUMMARY REPORT

ATTACHMENT A
TYPICAL SITE LOGBOOK ENTRY

START TIME: _____ DATE: _____

SITE LEADER: _____

PERSONNEL:

TtNUS	DRILLER	SITE VISITORS
_____	_____	_____
_____	_____	_____
_____	_____	_____

WEATHER: Clear, 68°F, 2-5 mph wind from SE

ACTIVITIES:

1. Steam jenney and fire hoses were set up.
2. Drilling activities at well ____ resumes. Rig geologist was _____. See Geologist's Notebook, No. 1, page 29-30, for details of drilling activity. Sample No. 123-21-S4 collected; see sample logbook, page 42. Drilling activities completed at 11:50 and a 4-inch stainless steel well installed. See Geologist's Notebook, No. 1, page 31, and well construction details for well _____.
3. Drilling rig No. 2 steam-cleaned at decontamination pit. Then set up at location of well _____.
4. Well _____ drilled. Rig geologist was _____. See Geologist's Notebook, No. 2, page ____ for details of drilling activities. Sample numbers 123-22-S1, 123-22-S2, and 123-22-S3 collected; see sample logbook, pages 43, 44, and 45.
5. Well _____ was developed. Seven 55-gallon drums were filled in the flushing stage. The well was then pumped using the pitcher pump for 1 hour. At the end of the hour, water pumped from well was "sand free."
6. EPA remedial project manger arrives on site at 14:25 hours.
7. Large dump truck arrives at 14:45 and is steam-cleaned. Backhoe and dump truck set up over test pit _____.
8. Test pit _____ dug with cuttings placed in dump truck. Rig geologist was _____. See Geologist's Notebook, No. 1, page 32, for details of test pit activities. Test pit subsequently filled. No samples taken for chemical analysis. Due to shallow groundwater table, filling in of test pit ___ resulted in a very soft and wet area. A mound was developed and the area roped off.
9. Express carrier picked up samples (see Sample Logbook, pages 42 through 45) at 17:50 hours. Site activities terminated at 18:22 hours. All personnel off site, gate locked.

_____

Field Operations Leader

ATTACHMENT B-1

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Page___ of ___

Project Site Name: _____
Project No.: _____

[] Domestic Well Data
[] Monitoring Well Data
[] Other Well Type: _____
[] QA Sample Type: _____

Sample ID No.: _____
Sample Location: _____
Sampled By: _____
C.O.C. No.: _____
Type of Sample:
[] Low Concentration
[] High Concentration

SAMPLING DATA:

Date:	Color	pH	S.C.	Temp.	Turbidity	DO	Salinity	Other
Time:	(Visual)	(S.U.)	(mS/cm)	(^{0}C)	(NTU)	(mg/l)	(%)	
Method:								

PURGE DATA:

Date:	Volume	pH	S.C.	Temp.	Turbidity	DO	Salinity	Other
Method:								
Monitor Reading (ppm):								
Well Casing Diameter & Material								
Type:								
Total Well Depth (TD):								
Static Water Level (WL):								
One Casing Volume(gal/L):								
Start Purge (hrs):								
End Purge (hrs):								
Total Purge Time (min):								
Total Vol. Purged (gal/L):								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected

OBSERVATIONS / NOTES:

Circle if Applicable:		Signature(s):
MS/MSD	Duplicate ID No.:	

ATTACHMENT B-2

Tetra Tech NUS, Inc.

SURFACE WATER SAMPLE LOG SHEET

Page___ of ___

Project Site Name: _____
Project No.: _____

[] Stream
[] Spring
[] Pond
[] Lake
[] Other: _____
[] QA Sample Type: _____

Sample ID No.: _____
Sample Location: _____
Sampled By: _____
C.O.C. No.: _____

Type of Sample:
[] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color (Visual)	pH (S.U.)	S.C. (mS/cm)	Temp. (°C)	Turbidity (NTU)	DO (mg/l)	Salinity (%)	Other
Date:								
Time:								
Depth:								
Method:								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected

OBSERVATIONS / NOTES:

MAP:

Circle if Applicable:

MS/MSD	Duplicate ID No.:

Signature(s):

ATTACHMENT B-3

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Page___ of ___

Project Site Name: _____
Project No.: _____

[] Surface Soil
[] Subsurface Soil
[] Sediment
[] Other: _____
[] QA Sample Type: _____

Sample ID No.: _____
Sample Location: _____
Sampled By: _____
C.O.C. No.: _____

Type of Sample:
[] Low Concentration
[] High Concentration

GRAB SAMPLE DATA:

Date:	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Time:			
Method:			
Monitor Reading (ppm):			

COMPOSITE SAMPLE DATA:

Date:	Time	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other

OBSERVATIONS / NOTES:

MAP:

Circle if Applicable:

MS/MSD	Duplicate ID No.:

Signature(s):

ATTACHMENT B-4

Tetra Tech NUS, Inc.

CONTAINER SAMPLE & INSPECTION SHEET

Page_____ of _____

Project Site Name: _____
Project Number: _____
Site Identification: _____
Container Number(s): _____
Sample Type: 0 Grab
0 Composite

Sample ID No. _____
Sampled By: _____
C.O.C. No. _____
Concentration: 0 High
0 Medium
0 Low

CONTAINER SOURCE	CONTAINER DESCRIPTION
DRUM: 0 Bung Top 0 Lever Lock 0 Bolted Ring 0 Other _____	**COLOR:** _____ **CONDITION:** _____
TANK: 0 Plastic 0 Metal 0 Other _____	**MARKINGS:** _____ **VOL. OF CONTENTS:** _____
OTHER: _____	**OTHER:** _____

CONTAINER DISPOSITION	CONTENTS DESCRIPTION
SAMPLED: _____ **OPENED BUT NOT SAMPLED:** Reason _____ _____ **NOT OPENED:** Reason _____ _____	**SINGLE PHASED:** _____ _____ **MULTIPHASE :** Layer 1 / Layer 2 / Layer 3 Phase (Sol. or Liq.) _____ _____ _____ Color _____ _____ _____ Viscosity L, M or H L, M or H L, M orH % of Total Volume _____ _____ _____
MONITOR READING:	**SAMPLE and /or INSPECTION DATE & TIME:** _____HRS. **METHOD:**_____
SAMPLER(S) and / or INSPECTOR(S) SIGNATURE:	**ANALYSIS:**

ATTACHMENT B-5

Tetra Tech NUS, Inc. 661 Andersen Drive Pittsburgh, 15220 (412)921-7090	**Project:** **Site:** **Location:**	
Sample No:		**Matrix:**
Date:	**Time:**	**Preserve:**
Analysis:		
Sampled by:	**Laboratory:**	

ATTACHMENT B-6

TETRA TECH NUS, INC. CHAIN OF CUSTODY | NUMBER | PAGE ____ OF _____

PROJECT NO: | SITE NAME: | PROJECT MANAGER AND PHONE NUMBER | LABORATORY NAME AND CONTACT:

SAMPLERS (SIGNATURE) | FIELD OPERATIONS LEADER AND PHONE NUMBER | ADDRESS

CARRIER/WAYBILL NUMBER | CITY, STATE

STANDARD TAT ☐
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

DATE YEAR	TIME	SAMPLE ID	MATRIX	GRAB (G) COMP (C)	No. OF CONTAINERS	CONTAINER TYPE PLASTIC (P) or GLASS (G)	PRESERVATIVE USED	TYPE OF ANALYSIS													COMMENTS

	DATE	TIME		DATE	TIME		DATE	TIME
1. RELINQUISHED BY			1. RECEIVED BY			1. RELINQUISHED BY		
2. RELINQUISHED BY			2. RECEIVED BY			2. RELINQUISHED BY		
3. RELINQUISHED BY			3. RECEIVED BY			3. RELINQUISHED BY		

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

FORM NO. TtNUS-001 3/99

ATTACHMENT B-7

CHAIN-OF-CUSTODY SEAL

CUSTODY SEAL	**CUSTODY SEAL**
Date	**Date**
Signature	**Signature**

ATTACHMENT B-8

Tetra Tech NUS, Inc.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Page __ of __

Project Site Name: _____ Sample ID No.: _____

Project No.: _____ Sample Location: _____

Sampled By: _____ Duplicate: ☐

Field Analyst: _____ Blank: ☐

Field Form Checked as per QA/QC Checklist (initials): ☐

SAMPLING DATA:

	Color (Visual)	pH (S.U.)	S.C. (mS/cm)	Temp. (°C)	Turbidity (NTU)	DO (mg/l)	Salinity (%)	Other
Date: / Time:								
Method:								

SAMPLE COLLECTION/ANALYSIS INFORMATION:

ORP (Eh) (+/- mv):_____ Electrode Make & Model:_____

Reference Electrode (circle one): Silver-Silver Chloride / Calomel / Hydrogen

Dissolved Oxygen:

Equipment: HACH Digital Titrator OX-DT CHEMetrics (Range: _____mg/L) Analysis Time: _____

Range Used:	Range	Sample Vol.	Cartridge	Multiplier
☐	1-5 mg/L	200 ml	0.200 N	0.01
☐	2-10 mg/L	100 ml	0.200 N	0.02

Titration Count	Multiplier		Concentration
_____	x 0.01	=	mg/L
_____	x 0.02	=	mg/L

CHEMetrics: _____mg/L

Notes:

Alkalinity: Analysis Time: _____

Equipment: HACH Digital Titrator AL-DT CHEMetrics (Range: _____mg/L) Filtered: ☐

Range Used:	Range	Sample Vol.	Cartridge	Multiplier	Titration Count	Multiplier		Concentration
☐	10-40 mg/L	100 ml	0.1600 N	0.1	_____ & _____	x 0.1	=	mg/L
☐	40-160 mg/L	25 ml	0.1600 N	0.4	_____ & _____	x 0.4	=	mg/L
☐	100-400 mg/L	100 ml	1.600 N	1.0	_____ & _____	x 1.0	=	mg/L
☐	200-800 mg/L	50 ml	1.600 N	2.0	_____ & _____	x 2.0	=	mg/L
☐	500-2000 mg/L	20 ml	1.600 N	5.0	_____ & _____	x 5.0	=	mg/L
☐	1000-4000 mg/L	10 ml	1.600 N	10.0	_____ & _____	x 10.0	=	mg/L

Parameter:	Hydroxide	Carbonate	Bicarbonate
Relationship:			

CHEMetrics: _____mg/L

Notes:

Standard Additions: ☐ Titrant Molarity:_____ Digits Required: 1st.:_____ 2nd.:_____ 3rd.:_____

Carbon Dioxide:

Equipment: HACH Digital Titrator CA-DT CHEMetrics (Range: _____mg/L) Analysis Time: _____

Range Used:	Range	Sample Vol.	Cartridge	Multiplier
☐	10-50 mg/L	200 ml	0.3636 N	0.1
☐	20-100 mg/L	100 ml	0.3636 N	0.2
☐	100-400 mg/L	200 ml	3.636 N	1.0
☐	200-1000 mg/L	100 ml	3.636 N	2.0

Titration Count			Concentration
_____	x 0.1	=	mg/L
_____	x 0.2	=	mg/L
_____	x 1.0	=	mg/L
_____	x 2.0	=	mg/L

CHEMetrics: _____mg/L

Notes:

Standard Additions: ☐ Titrant Molarity:_____ Digits Required: 1st.:_____ 2nd.:_____ 3rd.:_____

ATTACHMENT B-8 (Continued)

Tetra Tech NUS, Inc.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Page __ of __

Project Site Name: _____ Sample ID No.: _____

Project No.: _____ Sample Location: _____

Sampled By: _____ Duplicate: ☐

Field Analyst: _____ Blank: ☐

Field Form Checked as per QA/QC Checklist (initials): ☐

SAMPLE COLLECTION/ANALYSIS INFORMATION:

Sulfide (S^{2-}):

Equipment: DR-700 DR-8 _ _ HS-WR Color Wheel Other: _____ Analysis Time: _____

Program/Module: 610nm 93

Concentration: _____ mg/L Filtered: ☐

Notes: _____

Sulfate (SO_4^{2-}):

Equipment: DR-700 DR-8 _ _ Other: _____ Analysis Time: _____

Program/Module: 91

Concentration: _____ mg/L Filtered: ☐

Standard Solution: ☐ Results: _____

Standard Additions: ☐ Digits Required: 0.1ml:_____ 0.2ml:_____ 0.3ml:_____

Notes: _____

Nitrite (NO_2^--N):

Analysis Time: _____

Equipment: DR-700 DR-8 _ _ Other: _____ Filtered: ☐

Program/Module: 60

Concentration: _____ mg/L Reagent Blank Correction: ☐

Standard Solution: ☐ Results: ☐

Notes: _____

Nitrate (NO_3^--N):

Analysis Time: _____

Equipment: DR-700 DR-8 _ _ Other: _____ Filtered: ☐

Program/Module: 55

Concentration: _____ mg/L

Nitrite Interference Treatment: ☐

Standard Solution: ☐ Results: _____ Reagent Blank Correction: ☐

Standard Additions: ☐ Digits Required: 0.1ml:_____ 0.2ml:_____ 0.3ml:_____

Notes: _____

ATTACHMENT B-8 (Continued)

Tetra Tech NUS, Inc.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Page __ of __

Project Site Name: _____ Sample ID No.: _____

Project No.: _____ Sample Location: _____

Sampled By: _____ Duplicate: ☐

Field Analyst: _____ Blank: ☐

Field Form Checked as per QA/QC Checklist (initials): ☐

SAMPLE COLLECTION/ANALYSIS INFORMATION:

Manganese (Mn^{2+}):

Equipment: DR-700 DR-8 _ _ HACH MN-5 Other: _____ Analysis Time: _____

Program/Module: 525nm 41

Concentration: _____ mg/L Filtered: ☐

Digestion: ☐

Standard Solution: ☐ Results: _____ Reagent Blank Correction: ☐

Standard Additions: ☐ Digits Required: 0.1ml:_____ 0.2ml:_____ 0.3ml:_____

Notes: _____

Ferrous Iron (Fe^{2+}):

Equipment: DR-700 DR-8 _ _ IR-18C Color Wheel Other: _____ Analysis Time: _____

Program/Module: 500nm 33

Concentration: _____ mg/L Filtered: ☐

Notes: _____

Hydrogen Sulfide (H_2S):

Equipment: HS-C Other: _____ Analysis Time: _____

Concentration: _____ mg/L Exceeded 5.0 mg/L range on color chart: ☐

Notes: _____

QA/QC Checklist:

All data fields have been completed as necessary: ☐

Correct measurement units are cited in the SAMPLING DATA block: ☐

Values cited in the SAMPLING DATA block are consistent with the Groundwater Sample Log Sheet: ☐

Mulitplication is correct for each *Multiplier* table: ☐

Final calulated concentration is within the appropriate *Range Used* block: ☐

Alkalinity *Relationship* is determined appropriatly as per manufacturer (HACH) instructions: ☐

QA/QC sample (e.g., Std. Additions, etc.) frequency is appropriate as per the project planning documents: ☐

Nitrite Interference treatment was used for Nitrate test if Nitrite was detected: ☐

Title block on each page of form is initialized by person who performed this QA/QC Checklist: ☐

ATTACHMENT C-1
EXAMPLE GROUNDWATER LEVEL MEASUREMENT SHEET

Tetra Tech NUS, Inc.

GROUNDWATER LEVEL MEASUREMENT SHEET

Project Name: _____ **Project No.:** _____
Location: _____ **Personnel:** _____
Weather Conditions: _____ **Measuring Device:** _____
Tidally Influenced: Yes ___ No ___ **Remarks:** _____

Well or Piezometer Number	Date	Time	Elevation of Reference Point (feet)*	Total Well Depth (feet)*	Water Level Indicator Reading (feet)*	Thickness of Free Product (feet)*	Groundwater Elevation (feet)*	Comments

* All measurements to the nearest 0.01 foot

Page ____ of ____

ATTACHMENT C-2
EXAMPLE PUMPING TEST DATA SHEET

Tetra Tech NUS, Inc.

PUMPING TEST DATA SHEET

PROJECT NAME: _____ PUMPING WELL NUMBER: _____
PROJECT NUMBER: _____ MEASURED WELL NUMBER: _____

[ ] PUMPING TEST [ ] STEP DRAW DOWN TEST

DATE(s): MONITORING POINT:
MEASUREMENT METHOD: DEPTH CORRECTION (ft):
TEST NUMBER: PUMP SETTING (Ft. below monitoring point):
STATIC WATER LEVEL (ft): DISTANCE FROM PUMPING WELL (ft):
PERSONNEL:
REMARKS:

MILITARY TIME	ELAPSED TIME SINCE PUMP START OR STOP (Min.)	WATER LEVEL (Ft.)	CORRECTION (Ft.)	DRAW DOWN OR RECOVERY (Ft.)	PUMPING RATE (GPM)	FLOW METER READING (Gals.)	REMARKS

NOTE: All measurements to nearest 0.01 foot measured from top of well riser pipe unless otherwise noted.

ATTACHMENT C-3

ATTACHMENT C-3

PACKER TEST REPORT FORM

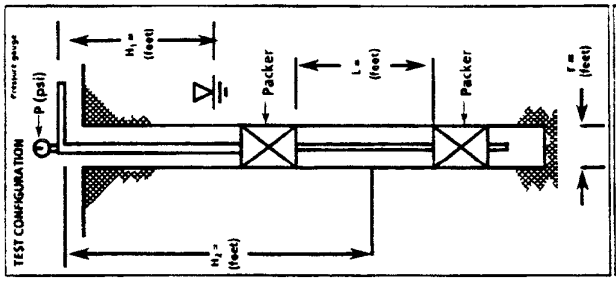
PROJECT: _____ PROJECT NO.: _____ TEST NO: _____ PAGE _____ OF _____

BORING NO.: _____ CASING DEPTH: _____ CONTRACTOR: _____ STATIC WATER LEVEL _____

TEST INTERVAL: _____ BY: _____ CHECKED: _____ PACKER PRESSURE _____

Flow Test							Calculated Results							
Pressure P (psi)	Elapsed Time (min)	Flow Reading	Δ Flow, ΔQ (ft³)	Δ Flow, ΔQ (gal)	Flow Rate Q (gal/min)	H_1* (ft)	$\frac{Hp(ft)}{2.31(psi)}$ =	H_2* (ft)	$\frac{H = Hp + (H1 \text{ or } H2)}{}$	Cp	K (ft/yr) = Cp·QH	$\frac{K\ (cm/sec)}{9.67 \times 10^{-5}}$ = K (ft/yr)

TEST CONFIGURATION



Length of Test Section in feet, L	Cp Drilling Bit Size			
	EX (1.5")	AX (1.875")	BX (2.3")	NX (3")
1	31,000	28,500	25,000	21,300
2	19,400	18,100	16,000	15,500
5	9,800	9,300	8,800	8,200
8	6,800	6,500	6,100	5,800
10	5,700	5,400	5,000	4,900
15	4,100	3,900	3,700	3,500
20	3,200	3,100	3,000	2,800

CP = (1/(2 π L)) ln(L/r) (70.315 5)
7.48 Gallons = 1 Ft³
1 psi = 2.31 ft head
Remarks: _____

* H_1 is used when the test length is below the water table.
H_2 is used when the test length is above the water table.

ATTACHMENT C-4

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME: _____ BORING No.: _____
PROJECT NUMBER: _____ DATE: _____
DRILLING COMPANY: _____ GEOLOGIST: _____
DRILLING RIG: _____ DRILLER: _____

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): _____

Remarks: _____

Converted to Well: Yes _____ No _____ Well I.D. #: _____

ATTACHMENT C4 (Continued)

LEGEND

SOIL TERMS

UNIFIED SOIL CLASSIFICATION (USCS)

COARSE-GRAINED SOILS
More Than Half of Material is LARGER Than No. 200 Sieve Size

FIELD IDENTIFICATION PROCEDURES (Excluding Particles Larger Than 3 Inches and Basing Fractions on Estimated Weights)			GROUP SYMBOL	TYPICAL NAMES
GRAVELS (50%(+)>1/4"⌀)	CLEAN GRAVELS (Low % Fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.	GW	Well graded gravels, gravel-sand mixtures, little or no fines.
		Predominantly one size or a range of sizes with some intermediate sizes missing.	GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.
	GRAVELS W/FINES (High % Fines)	Non-plastic fines (for identification procedures, see ML)	GM	Silty gravels, poorly graded gravel-sand-silt mixtures.
		Plastic fines (for identification procedures, see CL)	GC	Clayey gravels, poorly graded gravel-sand-clay mixtures.
SANDS 50%(+)<1/4"⌀	CLEAN SANDS (Low % Fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.	SW	Well graded sand, gravelly sands, little or no fines.
		Predominantly one size or a range of sizes with some intermediate sizes missing.	SP	Poorly graded sands, gravelly sands, little or no fines.
	SANDS W/FINES (High % Fines)	Non-plastic fines (for identification procedures, see MCL)	SM	Silty sands, poorly graded sand-silt mixtures.
		Plastic fines (for identification procedures, see CL)	SC	Clayey sands, poorly graded sand-clay mixtures.

FINE-GRAINED SOILS
More Than Half of Material is SMALLER Than No. 200 Sieve Size

FIELD IDENTIFICATION PROCEDURES (Excluding Particles Larger Than 3 Inches and Basing Fractions on Estimated Weights)	Identification Procedures on Fraction Smaller than No. 40 Sieve Size: DAY STRENGTH (Crushing Characteristics)	DILATANCY (Reaction to Shaking)	TOUGHNESS (Consistency Near Plastic Limit)	GROUP SYMBOL	TYPICAL NAMES
SILTS AND CLAYS Liquid Limit <50	None to Slight	Quick to Slow	None	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity.
	Medium to High	None to Very Slow	Medium	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
	Slight to Medium	Slow	Slight	OL	Organic silts and organic silt-clays of low plasticity.
SILTS AND CLAYS Liquid Limit >50	Slight to Medium	Slow to None	Slight to Medium	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
	High to Very High	None	High	CH	Inorganic clays of high plasticity, fat clays.
	Medium to High	None to Very Slow	Slight to Medium	OH	Organic clays of medium to high plasticity.
HIGHLY ORGANIC SOILS	Readily identified by color, odor, spongy feel and frequently by fibrous texture.			Pt	Peat and other organic soils

Boundary classifications: Soils possessing characteristics of two groups are designated by combining group symbols. For example, GW-GC, well graded gravel-sand mixture with clay binder.
All sieve sizes on this chart are U.S. Standard.

DENSITY OF GRANULAR SOILS	
DESIGNATION	STANDARD PENETRATION RESISTANCE-BLOWS/FOOT
Very Loose	0-4
Loose	5-10
Medium Loose	11-30
Dense	31-50
Very Dense	Over 50

CONSISTENCY OF COHESIVE SOILS			
CONSISTENCY	UNC COMPRESSIVE STRENGTH (TONS/SQ. FT.)	STANDARD PENETRATION RESISTANCE-BLOWS/FOOT	FIELD IDENTIFICATION METHODS
Very Soft	Less than 0.25	0 to 2	Easily pentrated several inches by fist
Soft	0.25 to 0.50	2 to 4	Easily penetrated several inches by thumb.
Medium Stiff	0.50 to 1.0	4 to 8	Can be penetrated several inches by thumb.
Stiff	1.0 to 2.0	8 to 15	Readily indented by thumb.
Very Stiff	2.0 to 4.0	15 to 30	Readily indented by thumbnail.
Hard	More than 4.0	Over 30	Indented with difficulty by thumbnail.

ROCK TERMS

ROCK HARDNESS (FROM CORE SAMPLES)			ROCK BROKENESS		
Descriptive Terms	Screwdriver or Knife Effects	Hammer Effects	Descriptive Terms	Abbreviation	Spacing
Soft	Easily Gouged	Crushes when pressed with hammer	Very Broken	(V. Br.)	0-2"
Medium Soft	Can be Gouged	Breaks (one blow); crumbly edges	Broken	(Br.)	2"-1'
Medium Hard	Can be scratched	Breaks (one blow); sharp edges	Blocky	(Bl.)	1'-3"
Hard	Cannot be scratched	Breaks conchoidally (several blows); sharp edges	Massive	(M.)	3'-10'

LEGEND:

SOIL SAMPLES - TYPES

5-2" Split-Barrel Sample

ST-3" O.D. Undisturbed Sample
O - Other Samples, Specify in Remarks

ROCK SAMPLES - TYPES

X-NX (Conventional) Core (~2-1/8" O.D.)

Q-NQ (Wireline) Core (~1-7/8" O.D.)
Z - Other Core Sizes, Specify in Remarks

WATER LEVELS

12/18
▽ 12.6'\Initial Level w/Date & Depth

12/18

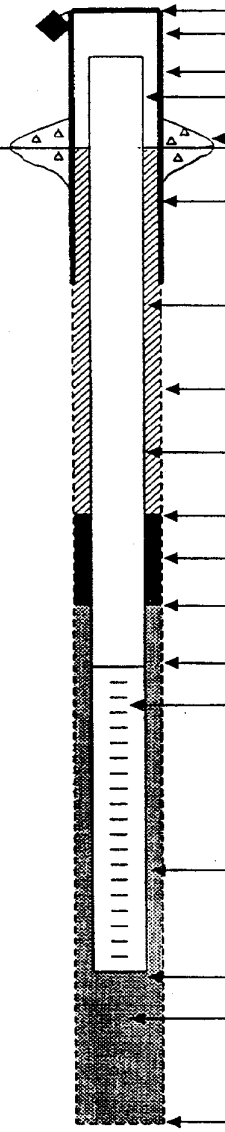
ATTACHMENT C-5
EXAMPLE OVERBURDEN MONITORING WELL SHEET

BORING NO.: _____

OVERBURDEN
MONITORING WELL SHEET

PROJECT _____ LOCATION _____
PROJECT NO. _____ BORING _____
ELEVATION _____ DATE _____
FIELD GEOLOGIST _____

DRILLER _____
DRILLING METHOD _____
DEVELOPMENT METHOD _____



ELEVATION OF TOP OF SURFACE CASING : _____
ELEVATION OF TOP OF RISER PIPE: _____

STICK - UP TOP OF SURFACE CASING: _____
STICK - UP RISER PIPE : _____

TYPE OF SURFACE SEAL: _____

I.D. OF SURFACE CASING: _____
TYPE OF SURFACE CASING: _____

RISER PIPE I.D. _____
TYPE OF RISER PIPE: _____

BOREHOLE DIAMETER: _____

TYPE OF BACKFILL: _____

ELEVATION / DEPTH TOP OF SEAL: _____ / _____

TYPE OF SEAL: _____

DEPTH TOP OF SAND PACK: _____

ELEVATION / DEPTH TOP OF SCREEN: _____ / _____

TYPE OF SCREEN: _____

SLOT SIZE x LENGTH: _____

I.D. OF SCREEN: _____

TYPE OF SAND PACK: _____

ELEVATION / DEPTH BOTTOM OF SCREEN: _____ / _____

ELEVATION / DEPTH BOTTOM OF SAND PACK: _____ / _____

TYPE OF BACKFILL BELOW OBSERVATION WELL: _____

ELEVATION / DEPTH OF HOLE: _____ / _____

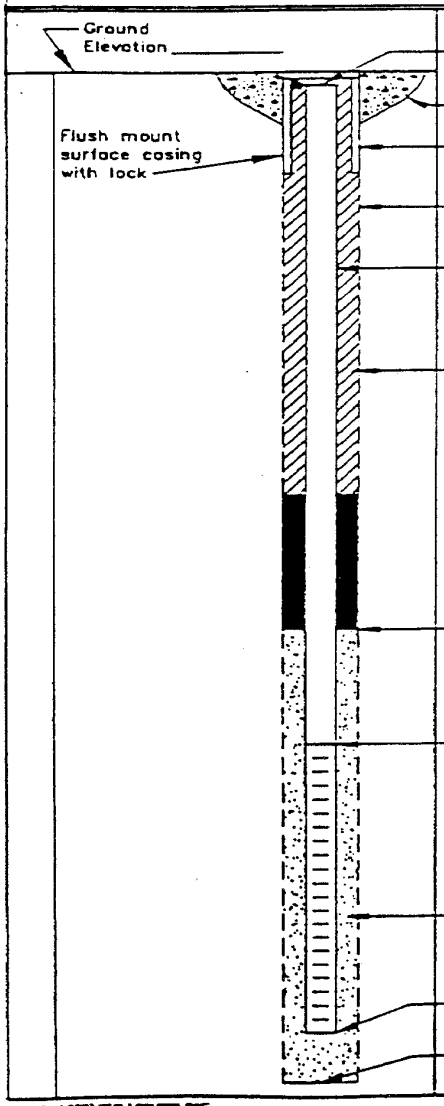
ATTACHMENT C-5A
EXAMPLE OVERBURDEN MONITORING WELL SHEET (FLUSHMOUNT)

BORING NO.: _____

MONITORING WELL SHEET

PROJECT _____ LOCATION _____
PROJECT NO. _____ BORING _____
ELEVATION _____ DATE _____
FIELD GEOLOGIST _____

DRILLER _____
DRILLING METHOD _____
DEVELOPMENT METHOD _____



ELEVATION TOP OF RISER: _____

TYPE OF SURFACE SEAL: _____

TYPE OF PROTECTIVE CASING: _____
I.D. OF PROTECTIVE CASING: _____

DIAMETER OF HOLE: _____

TYPE OF RISER PIPE: _____
RISER PIPE I.D.: _____

TYPE OF BACKFILL/SEAL: _____
_____

DEPTH/ELEVATION TOP OF SAND: _____/_____

DEPTH/ELEVATION TOP OF SCREEN: _____/_____
TYPE OF SCREEN: _____
SLOT SIZE x LENGTH: _____

TYPE OF SAND PACK: _____

DIAMETER OF HOLE IN BEDROCK: _____

DEPTH/ELEVATION BOTTOM OF SCREEN: _____/_____
DEPTH/ELEVATION BOTTOM OF SAND: _____/_____
DEPTH/ELEVATION BOTTOM OF HOLE: _____/_____
BACKFILL MATERIAL BELOW SAND: _____

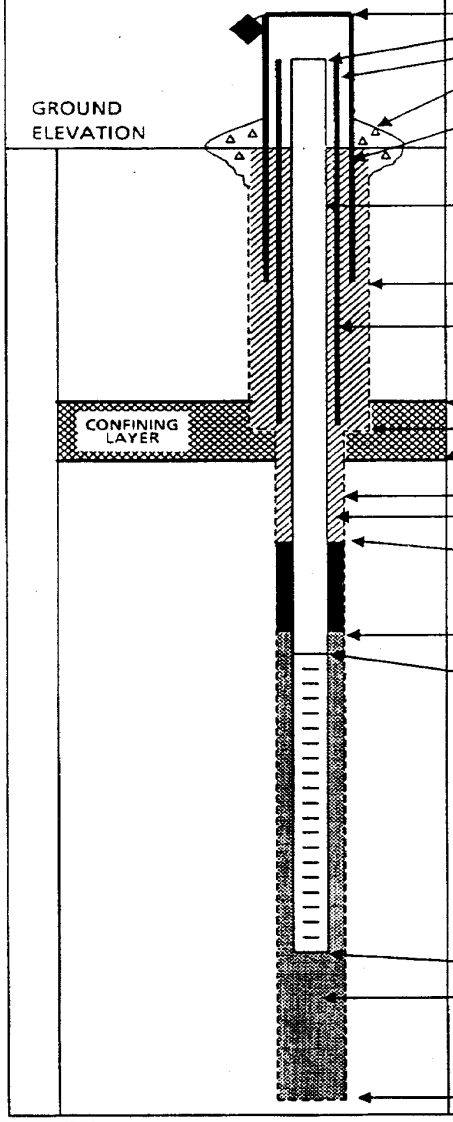
ATTACHMENT C-6
EXAMPLE CONFINING LAYER MONITORING WELL SHEET

BORING NO.: _____

CONFINING LAYER
MONITORING WELL SHEET

PROJECT _____ LOCATION _____
PROJECT NO. _____ BORING _____
ELEVATION _____ DATE _____
FIELD GEOLOGIST _____

DRILLER _____
DRILLING METHOD _____
DEVELOPMENT METHOD _____



ELEVATION OF TOP OF SURFACE CASING : _____
ELEVATION OF TOP OF RISER PIPE: _____
ELEVATION TOP OF PERM. CASING: _____
TYPE OF SURFACE SEAL: _____

I.D. OF SURFACE CASING: _____
TYPE OF SURFACE CASING: _____

RISER PIPE I.D. _____
TYPE OF RISER PIPE: _____

BOREHOLE DIAMETER: _____

PERM. CASING I.D. _____
TYPE OF CASING & BACKFILL: _____

ELEVATION / DEPTH TOP CONFINING LAYER: _____
ELEVATION / DEPTH BOTTOM OF CASING: _____
ELEVATION / DEPTH BOT. CONFINING LAYER: _____

BOREHOLE DIA. BELOW CASING: _____
TYPE OF BACKFILL: _____

ELEVATION / DEPTH TOP OF SEAL: _____
TYPE OF SEAL: _____

DEPTH TOP OF SAND PACK: _____

ELEVATION/DEPTH TOP OF SCREEN: _____
TYPE OF SCREEN: _____

TYPE OF SAND PACK: _____

ELEVATION / DEPTH BOTTOM OF SCREEN: _____

ELEVATION / DEPTH BOTTOM OF SAND PACK: _____
TYPE OF BACKFILL BELOW OBSERVATION WELL: _____

ELEVATION / DEPTH OF HOLE: _____

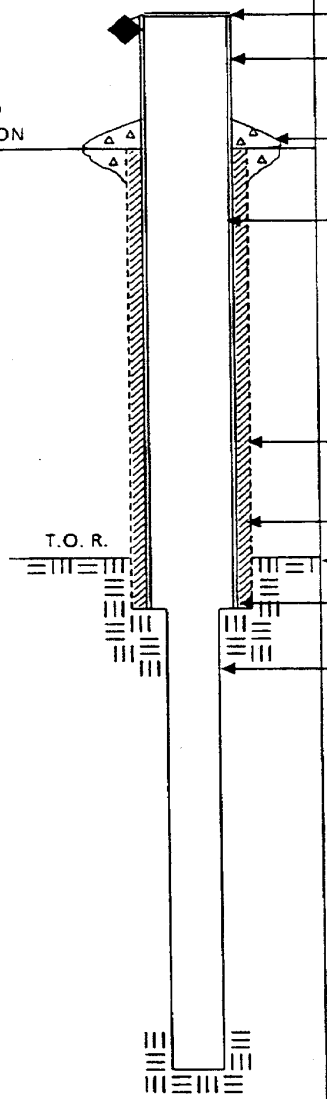
ATTACHMENT C-7
EXAMPLE BEDROCK MONITORING WELL SHEET - OPEN HOLE WELL

BORING NO.: _____

BEDROCK
MONITORING WELL SHEET
OPEN HOLE WELL

PROJECT _____ LOCATION _____
PROJECT NO. _____ BORING _____
ELEVATION _____ DATE _____
FIELD GEOLOGIST _____

DRILLER _____
DRILLING METHOD _____
DEVELOPMENT METHOD _____



ELEVATION OF TOP OF CASING: _____

STICK UP OF CASING ABOVE GROUND SURFACE: _____

TYPE OF SURFACE SEAL: _____

I.D. OF CASING: _____
TYPE OF CASING: _____

TEMP. / PERM.: _____

DIAMETER OF HOLE: _____

TYPE OF CASING SEAL: _____

DEPTH TO TOP OF ROCK: _____

DEPTH TO BOTTOM CASING: _____

DIAMETER OF HOLE IN BEDROCK: _____

DESCRIBE IF CORE / REAMED WITH BIT:

_____

DESCRIBE JOINTS IN BEDROCK AND DEPTH:

_____

ELEVATION / DEPTH OF HOLE: _____ / _____

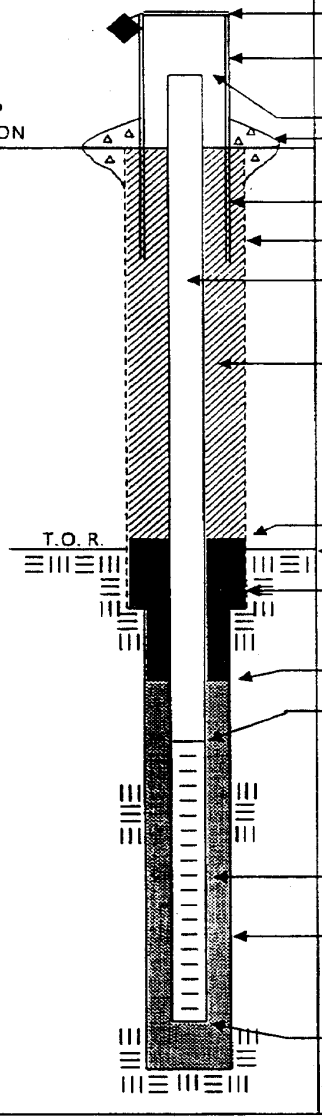
ATTACHMENT C-8
EXAMPLE BEDROCK MONITORING WELL SHEET - WELL INSTALLED IN BEDROCK

BORING NO.: _____

BEDROCK
MONITORING WELL SHEET
WELL INSTALLED IN BEDROCK

PROJECT _____ LOCATION _____
PROJECT NO. _____ BORING _____
ELEVATION _____ DATE _____
FIELD GEOLOGIST _____

DRILLER _____
DRILLING METHOD _____
DEVELOPMENT METHOD _____



ELEVATION OF TOP OF SURFACE CASING: _____

STICK UP OF CASING ABOVE GROUND SURFACE: _____

ELEVATION TOP OF RISER: _____

TYPE OF SURFACE SEAL: _____

I.D. OF SURFACE CASING: _____

DIAMETER OF HOLE: _____

RISER PIPE I.D.: _____

TYPE OF RISER PIPE: _____

TYPE OF BACKFILL: _____

ELEVATION / DEPTH TOP OF SEAL: _____ / _____

ELEVATION / DEPTH TOP OF BEDROCK: _____ / _____

TYPE OF SEAL: _____

ELEVATION / DEPTH TOP OF SAND: _____ / _____

ELEVATION / DEPTH TOP OF SCREEN: _____ / _____

TYPE OF SCREEN: _____

SLOT SIZE x LENGTH: _____

I.D. SCREEN: _____

TYPE OF SAND PACK: _____

DIAMETER OF HOLE IN BEDROCK:

CORE / REAM: _____

ELEVATION / DEPTH BOTTOM SCREEN: _____ / _____

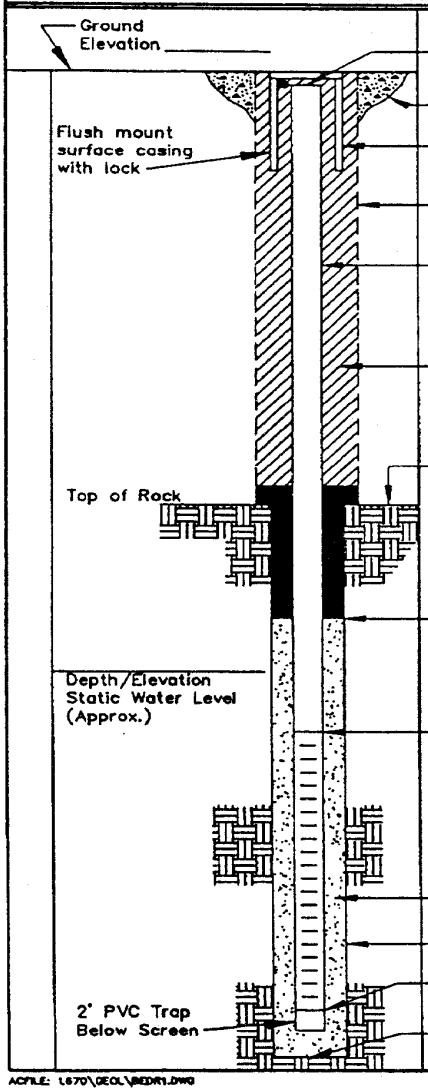
ELEVATION / DEPTH BOTTOM OF HOLE: _____ / _____

ATTACHMENT C-9
EXAMPLE BEDROCK MONITORING WELL SHEET
WELL INSTALLED IN BEDROCK (FLUSHMOUNT)

BORING NO.: _____

BEDROCK
MONITORING WELL SHEET
WELL INSTALLED IN BEDROCK

PROJECT: _____ LOCATION: _____ DRILLER: _____
PROJECT NO.: _____ BORING: _____ DRILLING METHOD: _____
ELEVATION: _____ DATE: _____ DEVELOPMENT METHOD: _____
FIELD GEOLOGIST: _____



ELEVATION TOP OF RISER: _____
TYPE OF SURFACE SEAL: _____
TYPE OF PROTECTIVE CASING: _____
I.D. OF PROTECTIVE CASING: _____
DIAMETER OF HOLE: _____
TYPE OF RISER PIPE: _____
RISER PIPE I.D.: _____
TYPE OF BACKFILL/SEAL: _____
_____
DEPTH/ELEVATION TOP OF BEDROCK: _____ / _____
DEPTH/ELEVATION TOP OF SAND: _____ / _____
DEPTH/ELEVATION TOP OF SCREEN: _____ / _____
TYPE OF SCREEN: _____
SLOT SIZE x LENGTH: _____
TYPE OF SAND PACK: _____
DIAMETER OF HOLE IN BEDROCK: _____
DEPTH/ELEVATION BOTTOM OF SCREEN: _____ / _____
DEPTH/ELEVATION BOTTOM OF SAND: _____ / _____
DEPTH/ELEVATION BOTTOM OF HOLE: _____ / _____
BACKFILL MATERIAL BELOW SAND: _____

ACFILE: L670\GEOL\BEDR1.DWG

ATTACHMENT C-10
EXAMPLE TEST PIT LOG

TEST PIT LOG

Tetra Tech NUS, Inc.

PROJECT: _____ TEST PIT NO.:

PROJECT NO _____ DATE: _____

LOCATION: _____

FIELD GEOLOGIST: _____

DEPTH (ft.)	LITHOLOGY CHANGE (Depth,ft.)	MATERIAL DESCRIPTION (Soil Density / Consistency, Color)	USCS	REMARKS

Test Pit Cross Section and / or Plan View

REMARKS _____

PHOTO LOG _____ TEST PIT _____

PAGE ____ OF ____

ATTACHMENT C-11
EXAMPLE CERTIFICATE OF CONFORMANCE

MONITORING WELL MATERIALS CERTIFICATE OF CONFORMANCE

Well Designation: _____ Site Geologist: _____

Site Name: _____ Drilling Company: _____

Date Installed: _____ Driller: _____

Project Name: _____ Project Number: _____

Material	Brand/Description	Source/Supplier	Sample Collected ?
Well Casing			
Well Screen			
End Cap			
Drilling Fluid			
Drilling Fluid Additives			
Backfill Material			
Annular Filter Pack			
Bentonite Seal			
Annular Grout			
Surface Cement			
Protective Casing			
Paint			
Rod Lubricant			
Compressor Oil			

To the best of my knowledge, I certify that the above described materials were used during installation of this monitoring well.

Signature of Site Geologist: _____

ATTACHMENT C-12
EXAMPLE MONITORING WELL DEVELOPMENT RECORD

Tetra Tech NUS, Inc.

MONITORING WELL DEVELOPMENT RECORD

Page ___ of ___

Site: _____ Depth to Bottom (ft.): _____ Project Name: _____
Well: _____ Static Water Level Before (ft.): _____ Project Number: _____
Date Installed: _____ Static Water Level After (ft.): _____ Site Geologist: _____
Date Developed: _____ Screen Length (ft.): _____ Drilling Co.: _____
Dev. Method: _____ Specific Capacity: _____
Pump Type: _____ Casing ID (in.): _____

Time	Estimated Sediment Thickness (Ft.)	Cumulative Water Volume (Gal.)	Water Level Readings (Ft. below TOC)	Temperature (Degrees C)	pH	Specific Conductance (Units ____)	Turbidity (NTU)	Remarks (odor, color, etc.)

ATTACHMENT D
EXAMPLE EQUIPMENT CALIBRATION LOG

Tetra Tech NUS, Inc.

EQUIPMENT CALIBRATION LOG

PROJECT NAME : _____ INSTRUMENT NAME/MODEL: _____

SITE NAME: _____ MANUFACTURER: _____

PROJECT No.: _____ SERIAL NUMBER: _____

Date of Calibration	Instrument I.D. Number	Person Performing Calibration	Instrument Settings		Instrument Readings		Calibration Standard (Lot No.)	Remarks and Comments
			Pre-calibration	Post-calibration	Pre-calibration	Post-calibration		

ATTACHMENT E

Tetra Tech NUS, Inc.

DAILY ACTIVITIES RECORD

PROJECT NAME: _____ **PROJECT NUMBER:** _____

CLIENT: _____ **LOCATION:** _____

DATE: _____ **ARRIVAL TIME:** _____

Tt NUS PERSONNEL: _____ **DEPARTURE TIME:** _____

CONTRACTOR: _____ **DRILLER:** _____

ITEM	QUANTITY ESTIMATE	QUANTITY TODAY	PREVIOUS TOTAL QUANTITY	CUMULATIVE QUANTITY TO DATE

COMMENTS: _____

APPROVED BY:

_____ _____

Tt NUS REPRESENTATIVE DRILLER

DATE: _____

ATTACHMENT F
FIELD TRIP SUMMARY REPORT
PAGE 1 OF 2

SUNDAY

Date: _____ Personnel: _____
Weather: _____ Onsite: _____

Site Activities: _____
_____
_____
_____

MONDAY

Date: _____ Personnel: _____
Weather: _____ Onsite: _____

Site Activities: _____
_____
_____
_____

TUESDAY

Date: _____ Personnel: _____
Weather: _____ Onsite: _____

Site Activities: _____
_____
_____
_____

WEDNESDAY

Date: _____ Personnel: _____
Weather: _____ Onsite: _____

Site Activities: _____
_____
_____
_____

ATTACHMENT F
PAGE 2 OF 2
FIELD TRIP SUMMARY REPORT

THURSDAY

Date: _____ Personnel: _____

Weather: _____ Onsite: _____

Site Activities: _____

_____

_____

_____

FRIDAY

Date: _____ Personnel: _____

Weather: _____ Onsite: _____

Site Activities: _____

_____

_____

_____

SATURDAY

Date: _____ Personnel: _____

Weather: _____ Onsite: _____

Site Activities: _____

_____

_____

_____

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1.0 PURPOSE

Decontamination is the process of removing and/or neutralizing site contaminants that have contacted and/or accumulated on equipment. The objective/purpose of this SOP is intended to protect site personnel, general public, and the sample integrity through the prevention of cross contamination onto unaffected persons or areas. It is further intended through this procedure to provide guidelines regarding the appropriate procedures to be followed when decontaminating drilling equipment, monitoring well materials, chemical sampling equipment and field analytical equipment.

2.0 SCOPE

This procedure applies to all equipment including drilling equipment, heavy equipment, monitoring well materials, as well as chemical sampling and field analytical equipment decontamination that may be used to provide access/acquire environmental samples. Where technologically and economically feasible, single use sealed disposable equipment will be employed to minimize the potential for cross contamination. This procedure also provides general reference information on the control of contaminated materials.

3.0 GLOSSARY

Acid - For decontamination of equipment when sampling for trace levels of inorganics, a 10% solution of nitric acid in deionized water should be used. Due to the leaching ability of nitric acid, it should not be used on stainless steel.

Alconox/Liquinox - A brand of phosphate-free laboratory-grade detergent.

Decontamination Solution - Is a solution selected/identified within the Health and Safety Plan or Project-Specific Quality Assurance Plan. The solution is selected and employed as directed by the project chemist/health and safety professional.

Deionized Water (DI) - Deionized water is tap water that has been treated by passing through a standard deionizing resin column. This water may also pass through additional filtering media to attain various levels of analyte-free status. The DI water should meet CAP and NCCLS specifications for reagent grade, Type I water.

Potable Water - Tap water used from any municipal water treatment system. Use of an untreated potable water supply is not an acceptable substitute for tap water.

Pressure Washing - Employs high pressure pumps and nozzle configuration to create a high pressure spray of potable water. High pressure spray is employed to remove solids.

Solvent - The solvent of choice is pesticide-grade Isopropanol. Use of other solvents (methanol, acetone, pesticide-grade hexane, or petroleum ether) may be required for particular projects or for a particular purpose (e.g. for the removal of concentrated waste) and must be justified in the project planning documents. As an example, it may be necessary to use hexane when analyzing for trace levels of pesticides, PCBs, or fuels. In addition, because many of these solvents are not miscible in water, the equipment should be air dried prior to use. Solvents should not be used on PVC equipment or well construction materials.

Steam Pressure Washing - This method employs a high pressure spray of heated potable water. This method through the application of heat provides for the removal of various organic/inorganic compounds.

4.0 RESPONSIBILITIES

Project Manager - Responsible for ensuring that all field activities are conducted in accordance with approved project plan(s) requirements.

Field Operations Leader (FOL) - Responsible for the onsite verification that all field activities are performed in compliance with approved Standards Operating Procedures or as otherwise dictated by the approved project plan(s).

Site Health and Safety Officer (SHSO) - The SHSO exercises shared responsibility with the FOL concerning decontamination effectiveness. All equipment arriving on-site (as part of the equipment inspection), leaving the site, moving between locations are required to go through a decontamination evaluation. This is accomplished through visual examination and/or instrument screening to determine the effectiveness of the decontamination process. Failure to meet these objectives are sufficient to restrict equipment from entering the site/exiting the site/ or moving to a new location on the site until the objectives are successfully completed.

5.0 PROCEDURES

The process of decontamination is accomplished through the removal of contaminants, neutralization of contaminants, or the isolation of contaminants. In order to accomplish this activity a level of preparation is required. This includes site preparation, equipment selection, and evaluation of the process. Site contaminant types, concentrations, media types, are primary drivers in the selection of the types of decontamination as well as where it will be conducted. For purposes of this SOP discussion will be provided concerning general environmental investigation procedures.

The decontamination processes are typically employed at:

- Temporary Decontamination Pads/Facilities
- Sample Locations
- Centralized Decontamination Pad/Facilities
- Combination of some or all of the above

The following discussion represents recommended site preparation in support of the decontamination process.

5.1 Decontamination Design/Constructions Considerations

5.1.1 Temporary Decontamination Pads

Temporary decontamination pads are constructed at satellite locations in support of temporary work sites. These structures are generally constructed to support the decontamination of heavy equipment such as drill rigs and earth moving equipment but can be employed for smaller articles.

The purpose of the decontamination pad is to contain wash waters and potentially contaminated soils generated during decontamination procedures. Therefore, construction of these pads should take into account the following considerations

- Site Location – The site selected should be within a reasonable distance from the work site but should avoid:

  - Pedestrian/Vehicle thoroughfares
  - Areas where control/custody cannot be maintained
  - Areas where a potential releases may be compounded through access to storm water transport systems, streams or other potentially sensitive areas.
  - Areas potentially contaminated.

- Pad – The pad should be constructed to provide the following characteristics

  - Size – The size of the pad should be sufficient to accept the equipment to be decontaminated as well as permitting free movement around the equipment by the personnel conducting the decontamination.

  - Slope – An adequate slope will be constructed to permit the collection of the water and potentially contaminated soils within a trough or sump constructed at one end. The collection point for wash waters should be of adequate distance that the decontamination workers do not have to walk through the wash waters while completing their tasks.

  - Sidewalls – The sidewalls should be a minimum of 6-inches in height to provide adequate containment for wash waters and soils. If splash represents a potential problem, splash guards should be constructed to control overspray. Sidewalls maybe constructed of wood, inflatables, sand bags, etc. to permit containment.

  - Liner – Depending on the types of equipment and the decontamination method the liner should be of sufficient thickness to provide a puncture resistant barrier between the decontamination operation and the unprotected environment. Care should be taken to examine the surface area prior to placing the liner to remove sharp articles (sticks, stones, debris) that could puncture the liner. Liners are intended to form an impermeable barrier. The thickness may vary from a minimum recommended thickness of 10 mil to 30 mil. Achieving the desired thickness maybe achieved through layering lighter constructed materials. It should be noted that various materials (rubber, polyethylene sheeting) become slippery when wet. To minimize this potential hazard associated with a sloped liner a light coating of sand maybe applied to provide traction as necessary.

  - Wash/drying Racks – Auger flights, drill/drive rods require racks positioned off of the ground to permit these articles to be washed, drained, and dried while secured from falling during this process. A minimum ground clearance of 2-feet is recommended.

  - Maintenance – The work area should be periodically cleared of standing water, soils, and debris. This action will aid in eliminating slip, trip, and fall hazards. In addition, these articles will reduce potential backsplash and cross contamination. Hoses should be gathered when not in use to eliminate potential tripping hazards.

5.1.2 Decontamination Activities at Drill Rigs/DPT Units

During subsurface sampling activities including drilling and direct push activities decontamination of drive rods, Macro Core Samplers, split spoons, etc. are typically conducted at an area adjacent to the operation. Decontamination is generally accomplished using a soap/water wash and rinse utilizing buckets and brushes. This area requires sufficient preparation to accomplish the decontamination objectives.

Buckets shall be placed within mortar tubs or similar secondary containment tubs to prevent splash and spills from reaching unprotected media. Drying racks will be employed as directed for temporary pads to permit parts to dry and be evaluated prior to use/re-use.

5.1.3 Decontamination Activities at Remote Sample Locations

When sampling at remote locations sampling devices such as trowels, pumps/tubing should be evacuated of potentially contaminated media to the extent possible. This equipment should be wrapped in plastic for transport to the temporary/centralized decontamination location for final cleaning and disposition.

5.2 Equipment Decontamination Procedures

The following represents procedures to be employed for the decontamination of equipment that may have contacted and/or accumulated contamination through site investigation activities.

5.2.1 Monitoring Well Sampling Equipment

5.2.1.1 Groundwater sampling pumps – This includes pumps inserted into the monitoring well such as Bladder pumps, Whale pumps, Redi-Flo, reusable bailers, etc.

1) Evacuate to the extent possible, any purge water within the pump.

2) Scrub using soap and water and/or steam clean the outside of the pump and tubing, where applicable.

3) Insert the pump and tubing into a clean container of soapy water. Pump a sufficient amount of soapy water through the pump to flush any residual purge water. Once flushed, circulate soapy water through the pump to ensure the internal components are thoroughly flushed.

4) Remove the pump and tubing from the container, rinse external components using tap water. Insert the pump and tubing into a clean container of tap water. Pump a sufficient amount of tap water through the pump to evacuate all of the soapy water (until clear).

5) Rinse equipment with pesticide grade isopropanol

6) Repeat item #4 using deionized water through the hose to flush out the tap water and solvent residue as applicable*.

7) Drain residual deionized water to the extent possible, allow components to air dry.

8) Wrap pump in aluminum foil or a clear clean plastic bag for storage.

5.2.1.2 Electronic Water Level Indicators/Sounders/Tapes

During water level measurements, rinsing with the extracted tape and probe with deionized water and wiping the surface of the extracted tape is acceptable. However, periodic full decontamination should be conducted as indicated below.

---

* - The solvent should be employed when samples contain oil, grease, PAHs, PCBs, and other hard to remove materials. If these are not of primary concern, the solvent step may be omitted. In addition, do not rinse PE, PVC, and associated tubing with solvents.

1) Wash with soap and water
2) Rinse with tap water
3) Rinse with deionized water

Note: In situations where oil, grease, free product, other hard to remove materials are encountered probes and exposed tapes should be washed in hot soapy water.

5.2.1.3 Miscellaneous Equipment

Miscellaneous equipment including analytical equipment (water quality testing equipment) should be cleaned per manufacturer's instructions. This generally includes wiping down the sensor housing and rinsing with tap and deionized water.

Coolers/Shipping Containers employed to ship samples are received from the lab in a variety of conditions from marginal to extremely poor. Coolers should be evaluated prior to use for

- Structural integrity – Coolers missing handles or having breaks within the outer housing should be removed and not used. Notify the laboratory that the risk of shipping samples will not be attempted and request a replacement unit.

- Cleanliness – As per protocol only volatile organic samples are accompanied by a trip blank. If a cooler's cleanliness is in question (visibly dirty/stained) or associated with noticeable odors it should be decontaminated prior to use.

  1) Wash with soap and water
  2) Rinse with tap water
  3) Dry

If these measures fail to clean the cooler to an acceptable level, remove the unit from use as a shipping container and notify the laboratory to provide a replacement unit.

5.2.2 Down-Hole Drilling Equipment

This includes any portion of the drill rig that is over the borehole including auger flights, drill stems, rods, and associated tooling that would extend over the borehole. This procedure is to be employed prior to initiating the drilling/sampling activity, then between locations.

1) Remove all soils to the extent possible using shovels, scrapers, etc. to remove loose soils.
2) Through a combination of scrubbing using soap and water and/or steam cleaning remove visible dirt/soils.
3) Rinse with tap water.
4) Rinse equipment with pesticide grade isopropanol
5) To the extent possible allow components to air dry.
6) Wrap or cover equipment in clear plastic until it is time to be used.

5.2.3 Soil/Sediment Sampling Equipment

This consists of soil sampling equipment including but not limited to hand augers, stainless steel trowels/spoons, bowls, dredges, scoops, split spoons, Macro Core samplers, etc.

1) Remove all soils to the extent possible.

2) Through a combination of scrubbing using soap and water and/or steam cleaning remove visible dirt/soils.

3) Rinse with tap water.

4) Rinse equipment with pesticide grade isopropanol

5) Rinse with deionized water

6) To the extent possible allow components to air dry.

7) If the device is to be used immediately, screen with a PID/FID to insure all solvents (if they were used) and trace contaminants have been adequately removed.

8) Once these devices have been dried wrap in aluminum foil for storage until it is time to be used.

5.3 Contact Waste/Materials

During the course of field investigations disposable/single use equipment becomes contaminated. These items include tubing, trowels, PPE (gloves, overboots, splash suits, etc.) broken sample containers.

With the exception of the broken glass, single use articles should be cleaned (washed and rinsed) of visible materials and disposed of as normal refuse. The exception to this rule is that extremely soiled materials that cannot be cleaned should be containerized for disposal in accordance with applicable federal state and local regulations.

5.3.1 Decontamination Solutions

All waste decontamination solutions and rinses must be assumed to contain the hazardous chemicals associated with the site unless there are analytical or other data to the contrary. The waste solution volumes could vary from a few gallons to several hundred gallons in cases where large equipment required cleaning.

Containerized waste rinse solutions are best stored in 55-gallon drums (or equivalent containers) that can be sealed until ultimate disposal at an approved facility. These containers must be appropriately labeled.

5.4 Decontamination Evaluation

Determining the effectiveness of the decontamination process will be accomplished in the following manner

- Visual Evaluation – A visual evaluation will be conducted to insure the removal of particulate matter. This will be done to insure that the washing/rinsing process is working as intended.

- Instrument Screening – A PID and/or an FID should be used to evaluate the presence of the contaminants or solvents used in the cleaning process. The air intake of the instrument should be passed over the article to be evaluated. A positive detection requires a repeat the decontamination process. It should be noted that the instrument scan is only viable if the contaminants are detectable within the instruments capabilities.

- Rinsate Blanks – It is recommended that Rinsate samples be collected to

  - Evaluate the decontamination procedure representing different equipment applications (pumps versus drilling equipment) and different decontamination applications.

  - Single use disposable equipment – The number of samples should represent different types of equipment as well as different Lot Numbers of single use articles.

The collection and the frequency of collection of rinsate samples are as follows:

- Per decontamination method
- Per disposable article/Batch number of disposable articles

It is recommended that an initial rinsate sample be collected early in the project to ensure that the decontamination process is functioning properly and in an effort to avoid using a contaminated batch of single use articles. It is recommended that a follow up sample be collected during the execution of the project to insure those conditions do not change. Lastly, rinsate samples collection may be driven by types of and/or contaminant levels. Hard to remove contaminants, oils/greases, some PAHs/PCBs, etc. may also support the collection of additional rinsates due to the obvious challenges to the decontamination process. This is a field consideration to be determined by the FOL.

FS 1000. GENERAL SAMPLING PROCEDURES

See also the following Standard Operating Procedures:

- FA 1000 and 2000 Administrative Procedures
- FC 1000 Cleaning/Decontamination Procedures
- FD 1000-9000 Documentation Procedures
- FM 1000 Field Planning and Mobilization
- FQ 1000 Field Quality Control Requirements

FS 1001. *Preliminary Activities*

1. Begin each sampling trip with some planning and coordination. Refer to FM 1000 for recommendations and suggestions on laboratory selection and communication, and field mobilization.

   1.1. DEP recommends that a minimum of two people be assigned to a field team. In addition to safety concerns, the process of collecting the samples, labeling the containers and completing the field records is much easier if more than one person is present.

   1.2. If responding to incidents involving hazardous substances, DEP recommends that four or five people be assigned to the team.

2. EQUIPMENT

   2.1. Select appropriate equipment based on the sampling source (see FS 2000 to FS 8200), the analytes of interest and the sampling procedure.

      2.1.1. If properly cleaned, sample containers may be used as collection devices or intermediate containers.

   2.2. The equipment construction must be consistent with the analytes or analyte groups to be collected (see Tables FS 1000-1 and FS 1000-2).

   2.3. Bring precleaned equipment to the field or use equipment that has been certified clean by the vendor or laboratory.

3. DEDICATED EQUIPMENT STORAGE

   3.1. Store all dedicated equipment (except dedicated pump systems or dedicated drop pipes) in a controlled environment.

   3.2. If possible, store equipment in an area that is located away from the sampling site. If equipment other than dedicated pumps or dedicated drop pipes is stored in monitoring wells, suspend the equipment above the formation water.

   3.3. Securely seal the monitoring well in order to prevent tampering between sampling events.

   3.4. Decontaminate all equipment (except dedicated pumps or drop pipes) before use according to the applicable procedures in FC 1000.

4. SAMPLE CONTAINERS

   4.1. The analyses to be performed on the sample determine the construction of sample containers.

4.2. Inspect all containers and lids for flaws (cracks, chips, etc.) before use. Do not use any container with visible defects or discoloration.

FS 1002. *Contamination Prevention and Sample Collection Order*

1. CONTAMINATION PREVENTION

1.1. Take special effort to prevent cross contamination and contamination of the environment when collecting samples. Protect equipment, sample containers and supplies from accidental contamination.

1.1.1. Do not insert pump tubing, measurement probes, other implements, fingers, etc. into sample containers or into samples that have been collected for laboratory analysis.

1.1.1.1. If it is necessary to insert an item into the container or sample, ensure that the item is adequately decontaminated for the analytes of interest to be analyzed in the sample.

1.1.2. If possible, collect samples from the least contaminated sampling location (or background sampling location) to the most contaminated sampling location.

1.1.2.1. Collect the ambient or background samples first and store them in separate ice chests or shipping containers.

1.1.3. Collect samples in flowing water from downstream to upstream.

1.1.4. Do not store or ship highly contaminated samples (concentrated wastes, free product, etc.) or samples suspected of containing high concentrations of contaminants in the same ice chest or shipping container with other environmental samples.

1.1.4.1. Isolate these sample containers by sealing them in separate, untreated plastic bags immediately after collecting, preserving, labeling, etc.

1.1.4.2. Use a clean, untreated plastic bag to line the ice chest or shipping container.

2. SAMPLE COLLECTION ORDER

2.1. Sampling order is a recommendation to be modified depending on site circumstances. Unless field conditions justify other sampling regimens, collect samples in the following order:

- Volatile Organics and Volatile Inorganics
- Extractable Organics, Petroleum Hydrocarbons, Aggregate Organics and Oil & Grease
- Total Metals
- Dissolved Metals
- Inorganic Nonmetallics, Physical and Aggregate Properties, and Biologicals
- Radionuclides
- Microbiological

Note: If the pump used to collect groundwater samples cannot be used to collect volatile or extractable organics, then collect all other parameters, withdraw the pump and tubing, and collect the volatile and extractable organics.

3. COMPOSITE SAMPLES

3.1. Do not collect composite samples unless required by permit or DEP program.

3.2. If compositing is required, use the following procedure:

3.2.1. Select sampling points from which to collect each aliquot.

3.2.2. Using the appropriate sampling technique, collect equal aliquots (same sample size) from each location and place in a properly cleaned container.

3.2.3. Record the approximate amount of each aliquot (volume or weight).

3.2.4. Add preservative(s), if required.

3.2.5. Label container and make appropriate field notes (see FD 1000-9000).

3.2.6. Notify the laboratory that the sample is a composite sample.

3.2.7. When collecting soil or sediment samples, combine the aliquots of the sample directly in the sample container with no pre-mixing. Notify the laboratory that the sample is an unmixed composite sample, and request that the laboratory thoroughly mix the sample before sample preparation or analysis.

3.2.8. When collecting water composites see FS 2000, section 1.3 or pertinent sections of other water matrix SOPs for specific details on collection.

FS 1003. *Protective Gloves*

1. Gloves serve a dual purpose to:

- Protect the sample collector from potential exposure to sample constituents
- Minimize accidental contamination of samples by the collector

2. The DEP recommends wearing protective gloves when conducting all sampling activities. They must be worn except when:

- The sample source is considered to be non-hazardous
- The samples will not be analyzed for trace constituents
- The part of the sampling equipment that is handled without gloves does not contact the sample source

3. Do not let gloves come into contact with the sample or with the interior or lip of the sample container.

4. Use clean, new, unpowdered and disposable gloves.

4.1. DEP recommends latex gloves, however, other types of gloves may be used as long as the construction materials do not contaminate the sample or if internal safety protocols require greater protection.

4.2. Note that certain materials (as might be potentially present in concentrated effluent) may pass through certain glove types and be absorbed in the skin. Many vendor catalogs provide information about the permeability of different gloves and the circumstances under which the glove material might be applicable.

4.3. The powder in powdered gloves can contribute significant contamination and DEP does not recommend wearing powdered gloves unless it can be demonstrated that the powder does not interfere with the sample analysis.

5. If gloves are used, change:
    - After preliminary activities such as pump placement;
    - After collecting all the samples at a single sampling point; or
    - If torn, or used to handle extremely dirty or highly contaminated surfaces.
6. Properly dispose of all used gloves.

FS 1004. *Container and Equipment Rinsing*

When collecting aqueous samples, rinse the sample collection equipment with a portion of the sample water before taking the actual sample. Sample containers do not need to be rinsed. In the case of petroleum hydrocarbons, oil & grease or containers with premeasured preservatives, the sample containers cannot be rinsed.

FS 1005. *Fuel-Powered Equipment and Related Activities*

1. Place all fuel-powered equipment away from, and downwind of, any site activities (e.g., purging, sampling, decontamination). If field conditions preclude such placement (i.e., the wind is from the upstream direction in a boat), place the fuel source(s) as far away as possible from the sampling activities and describe the conditions in the field notes.

2. Handle fuel (i.e., filling vehicles and equipment) prior to the sampling day. If such activities must be performed during sampling, the personnel must wear disposable gloves. Dispense all fuels, dispose of gloves downwind, and well away from the sampling activities.

3. If sampling at active gas stations, stop sample collection activities during fuel deliveries.

FS 1006. *Preservation, Holding Times and Container Types*

1. Preserve all samples according to the requirements specified in Tables FS 1000-4 through FS 1000-10.

    1.1. The information listed in the above-referenced tables supersedes any preservation techniques, holding time or container type that might be discussed in individual analytical methods.

    1.2. If samples are collected only for total phosphorus and are not for NPDES compliance, thermal preservation (ice) is not required if the sample containers are pre-preserved with acid.

2. The preservation procedures in the referenced tables specify immediate preservation. "Immediate" is defined as "within 15 minutes of sample collection." Perform all preservation on-site (in the field).

    2.1. Preservation is not required if samples can be transported back to the laboratory within 15 minutes of collecting the sample and

        2.1.1. The laboratory begins sample analysis within the 15-minute window and documents the exact time the analysis began, or

        2.1.2. The laboratory adds the appropriate preservatives (including thermal preservation) within 15 minutes of sample collection and documents the exact time that the preservation was done.

3. PRESERVING COMPOSITE WATER SAMPLES

3.1. If the sample preservation requires thermal preservation (e.g., <6°C), the samples must be cooled to the specified temperature.

3.1.1. Manually collected samples to be composited must be refrigerated at a temperature equal to or less than the required temperature.

3.1.2. Automatic samplers must be able to maintain the required temperature by packed ice or refrigeration.

3.2. When chemical preservation is also required, begin the preservation process within 15 minutes of the last collected sample.

3.3. Holding Times for Automatic Samplers:

3.3.1. If the collection period is 24 hours or less, the holding time begins at the last scheduled sample collection;

3.3.2. If the collection period exceeds 24 hours, the holding time begins with the time that the first sample is collected.

4. pH ADJUSTED PRESERVATION - Check the pH of pH-adjusted samples according to these frequencies:

4.1. During the first sampling event at a particular site, check **all** samples (includes each groundwater monitoring well, surface water location, or influent/effluent sampling location) that are pH-adjusted except volatile organics.

4.2. During subsequent visits to a particular site, check at least one sample per parameter group that must be pH-adjusted.

4.3. If the frequency of sample collection at a specified location is greater than once per month (i.e., weekly or daily), check the pH of at least one sample per parameter group (except volatile organics) according to the following schedule:

4.3.1. Weekly sampling: 1 pH check per month

4.3.2. Daily sampling: 1 pH check per week

4.4. If the frequency of sample collection at a specified location is once per month, check the pH of at least one sample per parameter group (except volatile organics) quarterly.

4.5. If site conditions vary from sampling event to sampling event, perform pH checks at increased intervals.

5. THERMAL PRESERVATION

5.1. When preservation requirements indicate cooling to a specific temperature, samples must be placed in wet ice within 15 minutes of sample collection (see 1006, section 2 above). Unless specified, do not freeze samples.

5.2. All supplies (ice, dry ice, etc.) necessary to meet a thermal preservation requirement must be onsite for immediate use.

5.3. Ship samples in wet ice. If samples are cooled to the required temperature before shipment, samples may be shipped with frozen ice packs if the specified temperature is maintained during shipment. The sample temperature must not exceed the specified temperature.

5.4. If immediate freezing is required, dry ice must be available in the field to begin the freezing process.

FS 1007. *Preventive and Routine Maintenance*

Preventive maintenance activities are necessary to ensure that the equipment can be used to obtain the expected results and to avoid unusable or broken equipment while in the field. Equipment is properly maintained when:

- It functions as expected during mobilization; and
- It is not a source of sample contamination (e.g., dust).

1. Follow the manufacturer's suggested maintenance activities and document all maintenance. At a minimum, DEP recommends the activities listed on Table FS 1000-12.

2. Maintain documentation for the following information for each piece of equipment or instrumentation. See FD 3000 also.

2.1. Designate the identity of specific instrumentation in the documentation with a unique description or code for each instrument unit employed. This identifier may include a manufacturer name, model number, serial number, inventory number or other unique identification.

2.2. Log all maintenance and repair performed for each instrument unit, including routine cleaning procedures and solution or parts replacement for instrument probes.

2.3. Include the calendar date for the procedures performed.

2.4. Record names of personnel performing the maintenance or repair tasks.

2.5. Describe any malfunctions necessitating repair or service.

2.6. Retain vendor service records for all affected instruments.

2.7. Record the following for rented equipment:

- Rental date(s)
- Equipment type and model or inventory number or other description

2.8. Retain the manufacturer’s operating and maintenance instructions.

FS 1008. *Documentation and References*

1. REFERENCES: All sampling references must be available for consultation in the field. These include:

- DEP SOPs;
- Internal SOPs;
- Sampling and analysis plans; and/or
- Quality Assurance Project Plans.

2. DOCUMENTATION: Complete and sign all documentation (see FD 1000).

FS 1009. *Sample Documentation and Evidentiary Custody*

1. SAMPLE DOCUMENTATION

1.1. Document all activities related to a sampling event, including sample collection, equipment calibration, equipment cleaning and sample transport.

1.2. The required documentation related to each sampling or other field activity is specified in the associated SOPs; i.e., FQ 1000, FC 1000, the FS series, and the FT series.

1.3. The documentation requirements are also summarized in FD 1000, Field Documentation. FD 1000 additionally contains a list of example forms published with the SOPs that may be used to document various activities or as templates for creating customized forms.

2. Legal Chain of Custody (COC)

The use of legal or evidentiary Chain-of-Custody (COC) protocols is not usually required by DEP, except for cases involving civil or criminal enforcement. Do not use these procedures for routine sampling for compliance unless evidentiary custody protocols are specifically mandated in a permit or other legal order or when required for enforcement actions.

Evidentiary sample custody protocols are used to demonstrate that the samples and/or sample containers were handled and transferred in such a manner as to eliminate possible tampering.

When a client or situation requires legal COC, use the procedures in FD 7000 to document and track all time periods associated with the physical possession and storage of sample containers, samples, and subsamples from point of origin through the final analytical result and sample disposal.

When legal or evidentiary COC is required, samples must be:

- In the actual possession of a person who is authorized to handle the samples (e.g., sample collector, laboratory technician);
- In the view of the same person after being in their physical possession;
- Secured by the same person to prevent tampering; or
- Stored in a designated secure area.

2.1. Control and document access to all evidentiary samples and subsamples with adequate tracking. Documentation must include records about each of the activities and situations listed below, when applicable to sample evidence, and must track the location and physical handling of all samples by all persons at all times.

2.1.1. Limit the number of individuals who physically handle the samples as much as practicable.

2.1.2. When storing samples and subsamples, place samples in locked storage (e.g., locked vehicle, locked storeroom, etc.) at all times when not in the possession or view of authorized personnel.

2.1.3. Alternatively, maintain restricted access to facilities where samples are stored. Ensure that unauthorized personnel are not able to gain access to the samples at any time.

2.1.4. Do not leave samples in unoccupied motel or hotel rooms or other areas where access cannot be controlled by the person(s) responsible for custody without first securing samples and shipping or storage containers with tamper-indicating evidence tape or custody seals. Ice chests or other storage containers used to store sample containers in hotel rooms may be sealed instead of sealing each sample container stored within.

2.2. Use a Chain of Custody form or other transmittal record to document sample transfers to other parties. Other records and forms may be used to document internal activities if they meet the requirements for legal chain of custody.

2.3. Legal COC begins when the precleaned sample containers are dispatched to the field.

2.3.1. The person who relinquishes the prepared sample kits or containers and the individual who receives the sample kits or containers must sign the COC form unless the same party provides the containers and collects the samples.

2.3.2. All parties handling the empty sample containers and samples are responsible for documenting sample custody, including relinquishing and receiving samples, except commercial common carriers.

2.4. Shipping Samples under Legal COC

2.4.1. Complete all relevant information on the COC transmittal form or record (see FD 7200, section 2).

2.4.2. Internal records must document the handling of the samples and shipping containers in preparation for shipment. The names of all persons who have prepared the shipment must be recorded. All time intervals associated with handling and preparation must be accounted for.

2.4.3. Place the forms in a sealed waterproof bag and place in the shipping container with the samples.

2.4.4. Seal the shipping container with tamper-proof seals (see 2.6 below) so that any tampering can be clearly seen by the individual who receives the samples.

2.4.5. Note: The common carrier does not sign COC records. However, the common carrier (when used) must be identified.

2.5. Delivering Samples to the Laboratory

2.5.1. All individuals who handle and relinquish the sample containers must sign the transmittal form. The legal custody responsibilities of the field operations end when the samples are relinquished to the laboratory.

2.6. Chain of Custody Seals: If required, affix tamper-indicating evidence tape or seals to all sample, storage and shipping container closures when transferring or shipping sample container kits or samples to another party.

2.6.1. Place the seal so that the closure cannot be opened without breaking the seal.

2.6.2. Record the time, calendar date and signatures of responsible personnel affixing and breaking all seals for each sample container and shipping container.

2.6.3. Affix new seals every time a seal is broken until continuation of evidentiary custody is no longer required.

FS 1010. *Health and Safety*

Implement all local, state and federal requirements relating the health and safety.

FS 1011. *Hazardous Wastes*

Follow all local, state and federal requirements pertaining to the storage and disposal of any hazardous or investigation-derived wastes.

1. Properly manage all investigation-derived waste (IDW) so contamination is not spread into previously uncontaminated areas.

1.1. IDW includes all water, soil, drilling mud, decontamination wastes, discarded personal protective equipment (PPE), etc. from site investigations, exploratory borings, piezometer and monitoring well installation, refurbishment, and abandonment, and other investigative activities. Containerize the IDW at the time it is generated.

1.2. Determine if the IDW must be managed as Resource Conservation and Recovery Act (RCRA) regulated hazardous waste through appropriate testing or generator knowledge. Manage all IDW that is determined to be RCRA regulated hazardous waste according to the local state and federal requirements.

1.3. Properly dispose of IDW that is not a RCRA-regulated hazardous waste but is contaminated above the Department's Soil Cleanup Target Levels or the state standards and/or minimum criteria for ground water quality.

1.4. IDW that is not contaminated or contains contaminants below the Department's Soil Cleanup Target Levels or the state standards and/or minimum criteria for ground water quality may be disposed of onsite as long as the IDW will not cause a surface water violation.

1.5. Maintain all containers holding IDW in good condition:

1.5.1. Periodically inspect the containers for damage

1.5.2. Ensure that all required labeling (DOT, RCRA, etc.) are clearly visible.

Appendix FS 1000
Tables, Figures and Forms

Table FS 1000-1 Equipment Construction Materials

Table FS 1000-2 Construction Material Selection for Equipment and Sample Containers

Table FS 1000-3 Equipment Use and Construction

Table FS 1000-4 40 CFR Part 136 Table II: Required Containers, Preservation Techniques, and Holding Times (Water/Wastewater Samples)

Table FS 1000-5 Approved Water and Wastewater Procedures, Containers, Preservation and Holding Times for Analytes not found in 40 CFR Part 136

Table FS 1000-6 Recommended Sample Containers, Sample Volumes, Preservation Techniques and Holding Times for Residuals, Soil and Sediment Samples.

Table FS 1000-7 Sample Handling, Preservation and Holding Time Table for SW 846 Method 5035

Table FS 1000-8 Preservation Methods and Holding Times for Drinking Water Samples that Differ from 40 CFR Part 136, Table II

Table FS 1000-9 Containers, Preservation and Holding Times for Biosolids Samples and Protozoans

Table FS 1000-10 Container Materials, Preservation, and Holding Times for Fish and Shellfish

Table FS 1000-11 Holding Times for SPLP or TCLP Extraction, Sample Preparation and Determinative Analysis

Table FS 1000-12 Preventive Maintenance Tasks

Figure FS 1000-1 Organic Trap Configuration for Collecting Extractable Organics with a Peristaltic Pump

Table FS 1000-1

Equipment Construction Materials

Construction Material[1]	Acceptable Analyte Groups	Precautions
Metals		
316 Stainless Steel	All analyte groups. Recommended for inorganic nonmetallics, metals, volatile and extractable organics.	Do not use if weathered, corroded or pitted.[2]
300-Series Stainless Steel (304, 303, 302)	Suitable for all analyte groups (if used, check for corrosion before use). Recommended for inorganic nonmetallics, metals, volatile and extractable organics.	Do not use if weathered, corroded or pitted.[2] If corroded, there is a potential for samples to be contaminated with iron, chromium, copper or nickel. Check for compatibility with water chemistry for dedicated applications. Do not use in low pH, high chloride, or high TDS waters.
Low Carbon Steel Galvanized Steel Carbon Steel	Inorganic nonmetallics only.	Coring devices are acceptable for all analyte groups **if** appropriate liners are used. Use Teflon liners for organics. Use plastic or Teflon liners for metals. Do not use if weathered, corroded or pitted.[2] If corroded, there is a potential for samples to be contaminated with iron and manganese. Galvanized equipment will also contaminate with zinc and cadmium. If used to collect large samples (e.g., dredges), collect organic and metal samples may be collected from portions of the interior of the collected material.
Brass	Inorganic nonmetallics only.	Do not use if weathered, corroded or pitted.[2]
Plastics[3]		
Teflon and other fluorocarbon polymers	All analyte groups. Especially recommended for trace metals and organics.	Easily scratched. Do not use if scratched or discolored.
Polypropylene Polyethylene (All Types)	All analyte groups.	Easily scratched. Do not use if scratched or discolored.
Polyvinyl chloride (PVC)	All analyte groups except extractable and volatile organics.	Do not use when collecting extractable or volatile organics samples.

Table FS 1000-1

Equipment Construction Materials

Construction Material[1]	Acceptable Analyte Groups	Precautions
Tygon, Silicone, Neoprene	All analyte groups except extractable and volatile organics.	Do not use when collecting extractable or volatile organic samples. Do not use silicone if sampling for silica.
Viton	All analyte groups except extractable and volatile organics.[4]	Minimize contact with sample. Use only if no alternative material exists.
Glass		
Glass, borosilicate	All analyte groups except silica and boron.	

Adapted from USGS Field Manual, Chapter 2, January 2000.

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[1] Refers to construction material of the portions of the sampling equipment that come in contact with the sample (e.g., housing of variable speed submersible pump must be stainless steel if extractable organics are sampled; the housing of a variable speed submersible pump used to sample metals may be plastic.)

[2] Corroded/weathered surfaces are active sorption sites for organic compounds.

[3] Plastics used in connection with inorganic trace element samples (including metals) must be uncolored or white.

[4] May be allowable for specialized parts where no alternative material exists (e.g., Viton seals are the best available seal for some dedicated pump systems), however, contact with the sample must be minimized.

Table FS 1000-2
Construction Material Selection for Equipment and Sample Containers

Analyte Group	Acceptable Materials
Extractable Organics	Teflon Stainless steel Glass Polypropylene (All types) Polyethylene (All types) All parts of the system including connectors and gaskets must be considered – Viton may be used if no other material is acceptable.
Volatile Organics	Teflon Stainless steel Glass Polypropylene (All types) Polyethylene (All types) All parts of the system including connectors and gaskets must be considered – Viton may be used if no other material is acceptable.
Metals	Teflon Stainless steel Polyethylene (All types) Polypropylene (All types) Tygon, Viton, Silicone, Neoprene PVC Glass (except silica and boron)
Ultratrace Metals	Teflon Polyethylene (All types) Polypropylene (All types) Polycarbonate Mercury must be in glass or Teflon
Inorganic Nonmetallics	Teflon Stainless steel Low carbon, Galvanized or Carbon steel Polyethylene (All types) Polypropylene (All types) Tygon, Viton, Silicone, Neoprene PVC Glass Brass

Table FS 1000-2
Construction Material Selection for Equipment and Sample Containers

Analyte Group	Acceptable Materials
Microbiological samples	Teflon Stainless steel Polyethylene (All types) Polypropylene (All types) Tygon, Viton, Silicone, Neoprene PVC Glass Sterilize all **sample** containers. Thoroughly clean **sampling equipment** and rinse several times with sample water before collection. Sampling equipment **does not require** sterilization **Do not rinse sample containers**

Table FS 1000-3
Equipment Use and Construction

EQUIPMENT	CONSTRUCTION HOUSING[1]	CONSTRUCTION TUBING	USE	PERMISSIBLE ANALYTE GROUPS	RESTRICTIONS AND PRECAUTIONS
WATER SAMPLING					
GROUNDWATER					
1 Positive displacement pumps[2]					
a. Submersible (turbine, helical rotor, gear driven)	SS, Teflon	SS, Teflon, PE, PP	Purging	All analyte groups	[3,4,5]; must be variable speed
			Sampling	All analyte groups	[3,4,5] must be variable speed
	SS, Teflon	Non-inert[6]	Purging	All analyte groups	[3,4,5] must be variable speed; polishing required[7]
			Sampling	All analyte groups except volatile and extractable organics	Must be variable speed If sampling for metals, the tubing must be non-metallic if not SS
	Non-inert[6]	Non-inert[6]	Purging	All analyte groups	[3,4,5] must be variable speed; polishing required[7]
			Sampling	All analyte groups except volatile and extractable organics	Must be variable speed If sampling for metals, the tubing must be non-metallic if not SS
b. Bladder pump (no gas contact)	SS, Teflon, PE, PP or PVC if permanently installed	SS, Teflon, PE, PP	Purging	All analyte groups	[3,4,5] must be variable speed
			Sampling	All analyte groups	[3,4] must be variable speed Bladder must be Teflon if sampling for volatile or extractable organics or PE or PP if used in portable pumps
	SS, Teflon, PE, PP	Non-inert[6]	Purging	All analyte groups	[3,4] must be variable speed; polishing required[7] **This configuration is not recommended**
			Sampling	All analyte groups except volatile and extractable organics	[3,4] must be variable speed If sampling for metals, the tubing must be non-metallic if not SS
	Non-inert[6]	Non-inert[6]	Purging	All analyte groups	[3,4] must be variable speed; polishing required[7]
			Sampling	All analyte groups except volatile and extractable organics	[3,4] must be variable speed; polishing required[7] If sampling for metals, the tubing must be non-metallic if not SS

Table FS 1000-3
Equipment Use and Construction

EQUIPMENT	CONSTRUCTION HOUSING[1]	CONSTRUCTION TUBING	USE	PERMISSIBLE ANALYTE GROUPS	RESTRICTIONS AND PRECAUTIONS
2. Suction lift pumps					
a. Centrifugal	N/A	SS, Teflon, PE, PP	Purging	All analyte groups	[4] foot-valve required Must be variable speed
	N/A	Non-inert[6]	Purging	All analyte groups	[4] foot-valve required; polishing required[7] Must be variable speed
b. Peristaltic	N/A	SS, Teflon, PE, PP	Purging	All analyte groups	[4] foot-valve required; polishing required[7] or continuous pumping required Must be variable speed
			Sampling	All analyte groups <u>except</u> volatile organics	[4] Silicone tubing in pump head Must be variable speed
	N/A	Non-inert[6]	Purging	All analyte groups	[4] foot-valve required Must be variable speed
			Sampling	All analyte groups <u>except</u> volatile and extractable organics	[4] Silicone tubing in pump head Must be variable speed
3. Bailers	SS, Teflon, PE, PP	N/A	Purging	All analyte groups	None; **<u>not recommended</u>**
		N/A	Sampling	All analyte groups	None; **<u>not recommended</u>**
	Non-inert[6]	N/A	Purging	All analyte groups <u>except</u> volatile and extractable organics	None; **<u>not recommended</u>** If sampling for metals, the tubing must be non-metallic if not SS
			Sampling	All analyte groups <u>except</u> volatile and extractable organics	None; **<u>not recommended</u>** If sampling for metals, the tubing must be non-metallic if not SS
<u>SURFACE WATER</u>					
1. Intermediate containers such as pond sampler, scoops, beakers, buckets, and dippers	SS, Teflon, Teflon-coated, PE, PP	N/A	Grab sampling	All analyte groups	None
	Glass	N/A		All analyte groups except boron and fluoride	None
	Non-inert[6]	N/A		All analyte groups <u>except</u> volatile and extractable organics	None

Table FS 1000-3
Equipment Use and Construction

EQUIPMENT	CONSTRUCTION HOUSING[1]	CONSTRUCTION TUBING	USE	PERMISSIBLE ANALYTE GROUPS	RESTRICTIONS AND PRECAUTIONS
2. Nansen, Kemmerer, Van Dorn, Alpha and Beta Samplers, Niskin (or equivalent)	SS, Teflon, Teflon-coated, PE, PP	N/A	Specific depth grab sampling	All analyte groups	None
	Non-inert[6]	N/A		All analyte groups <u>except</u> volatile and extractable organics	None
3. DO Dunker	SS, Teflon, glass, PE, PP	N/A	Water column composite sampling	All analyte groups	None
4 Bailers – double valve	SS, Teflon, PE, PP	N/A	Grab sampling	All analyte groups	None
	Non-inert[6]	N/A	Grab sampling	All analyte groups <u>except</u> volatile and extractable organics	None If sampling for metals, the tubing must be non-metallic if not SS
5. Peristaltic pump	N/A	SS, Teflon, PE, PP	Specific depth sampling	All analyte groups <u>except</u> volatile organics	Silicone tubing in pump head Must be variable speed
	N/A	Non-inert[6]		All analyte groups <u>except</u> volatile and extractable organics	Silicone tubing in pump head Must be variable speed
<u>FIELD FILTRATION UNITS</u>	N/A		Dissolved constituents	Inorganic nonmetallics and metals in surface water	Must use a 0.45 μm filter
				Inorganic nonmetallics in groundwater	Must use a 0.45 μm filter
				Metals in groundwater and static wastewater and surface water	Must use in-line, high capacity, one-piece molded filter that is connected to the outlet of a pump; no intermediate vessels; positive pressure PE, PP & Teflon bailers acceptable Must use a 1 μm filter in groundwater, a 0.45 μm filter in surface water
				Metals in moving surface water (i.e., river/stream)	Must use positive pressure device, but an intermediate vessel may be used. Use a 0.45 μm filter

Table FS 1000-3
Equipment Use and Construction

EQUIPMENT	CONSTRUCTION HOUSING[1]	CONSTRUCTION TUBING	USE	PERMISSIBLE ANALYTE GROUPS	RESTRICTIONS AND PRECAUTIONS
SOLID SAMPLING					
SOILS					
1. Core barrel (or liner)	SS, Teflon, glass, Teflon-coated, aluminum, PE, PP	N/A	Sampling	All analyte groups[8]	[9, 10, 11]
	Non-inert[6] nonmetallics	N/A	Sampling	All analyte groups	[12]
	Non-inert[6] metals	N/A	Sampling	All analyte groups	[12]
2. Trowel, scoop, spoon or spatula	SS, Teflon, Teflon-coated, PE, PP	N/A	Sampling	All analyte groups[8]	
			Compositing	All analyte groups except volatile organics	Samples for volatile organics must grab samples
	Plastic	N/A	Sampling and compositing	All analyte groups except volatile and extractable organics	None Must be nonmetallic if not SS
3. Mixing tray (pan)	SS, Teflon, glass, Teflon-coated, aluminum , PE, PP	N/A	Sampling	All analyte groups[8]	[11]
			Compositing or homogenizing	All analyte groups except volatile organics	[11]
	Non-inert[6]	N/A	Compositing or homogenizing	All analyte groups	[10,11,12] must be nonmetallic if not SS
4. Shovel, bucket auger	SS	N/A	Sampling	All analyte groups[8]	None
	Non-SS	N/A	Sampling	All analyte groups[8]	[10,11,12]
5. Split spoon	SS or carbon steel w/ Teflon insert	N/A	Sampling	All analyte groups[8]	[10,11,12]
6. Shelby tube	SS	N/A	Sampling	All analyte groups[8]	[9]
	Carbon steel	N/A	Sampling	All analyte groups	[9,10,12]
SEDIMENT					
1. Coring devices	SS, Teflon, glass, Teflon-coated, aluminum, PE, PP	N/A	Sampling	All analyte groups[8]	[9,10,11]

Table FS 1000-3
Equipment Use and Construction

EQUIPMENT	CONSTRUCTION HOUSING[1]	CONSTRUCTION TUBING	USE	PERMISSIBLE ANALYTE GROUPS	RESTRICTIONS AND PRECAUTIONS
	Non-inert[6] nonmetallics	N/A	Sampling	All analyte groups	[12]
	Non-inert[6] metals	N/A	Sampling	All analyte groups	[9,10,11]
2. Grab – Young, Petersen, Shipek	Teflon, Teflon-lined, SS	N/A	Sampling	All analyte groups[8]	None
	Carbon steel	N/A	Sampling	All analyte groups	[10,11]
3. Dredges – Eckman, Ponar, Petit Ponar Van Veen	SS	N/A	Sampling	All analyte groups[8]	None
	Carbon steel, brass	N/A	Sampling	All analyte groups	[10,11]
4. Trowel, scoop, spoon or spatula	SS, Teflon, Teflon-coated, PE, PP	N/A	Sampling	All analyte groups[8]	
			Compositing	All analyte groups except volatile organics	Samples for volatile organics be grab samples
	Plastic	N/A	Sampling and compositing	All analyte groups <u>except</u> volatile and extractable organics	None must be nonmetallic if not SS
5. Mixing tray (pan)	SS, Teflon, glass, Teflon-coated, aluminum, PE, PP	N/A	Sampling	All analyte groups[8]	[11]
			Compositing or homogenizing	All analyte groups except volatile organics	[11]
	Non-inert[6]	N/A	Compositing or homogenizing	All analyte groups <u>except</u> volatile and extractable organics	none [11] must be nonmetallic if not SS
WASTE[13]					
Scoop	SS	N/A	Liquids, solids & sludges	All analyte groups[8]	Cannot collect deeper phases
Spoon	SS	N/A	Solids, sludges	All analyte groups[8]	Cannot collect deeper phases
Push tube	SS	N/A	Solids, sludges	All analyte groups[8]	Cannot collect deeper phases
Auger	SS	N/A	Solids	All analyte groups[8]	None

Table FS 1000-3
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EQUIPMENT	CONSTRUCTION HOUSING[1]	CONSTRUCTION TUBING	USE	PERMISSIBLE ANALYTE GROUPS	RESTRICTIONS AND PRECAUTIONS
Sediment sampler	SS	N/A	Impoundments, piles	All analyte groups[8]	None
Ponar dredge	SS	N/A	Solids, sludges & sediments	All analyte groups[8]	None
Coliwasa, Drum thief	Glass	N/A	Liquids, sludges	All analyte groups	None
Mucksucker, Dipstick	Teflon		Liquids, sludges	All analyte groups	Not recommended for tanks > 11 feet deep
Bacon bomb	SS	N/A	Liquids	All analyte groups[8]	Not recommended for viscous wastes
Bailer	SS, Teflon	N/A	Liquids	All analyte groups[8]	Do not use with heterogeneous wastes Not recommended for viscous wastes
Peristaltic pump	N/A	Teflon, Glass	Liquids	All analyte groups except volatile organics	Do not use in flammable atmosphere Not recommended for viscous wastes
Backhoe bucket	Steel	N/A	Solids, Sludges		Difficult to clean Volatiles and metals must be taken from the interior part of the sample
Split spoon	SS	N/A	Solids	All analyte groups[8]	
Roto-Hammer	Steel	N/A	Solids	All analyte groups[8]	Physically breaks up sample Not for flammable atmospheres

Acronyms:

N/A	not applicable
SS	stainless steel
HDPE	high-density polyethylene
PE	polyethylene
PVC	polyvinyl chloride
PP	polypropylene

Table FS 1000-3
Equipment Use and Construction

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[1] Refers to tubing and pump housings/internal parts that are in contact with purged or sampled water (interior and exterior of delivery tube, inner lining of the discharge tube, etc.).

[2] If used to collect volatile or extractable organics, all power cords and other tubing must be encased in Teflon, PE or PP.

[3] If used as a non-dedicated system, pump must be completely disassembled, if practical, and cleaned between wells.

[4] Delivery tubing must be precleaned and precut at the base of operations or laboratory. If the same tubing is used during the sampling event, it must be cleaned and decontaminated between uses.

[5] In-line check valve required.

[6] "Non-inert" pertains to materials that are reactive (adsorb, absorb, etc.) to the analytes being sampled. For organics, materials include rubber, plastics (except PE and PP), and PVC. For metals, materials include brass, galvanized, and carbon steel.

[7] "Polishing": When purging for volatile or extractable organics, the entire length of tubing or the portion which comes in contact with the formation water must be constructed of Teflon, SS, PE or PP. If other materials (e.g., PVC, garden hoses, etc.) are used, the following protocols must be followed: 1) slowly withdraw the pump from the water column during the last phase of purging, to remove any water from the well that may have contacted the exterior of the pump and/or tubing; 2) remove a single well volume with the sampling device before sampling begins. **Do not use Tygon** for purging if purgeable or extractable organics are of interest. Polishing **is not recommended;** use of sampling equipment constructed of appropriate materials is preferred.

[8] Do not use if collecting for hexavalent chromium (Chromium^{+6})

[9] If samples are sealed in the liner for transport to the laboratory, the sample for VOC analysis must be taken from the interior part of the core.

[10] If a non-stainless steel (carbon steel, aluminum) liner, core barrel or implement is used, take the samples for metals, purgeable organics and organics from the interior part of the core sample.

[11] Aluminum foil, trays or liners may be used only if aluminum is not an analyte of interest.

[12] If non-inert-liner, core barrel or implement is used, take samples from the interior part of the collected sample.

[13] If disposable equipment of alternative construction materials is used, the construction material must be compatible with the chemical composition of the waste, cannot alter the characteristics of the waste sample in any way, and cannot contribute analytes of interest or any interfering components.

Table FS1000-4

40 CFR Part 136 TABLE II: Required Containers, Preservation Techniques, and Holding Times

Applicable to **all** Non-Potable Water Samples (includes wastewater, surface water, and groundwater)

Parameter No./Name (refers to parameter number on Tables IA,B, C, D,E, F, G & H as noted)	Container[1]	Preservation[2, 3]	Maximum holding time[4]
Table IA—Bacterial Tests:			
1–5. Coliform, total, fecal, and *E. coli*	PA, G	Cool, <10 °C, 0.0008% $Na_2S_2O_3$ [5]	6 hours[6, 7]
6. Fecal streptococci	PA, G	Cool, <10 °C, 0.0008% $Na_2S_2O_3$ [5]	6 hours[6]
7. Enterococci	PA, G	Cool, <10 °C, 0.0008% $Na_2S_2O_3$ [5]	6 hours[6]
8. Salmonella	PA, G	Cool, <10 °C, 0.0008% $Na_2S_2O_3$ [5]	6 hours[6]
Table IA— Aquatic Toxicity Tests:			
9–11. Toxicity, acute and chronic	P, FP, G	Cool, ≤6 °C [8]	36 hours
Table IB—Inorganic Tests:			
1. Acidity	P, FP, G	Cool, ≤6 °C[9]	14 days
2. Alkalinity	P, FP, G	Cool, ≤6 °C[9]	14 days
4. Ammonia	P, FP, G	Cool, ≤6 °C[9], H_2SO_4 to pH<2	28 days
9. Biochemical oxygen demand	P, FP, G	Cool, ≤6 °C[9]	48 hours
10. Boron	P, FP, or Quartz	HNO_3 to pH<2	6 months
11. Bromide	P, FP, G	None required	28 days
14. Biochemical oxygen demand, carbonaceous	P, FP G	Cool, ≤6 °C[9]	48 hours
15. Chemical oxygen demand	P, FP, G	Cool, ≤6 °C[9], H_2SO_4 to pH<2	28 days
16. Chloride	P, FP, G	None required	28 days
17. Chlorine, total residual	P, G	None required	Analyze within 15 minutes
21. Color	P, FP, G	Cool, ≤6 °C[9]	48 hours
23–24. Cyanide, total or available (or CATC)	P, FP, G	Cool, ≤6 °C[9], NaOH to pH>12[10], reducing agent [5]	14 days
25. Fluoride	P	None required	28 days
27. Hardness	P, FP, G	HNO_3 or H_2SO_4 to pH<2	6 months
28. Hydrogen ion (pH)	P, FP, G	None required	Analyze within 15 minutes
31, 43. Kjeldahl and organic N	P, FP, G	Cool, ≤6 °C[9], H_2SO_4 to pH<2	28 days
Table IB—Metals:			
7 18. Chromium VI	P, FP, G	Cool, ≤6 °C[9], pH = 9.3–9.7[12]	28 days
35. Mercury (CVAA)	P, FP, G	HNO_3 to pH<2	28 days

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40 CFR Part 136 TABLE II: Required Containers, Preservation Techniques, and Holding Times

Applicable to **all** Non-Potable Water Samples (includes wastewater, surface water, and groundwater)

Parameter No./Name (refers to parameter number on Tables IA,B, C, D,E, F, G & H as noted)	Container[1]	Preservation[2, 3]	Maximum holding time[4]
35. Mercury (CVAFS)	FP, G; and FP-lined cap[13]	5 mL/L 12N HCl or 5 mL/L BrCl[13]	90 days[13]
3, 5–8, 12, 13, 19, 20, 22, 26, 29, 30, 32–34, 36, 37, 45, 47, 51, 52, 58–60, 62, 63, 70– 72, 74, 75. Metals, except boron, chromium VI, and mercury.	P, FP, G	HNO_3 to pH<2, or at least 24 hours prior to analysis[14]	6 months
38. Nitrate	P, FP, G	Cool, ≤6 °C[9]	48 hours
39. Nitrate-nitrite	P, FP, G	Cool, ≤6 °C[9], H_2SO_4 to pH<2	28 days
40. Nitrite	P, FP, G	Cool, ≤6 °C[9]	48 hours
41. Oil and grease	G	Cool, ≤6 °C[9], HCl or H2SO4 to pH<2	28 days
42. Organic Carbon	P, FP, G	Cool, ≤6 °C[9], HCl, H_2SO_4, or H_3PO_4 to pH<2.	28 days
44. Orthophosphate	P, FP, G	Cool, ≤6 °C[9]	Filter within 15 minutes; Analyze within 48 hours
46. Oxygen, Dissolved Probe	G, Bottle and top	None required	Analyze within 15 minutes
47. Winkler	G, Bottle and top	Fix on site and store in dark	8 hours
48. Phenols	G	Cool, ≤6 °C[9], H_2SO_4 to pH<2	28 days
49. Phosphorous (elemental)	G	Cool, ≤6 °C[9]	48 hours
50. Phosphorous, total	P, FP, G	Cool, ≤6 °C[9], H_2SO_4 to pH<2	28 days
53. Residue, total	P, FP, G	Cool, ≤6 °C[9]	7 days
54. Residue, Filterable	P, FP, G	Cool, ≤6 °C[9]	7 days
55. Residue, Nonfilterable (TSS)	P, FP, G	Cool, ≤6 °C[9]	7 days
56. Residue, Settleable	P, FP, G	Cool, ≤6 °C[9]	48 hours
57. Residue, Volatile	P, FP, G	Cool, ≤6 °C[9]	7 days
61. Silica	P or Quartz	Cool, ≤6 °C[9]	28 days
64. Specific conductance	P, FP, G	Cool, ≤6 °C[9]	28 days
65. Sulfate	P, FP, G	Cool, ≤6 °C[9]	28 days
66. Sulfide	P, FP, G	Cool, ≤6 °C[9], add zinc acetate plus sodium hydroxide to pH>9	7 days
67. Sulfite	P, FP, G	None required	Analyze within 15 minutes
68. Surfactants	P, FP, G	Cool, ≤6 °C[9]	48 hours

Table FS1000-4

40 CFR Part 136 TABLE II: Required Containers, Preservation Techniques, and Holding Times

Applicable to **all** Non-Potable Water Samples (includes wastewater, surface water, and groundwater)

Parameter No./Name (refers to parameter number on Tables IA,B, C, D,E, F, G & H as noted)	Container[1]	Preservation[2, 3]	Maximum holding time[4]
69. Temperature	P, FP, G	None required	Analyze
73. Turbidity	P, FP, G	Cool, ≤6 °C[9]	48 hours
Table IC—Organic Tests 8			
13, 18–20, 22, 24–28, 34–37, 39–43, 45–47, 56, 76, 104, 105, 108–111, 113. Purgeable Halocarbons	G, FP-lined septum	Cool, ≤6 °C[9], 0.008% $Na_2S_2O_3$ [5]	14 days
6, 57, 106. Purgeable aromatic hydrocarbons	G, FP-lined septum	Cool, ≤6 °C[9], 0.008% $Na_2S_2O_3$ [5], HCl to pH 2[16]	14 days[16]
3, 4. Acrolein and acrylonitrile	G, FP-lined septum	Cool, ≤6 °C[9], 0.008% $Na_2S_2O_3$ [5], pH to 4–5[17]	14 days[17]
23, 30, 44, 49, 53, 77, 80, 81, 98, 100, 112. Phenols[18]	G, FP-lined cap	Cool, ≤6 °C[9], 0.008% $Na_2S_2O_3$ [5]	7 days until extraction, 40 days after extraction
7, 38. Benzidines [18, 19]	G, FP-lined cap	Cool, ≤6 °C[9], 0.008% $Na_2S_2O_3$ [5]	7 days until extraction[20]
14, 17, 48, 50–52. Phthalate esters [18]	G, FP-lined cap	Cool, ≤6 °C[9]	7 days until extraction, 40 days after extraction
82–84. Nitrosamines [18, 21]	G, FP-lined cap	Cool, ≤6 °C[9], store in dark, 0.008% $Na_2S_2O_3$ [5]	7 days until extraction, 40 days after extraction
88–94. PCBs[18]	G, FP-lined cap	Cool, ≤6 °C[9]	1 year until extraction, 1 year after extraction
54, 55, 75, 79. Nitroaromatics and isophorone[18]	G, FP-lined cap	Cool, ≤6 °C[9], store in dark, 0.008% $Na_2S_2O_3$ [5]	7 days until extraction, 40 days after extraction
1, 2, 5, 8–12, 32, 33, 58, 59, 74, 78, 99, 101. Polynuclear aromatic hydrocarbons[18]	G, FP-lined cap	Cool, ≤6 °C[9], store in dark, 0.008% $Na_2S_2O_3$ [5]	7 days until extraction, 40 days after extraction
15, 16, 21, 31, 87. Haloethers[18]	G, FP-lined cap	Cool, ≤6 °C[9], 0.008% $Na_2S_2O_3$ [5]	7 days until extraction, 40 days after extraction
29, 35–37, 63–65, 107. Chlorinated hydrocarbons[18]	G, FP-lined cap	Cool, ≤6 °C[9]	7 days until extraction, 40 days after extraction
60–62, 66–72, 85, 86, 95–97, 102, 103. CDDs/CDFs[18]			
Aqueous Samples: Field and Lab Preservation	G	Cool, ≤6 °C[9], 0.008% $Na_2S_2O_3$ [5], pH<9	1 year

Table FS1000-4

40 CFR Part 136 TABLE II: Required Containers, Preservation Techniques, and Holding Times

Applicable to **all** Non-Potable Water Samples (includes wastewater, surface water, and groundwater)

Parameter No./Name (refers to parameter number on Tables IA,B, C, D,E, F, G & H as noted)	Container[1]	Preservation[2, 3]	Maximum holding time[4]
Solids and Mixed-Phase Samples: Field Preservation	G	Cool, ≤6 °C[9]	7 days
Tissue Samples: Field Preservation	G	Cool, ≤6 °C[9]	24 hours
Solids, Mixed-Phase, and Tissue Samples: Lab Preservation	G	Freeze, ≤-10 °C	1 year
Table ID—Pesticides			
Tests: 1–70. Pesticides[18]	G, FP-lined cap	Cool, ≤6 °C[9], pH 5–9[22]	7 days until extraction, 40 days after extraction
Table IE—Radiological Tests:			
1–5. Alpha, beta, and radium	P, FP, G	HNO_3 to pH<2	6 months
Table IH—Bacterial Tests:			
1. *E. coli*			
2. Enterococci	PA, G	Cool, <10 °C, 0.008% $Na_2S_2O_3$ [5]	6 hours[6]
Table IH—Protozoan Tests:			
8. Cryptosporidium	LDPE; field filtration	0–8 °C	96 hours.[23]
9. Giardia	LDPE; field filtration	0–8 °C	96 hours[23]

Reference: This table is adapted from Table II, 40 CFR Part 136, 2007

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[1] ‘‘P’’ is polyethylene; ‘‘FP’’ is fluoropolymer (polytetrafluoroethylene (PTFE; Teflon®), or other fluoropolymer, unless stated otherwise in this Table II; ‘‘G’’ is glass; ‘‘PA’’ is any plastic that is made of a sterlizable material (polypropylene or other autoclavable plastic); ‘‘LDPE’’ is low density polyethylene.

[2] Except where noted in this Table II and the method for the parameter, preserve each grab sample within 15 minutes of collection. For a composite sample collected with an automated sampler (e.g., using a 24-hour composite sampler; see 40 CFR 122.21(g)(7)(i) or 40 CFR Part 403, Appendix E), refrigerate the sample at ≤6 °C during collection unless specified otherwise in this Table II or in the method(s). For a composite sample to be split into separate aliquots for preservation and/or analysis, maintain the sample at ≤6 °C, unless specified otherwise in this Table II or in the method(s), until collection, splitting, and preservation is completed. Add the preservative to the sample container prior to sample collection when the preservative will not compromise the integrity of a grab sample, a composite sample, or an aliquot split from a composite sample; otherwise, preserve the grab sample, composite sample,

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Applicable to **all** Non-Potable Water Samples (includes wastewater, surface water, and groundwater)

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or aliquot split from a composite sample within 15 minutes of collection. If a composite measurement is required but a composite sample would compromise sample integrity, individual grab samples must be collected at prescribed time intervals (e.g., 4 samples over the course of a day, at 6-hour intervals). Grab samples must be analyzed separately and the concentrations averaged. Alternatively, grab samples may be collected in the field and composited in the laboratory if the compositing procedure produces results equivalent to results produced by arithmetic averaging of the results of analysis of individual grab samples. For examples of laboratory compositing procedures, see EPA Method 1664A (oil and grease) and the procedures at 40 CFR 141.34(f)(14)(iv) and (v) (volatile organics).

[3] When any sample is to be shipped by common carrier or sent via the U.S. Postal Service, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring such compliance. For the preservation requirements of Table II, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials Regulations do not apply to the following materials: Hydrochloric acid (HCl) in water solutions at concentrations of 0.04% by weight or less (pH about 1.96 or greater); Nitric acid (HNO3) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H2SO4) in water solutions at concentrations of 0.35% by weight or less (pH about 1.15 or greater); and Sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH about 12.30 or less).

[4] Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before the start of analysis and still be considered valid (e.g., samples analyzed for fecal coliforms may be held up to 6 hours prior to commencing analysis). Samples may be held for longer periods only if the permittee or monitoring laboratory has data on file to show that, for the specific types of samples under study, the analytes are stable for the longer time, and has received a variance from the Regional Administrator under § 136.3(e). For a grab sample, the holding time begins at the time of collection. For a composite sample collected with an automated sampler (e.g., using a 24-hour composite sampler; see 40 CFR 122.21(g)(7)(i) or 40 CFR Part 403, Appendix E), the holding time begins at the time of the end of collection of the composite sample. For a set of grab samples composited in the field or laboratory, the holding time begins at the time of collection of the last grab sample in the set. Some samples may not be stable for the maximum time period given in the table. A permittee or monitoring laboratory is obligated to hold the sample for a shorter time if it knows that a shorter time is necessary to maintain sample stability. See § 136.3(e) for details. The date and time of collection of an individual grab sample is the date and time at which the sample is collected. For a set of grab samples to be composited, and that are all collected on the same calendar date, the date of collection is the date on which the samples are collected. For a set of grab samples to be composited, and that are collected across two calendar dates, the date of collection is the dates of the two days; e.g., November 14–15. For a composite sample collected automatically on a given date, the

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Applicable to **all** Non-Potable Water Samples (includes wastewater, surface water, and groundwater)

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date of collection is the date on which the sample is collected. For a composite sample collected automatically, and that is collected across two calendar dates, the date of collection is the dates of the two days; e.g., November 14–15.

[5] Add a reducing agent only if an oxidant (e.g., chlorine) is present. Reducing agents shown to be effective are sodium thiosulfate ($Na_2S_2O_3$), ascorbic acid, sodium arsenite ($NaAsO_2$), or sodium borohydride ($NaBH_4$). However, some of these agents have been shown to produce a positive or negative cyanide bias, depending on other substances in the sample and the analytical method used. Therefore, do not add an excess of reducing agent. Methods recommending ascorbic acid (e.g., EPA Method 335.4) specify adding ascorbic acid crystals, 0.1–0.6 g, until a drop of sample produces no color on potassium iodide (KI) starch paper, then adding 0.06 g (60 mg) for each liter of sample volume. If $NaBH_4$ or $NaAsO_2$ is used, 25 mg/L $NaBH_4$ or 100 mg/L $NaAsO_2$ will reduce more than 50 mg/L of chlorine (see method ‘‘Kelada-01’’ and/or Standard Method

4500–CN^- for more information). After adding reducing agent, test the sample using KI paper, a test strip (e.g. for chlorine, SenSafeTM Total Chlorine Water Check 480010) moistened with acetate buffer solution (see Standard Method 4500–Cl.C.3e), or a chlorine/oxidant test method (e.g., EPA Method 330.4 or 330.5), to make sure all oxidant is removed. If oxidant remains, add more reducing agent. Whatever agent is used, it should be tested to assure that cyanide results are not affected adversely.

[6] Samples analysis should begin immediately, preferably within 2 hours of collection. The maximum transport time to the laboratory is 6 hours, and samples should be processed within 2 hours of receipt at the laboratory.

[7] For fecal coliform samples for sewage sludge (biosolids) only, the holding time is extended to 24 hours for the following sample types using either EPA Method 1680 (LTB–EC) or 1681 (A–1): Class A composted, Class B aerobically digested, and Class B anaerobically digested.

[8] Sufficient ice should be placed with the samples in the shipping container to ensure that ice is still present when the samples arrive at the laboratory. However, even if ice is present when the samples arrive, it is necessary to immediately measure the temperature of the samples and confirm that the preservation temperature maximum has not been exceeded. In the isolated cases where it can be documented that this holding temperature cannot be met, the permittee can be given the option of on-site testing or can request a variance. The request for a variance should include supportive data which show that the toxicity of the effluent samples is not reduced because of the increased holding temperature.

[9] Aqueous samples must be preserved at ≤6 °C, and should not be frozen unless data demonstrating that sample freezing does not adversely impact sample integrity is maintained on file and accepted as valid by the regulatory authority. Also, for purposes of NPDES monitoring, the specification of ‘‘≤°C’’ is used in place of the ‘‘4 °C’’ and ‘‘< 4 °C’’ sample temperature requirements listed in some methods. It is not necessary to measure the sample temperature to three significant figures (1/100th of 1 degree); rather, three

Table FS1000-4
40 CFR Part 136 TABLE II: Required Containers, Preservation Techniques, and Holding Times
Applicable to **all** Non-Potable Water Samples (includes wastewater, surface water, and groundwater)

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significant figures are specified so that rounding down to 6 °C may not be used to meet the ≤6 °C requirement. The preservation temperature does not apply to samples that are analyzed immediately (less than 15 minutes).

[10] Sample collection and preservation: Collect a volume of sample appropriate to the analytical method in a bottle of the material specified. If the sample can be analyzed within 48 hours and sulfide is not present, adjust the pH to > 12 with sodium hydroxide solution (e.g., 5% w/v), refrigerate as specified, and analyze within 48 hours. Otherwise, to extend the holding time to 14 days and mitigate interferences, treat the sample immediately using any or all of the following techniques, as necessary, followed by adjustment of the sample pH to > 12 and refrigeration as specified. There may be interferences that are not mitigated by approved procedures. Any procedure for removal or suppression of an interference may be employed, provided the laboratory demonstrates that it more accurately measures cyanide. Particulate cyanide (e.g., ferric ferrocyanide) or a strong cyanide complex (e.g., cobalt cyanide) are more accurately measured if the laboratory holds the sample at room temperature and pH > 12 for a minimum of 4 hours prior to analysis, and performs UV digestion or dissolution under alkaline (pH=12) conditions, if necessary.

(1) SULFUR: To remove elemental sulfur (S8), filter the sample immediately. If the filtration time will exceed 15 minutes, use a larger filter or a method that requires a smaller sample volume (e.g., EPA Method 335.4 or Lachat Method 01). Adjust the pH of the filtrate to > 12 with NaOH, refrigerate the filter and filtrate, and ship or transport to the laboratory. In the laboratory, extract the filter with 100 mL of 5% NaOH solution for a minimum of 2 hours. Filter the extract and discard the solids. Combine the 5% NaOH-extracted filtrate with the initial filtrate, lower the pH to approximately 12 with concentrated hydrochloric or sulfuric acid, and analyze the combined filtrate. Because the detection limit for cyanide will be increased by dilution by the filtrate from the solids, test the sample with and without the solids procedure if a low detection limit for cyanide is necessary. Do not use the solids procedure if a higher cyanide concentration is obtained without it. Alternatively, analyze the filtrates from the sample and the solids separately, add the amounts determined (in µg or mg), and divide by the original sample volume to obtain the cyanide concentration.

(2) SULFIDE: If the sample contains sulfide as determined by lead acetate paper, or if sulfide is known or suspected to be present, immediately conduct one of the volatilization treatments or the precipitation treatment as follows: Volatilization—Headspace expelling. In a fume hood or well-ventilated area, transfer 0.75 liter of sample to a 4.4 L collapsible container (e.g., CubitainerTM). Acidify with concentrated hydrochloric acid to pH
< 2. Cap the container and shake vigorously for 30 seconds. Remove the cap and expel the headspace into the fume hood or open area by collapsing the container without expelling the sample. Refill the headspace by expanding the container. Repeat expelling a total of five headspace volumes. Adjust the pH to > 12, refrigerate, and ship or transport to the laboratory. Scaling to a smaller or larger sample volume must maintain the air to sample volume ratio. A larger volume of air will result in too great a loss of cyanide (> 10%). Dynamic stripping: In a fume hood or well- ventilated area, transfer 0.75 liter of sample to a container of the material specified and acidify with concentrated hydrochloric acid to pH < 2. Using a calibrated air sampling pump or flowmeter, purge the acidified sample into the fume hood or open area through a fritted glass aerator at a flow rate of 2.25 L/min for 4 minutes. Adjust the pH to >

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12, refrigerate, and ship or transport to the laboratory. Scaling to a smaller or larger sample volume must maintain the air to sample volume ratio. A larger volume of air will result in too great a loss of cyanide (> 10%). Precipitation: If the sample contains particulate matter that would be removed by filtration, filter the sample prior to treatment to assure that cyanide associated with the particulate matter is included in the measurement. Ship or transport the filter to the laboratory. In the laboratory, extract the filter with 100 mL of 5% NaOH solution for a minimum of 2 hours. Filter the extract and discard the solids. Combine the 5% NaOH-extracted filtrate with the initial filtrate, lower the pH to approximately 12 with concentrated hydrochloric or sulfuric acid, and analyze the combined filtrate. Because the detection limit for cyanide will be increased by dilution by the filtrate from the solids, test the sample with and without the solids procedure if a low detection limit for cyanide is necessary. Do not use the solids procedure if a higher cyanide concentration is obtained without it. Alternatively, analyze the filtrates from the sample and the solids separately, add the amounts determined (in µg or mg), and divide by the original sample volume to obtain the cyanide concentration. For removal of sulfide by precipitation, raise the pH of the sample to > 12 with NaOH solution, then add approximately 1 mg of powdered cadmium chloride for each mL of sample. For example, add approximately 500 mg to a 500-mL sample. Cap and shake the container to mix. Allow the precipitate to settle and test the sample with lead acetate paper. If necessary, add cadmium chloride but avoid adding an excess. Finally, filter through 0.45 micron filter. Cool the sample as specified and ship or transport the filtrate and filter to the laboratory. In the laboratory, extract the filter with 100 mL of 5% NaOH solution for a minimum of 2 hours. Filter the extract and discard the solids. Combine the 5% NaOH-extracted filtrate with the initial filtrate, lower the pH to approximately 12 with concentrated hydrochloric or sulfuric acid, and analyze the combined filtrate. Because the detection limit for cyanide will be increased by dilution by the filtrate from the solids, test the sample with and without the solids procedure if a low detection limit for cyanide is necessary. Do not use the solids procedure if a higher cyanide concentration is obtained without it. Alternatively, analyze the filtrates from the sample and the solids separately, add the amounts determined (in µg or mg), and divide by the original sample volume to obtain the cyanide concentration. If a ligand-exchange method is used (e.g., ASTM D6888), it may be necessary to increase the ligand-exchange reagent to offset any excess of cadmium chloride.

(3) SULFITE, THIOSULFATE, OR THIOCYANATE: If sulfite, thiosulfate, or thiocyanate is known or suspected to be present, use UV digestion with a glass coil (Method Kelada-01) or ligand exchange (Method OIA–1677) to preclude cyanide loss or positive interference.

(4) ALDEHYDE: If formaldehyde, acetaldehyde, or another water-soluble aldehyde is known or suspected to be present, treat the sample with 20 mL of 3.5% ethylenediamine solution per liter of sample.

(5) CARBONATE: Carbonate interference is evidenced by noticeable effervescence upon acidification in the distillation flask, a reduction in the pH of the absorber solution, and incomplete cyanide spike recovery. When significant carbonate is present, adjust the pH to ≥12 using calcium hydroxide instead of sodium hydroxide. Allow the precipitate to settle and decant or filter the sample prior to analysis (also see Standard Method 4500–CN.B.3.d).

Table FS1000-4
40 CFR Part 136 TABLE II: Required Containers, Preservation Techniques, and Holding Times
Applicable to **all** Non-Potable Water Samples (includes wastewater, surface water, and groundwater)

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(6) CHLORINE, HYPOCHLORITE, OR OTHER OXIDANT: Treat a sample known or suspected to contain chlorine, hypochlorite, or other oxidant as directed in footnote 5.

[11] For dissolved metals, filter grab samples within 15 minutes of collection and before adding preservatives. For a composite sample collected with an automated sampler (e.g., using a 24-hour composite sampler; see 40 CFR 122.21(g)(7)(i) or 40 CFR Part 403, Appendix E), filter the sample within 15 minutes after completion of collection and before adding preservatives. If it is known or suspected that dissolved sample integrity will be compromised during collection of a composite sample collected automatically over time (e.g., by interchange of a metal between dissolved and suspended forms), collect and filter grab samples to be composited (footnote 2) in place of a composite sample collected automatically.

[12] To achieve the 28-day holding time, use the ammonium sulfate buffer solution specified in EPA Method 218.6. The allowance in this footnote supersedes preservation and holding time requirements in the approved hexavalent chromium methods, unless this supersession would compromise the measurement, in which case requirements in the method must be followed.

[13] Samples collected for the determination of trace level mercury (<100 ng/L) using EPA Method 1631 must be collected in tightly-capped fluoropolymer or glass bottles and preserved with BrCl or HCl solution within 48 hours of sample collection. The time to preservation may be extended to 28 days if a sample is oxidized in the sample bottle. A sample collected for dissolved trace level mercury should be filtered in the laboratory within 24 hours of the time of collection. However, if circumstances preclude overnight shipment, the sample should be filtered in a designated clean area in the field in accordance with procedures given in Method 1669. If sample integrity will not be maintained by shipment to and filtration in the laboratory, the sample must be filtered in a designated clean area in the field within the time period necessary to maintain sample integrity. A sample that has been collected for determination of total or dissolved trace level mercury must be analyzed within 90 days of sample collection.

[14] An aqueous sample may be collected and shipped without acid preservation. However, acid must be added at least 24 hours before analysis to dissolve any metals that adsorb to the container walls. If the sample must be analyzed within 24 hours of collection, add the acid immediately (see footnote 2). Soil and sediment samples do not need to be preserved with acid. The allowances in this footnote supersede the preservation and holding time requirements in the approved metals methods.

[15] Guidance applies to samples to be analyzed by GC, LC, or GC/MS for specific compounds.

[16] If the sample is not adjusted to pH 2, then the sample must be analyzed within seven days of sampling.

[17] The pH adjustment is not required if acrolein will not be measured. Samples for acrolein receiving no pH adjustment must be analyzed within 3 days of sampling.

Table FS1000-4

40 CFR Part 136 TABLE II: Required Containers, Preservation Techniques, and Holding Times

Applicable to **all** Non-Potable Water Samples (includes wastewater, surface water, and groundwater)

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[18] When the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding times should be observed for optimum safeguard of sample integrity (i.e., use all necessary preservatives and hold for the shortest time listed). When the analytes of concern fall within two or more chemical categories, the sample may be preserved by cooling to ≤6 °C, reducing residual chlorine with 0.008% sodium thiosulfate, storing in the dark, and adjusting the pH to 6–9; samples preserved in this manner may be held for seven days before extraction and for forty days after extraction. Exceptions to this optional preservation and holding time procedure are noted in footnote 5 (regarding the requirement for thiosulfate reduction), and footnotes 19, 20 (regarding the analysis of benzidine).

[19] If 1,2-diphenylhydrazine is likely to be present, adjust the pH of the sample to 4.0 ± 0.2 to prevent rearrangement to benzidine.

[20] Extracts may be stored up to 30 days at < 0 °C.

[21] For the analysis of diphenylnitrosamine, add 0.008% $Na_2S_2O_3$ and adjust pH to 7–10 with NaOH within 24 hours of sampling

[22] The pH adjustment may be performed upon receipt at the laboratory and may be omitted if the samples are extracted within 72 hours of collection. For the analysis of aldrin, add 0.008% $Na_2S_2O_3$.

[23] Holding time is calculated from time of sample collection to elution for samples shipped to the laboratory in bulk and calculated from the time of sample filtration to elution for samples filtered in the field

Table FS 1000-5
Approved Water and Wastewater Procedures, Containers, Preservation and Holding Times
For Analytes not Found in 40 CFR 136

Analyte	Methods	Reference [1]	Container[2]	Preservation[3]	Maximum Holding Time[4]
Bromine	DPD Colorimetric[5]	SM 4500-Cl-G	P, G	None required	Analyze immediately
Bromates	Ion Chromatography	EPA 300.0 [6]	P, G	Cool 4°C	30 days
Chlorophylls	Spectrophotometric	SM 10200 H	P, G[7]	Dark 4°C Filtered, dark, ¯20°C	48 hours chilled until filtration[8], and analyze immediately or 48 hours chilled until filtration[8],and 28 days (frozen)after filtration
Corrosivity	Calculated ($CaCO_3$ Stability, Langelier Index)	SM 2330 ASTM D513-92	P, G	Cool 4°C[9]	7 days[9]
FL-PRO	Gas Chromatography	DEP (11/1/95)	G only	Cool 4°C, H_2SO_4 or HCl to pH<2	7 days until extraction, 40 days after extraction
Odor	Human Panel	SM 2150	G only	Cool 4°C	6 hours
Salinity	Electrometric [10] Hydrometric[10]	SM 2520 B SM 2520 C	G, wax seal	Analyze immediately or use wax seal	30 days[10]
Taste	Human Panel	SM 2160 B, C, D ASTM E679-91	G only	Cool 4°C	24 hours
Total Dissolved Gases	Direct-sensing Membrane-diffusion	SM 2810	_____	_____	Analyze in-situ
Total Petroleum Hydrocarbons	Gravimetry	EPA 1664	G only	Cool 4°C, H_2SO_4 or HCl to pH<2	28 days
Transparency	Irradiometric[11]	62-302.200(6), FAC	_____	_____	Analyze in-situ
Un-ionized Ammonia	Calculated[12]	DEP-SOP[13]	P, G	Cool 4°C $Na_2S_2O_3$ [12]	8 hours unpreserved 28 days preserved [12]
Organic Pesticides[14]	GC and HPLC	EPA (600-series) [14]	[15]	[15]	[15]

[1] SM XXXX = procedures from "Standard Methods for the Examination of Water and Wastewater", APHA-AWWA-WPCF, 20th edition, 1998 and Standard Methods Online.

ASTM XXXX-YY = procedure from "Annual Book of ASTM Standards", Volumes 11.01 and 11.02 (Water I and II), 1999.

[2] P = plastic, G = glass.

[3] When specified, sample preservation should be performed immediately upon sample collection.

[4] The times listed are the maximum times that samples may be held before analysis and still be considered valid.

Table FS 1000-5
Approved Water and Wastewater Procedures, Containers, Preservation and Holding Times For Analytes not Found in 40 CFR 136

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[5] The approved procedure is for residual chlorine. However, in the absence of chlorine, the DPD colorimetric procedure can be adapted to measure bromine content of the sample. In such case, the validity of this assumption must be verified by using another procedure for chlorine which is not affected by the presence of bromine (i.e., negligible interference).

[6] The Determination of Inorganic Anions in Water by Ion Chromatography", EPA Method 300.0, Revised August 1993, by John D. Pfaff, U. S. EPA Cincinnati, Ohio 45268.

[7] Collect samples in opaque bottles and process under reduced light.

[8] Samples must be filtered within 48 hours of collection. Add magnesium carbonate to the filter while the last of the sample passes through the filter..

[9] Temperature and pH must be measured on site at the time of sample collection. 7 days is the maximum time for laboratory analysis of total alkalinity, calcium ion and total solids.

[10] The electrometric and hydrometric analytical methods are suited for field use. The argentometric method is suited for laboratory use. Samples collected for laboratory analysis, when properly sealed with paraffin waxed stopper, may be held indefinitely. The maximum holding time of 30 days is recommended as a practical regulatory limit.

[11] Transparency in surface waters is defined as a compensation point for photosynthetic activity, i.e., the depth at which one percent of the light intensity entering at the water surface remains unabsorbed. The DEP Chapter 62-302, FAC requires that the light intensities at the surface and subsurface be measured simultaneously by irradiance meters such as the Kahlsico Underwater Irradiometer, Model No. 268 WA 310, or an equivalent device having a comparable spectral response.

[12] The results of the measurements of pH, temperature, salinity (if applicable) and the ammonium ion concentration in the sample are used to calculate the concentration of ammonia in the unionized state. Temperature, pH and salinity must be measured on-site at the time of sample collection. Laboratory analysis of the ammonium ion concentration should be conducted within eight hours of sample collection. If prompt analysis of ammonia is impossible, preserve samples with H_2SO_4 to pH between 1.5 and 2. Acid-preserved samples, stored at 4°C, may be held up to 28 days for ammonia determination. Sodium thiosulfate should only be used if fresh samples contain residual chlorine.

[13] DEP Central Analytical Laboratory, Tallahassee, FL, Revision No. 2, 2-12-2001. The document is available from the DEP Standards & Assessment Section..

[14] Other pesticides listed in approved EPA methods (608.1, 608.2, 614, 614.1, 615, 617, 618, 619, 622, 622.1, 627, 629, 631, 632, 632.1, 633, 642, 643, 644 and 645) that are not included in Table ID of 40 CFR Part 136 (July 2007).

[15] Container, preservation and holding time as specified in each individual method must be followed.

Table FS 1000-6
Recommended Sample Containers, Sample Volumes, Preservation Techniques and Holding Times for Residuals, Soil and Sediment Samples

Analyte	Methods	References	Container	Preservation	Maximum Holding Times
Volatile Organics	Purge-and-Trap GC and GC-MS	8015, 8260, 8021, 5035	See Table 1000-7		
Semivolatile Organics	GC, HPLC, and GC-MS	8041, 8061, 8070, 8081, 8082, 8091, 8111, 8121, 8131, 8141, 8151, 8270, 8275, 8280, 8290, 8310, 8315, 8316, 8318, 8321, 8325, 8330, 8331, 8332, 8410, 8430, 8440, FL-PRO	Glass, 8 oz widemouth with Teflon® -Lined lid	Cool 4°C [1]	14 days until extraction, 40 days after extraction
Dioxins		8290	Amber Glass, 8 oz widemouth with Teflon® -Lined lid	Cool 4°C[1] in dark	30 days until extraction, 45 days after extraction
Total Metals-except mercury and chromium VI methods	Flame AA, Furnace AA, Hydride and ICP	All 7000-series (except 7195, 7196, 7197, 7198, 7470 and 7471), and 6010 (ICP)	Glass or plastic 8 oz widemouth (200 grams sample)	None	6 months
Chromium VI	Colorimetric, Chelation with Flame AA (200 gram sample)	7196 and 7197 (prep 3060)	Glass or plastic, 8 oz widemouth (200 gram sample)	Cool 4°± 2°C[1]	1 month until extraction, 4 days after extraction [2]
Mercury	Manual Cold Vapor AA	7471	Glass or plastic 8 oz widemouth (200 grams sample)	Cool 4°± 2°C[1]	28 days
Microbiology (MPN)		MPN	Sterile glass or plastic	Cool 4°C[1]	24 hours
Aggregate Properties			Glass or plastic	Cool 4°C[1]	14 days
Inorganic nonmetallics all except:			Glass or plastic	Cool 4°C[1]	28 days
Sulfite, Nitrate, Nitrite & o-phosphate			Glass or plastic		48 hours
Elemental Phosphorus			Glass		48 hours

Table FS 1000-6
Recommended Sample Containers, Sample Volumes, Preservation Techniques and Holding Times for Residuals, Soil and Sediment Samples

The term "residuals" include: (1) sludges of domestic origin having no specific requirements in Tables FS-1000-4 or FS-1000-9; (2) sludges of industrial origin; and (3) concentrated waste samples.

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[1] Keep soils, sediments and sludges cool at 4°C from collection time until analysis. No preservation is required for concentrated waste samples.

[2] Storage Temperature is 4°C, ±2°C

Table FS 1000-7

Sample Handling, Preservation and Holding Time Table for SW 846 Method 5035

			Sample Container					
Conc. Level	Sampling Device	Collection Procedure	Type	Vial Preparation	Preservation	Sample Preparation	Max HT①	Determinative Procedure
≤200 ug/kg	Coring Device	5035 - Section 6.2.1	Glass Vial w/ PTFE-silicone Septum	5035 - 6.1.1	$NaHSO_4$ / 4ºC	5035 - Section 7.2	14 D	Any recognized VOC Method
				5035 - 6.1.1②	4ºC	5035 - Section 7.2	48 H	Any recognized VOC Method
				5035 - 6.1.1②	4ºC / -10ºC③,④	5035 - Section 7.2	48 H / 14 D⑤	Any recognized VOC Method
	EnCore or equivalent	5035 - Section 6.2.1	EnCore or equivalent	5035 - 6.1.1②,⑥,⑦	4ºC	5035 - Section 7.2	48 H	Any recognized VOC Method
		5035 - Section 6.2.1	EnCore or equivalent	5035 - 6.1.1⑥,⑦	$NaHSO_4$ / 4ºC	5035 - Section 7.2⑤	48 H / 14 D⑤	Any recognized VOC Method
		5035 - Section 6.2.1	EnCore or equivalent	5035-6.1.1②⑥⑦	4ºC / -10ºC③,④	5035 - Section 7.2⑤	48 H / 14 D⑤	Any recognized VOC Method
>200 ug/kg	EnCore or equivalent	5035 - Section 6.2.2.3⑥	EnCore or equivalent	5035 - 6.1.3⑥,⑦	4ºC	5035 - Sections 7.3.2 & 7.3.3⑤	48 H / 14 D⑤	Any recognized VOC Method
>200 ug/kg⑧	Coring Device	5035 - Section 6.2.2.3⑨	Glass Vial w/ PTFE-silicone Septum	6.1.3⑨	Methanol/PEG + 4ºC	5035 - Section 7.3.4	14 D	Any recognized VOC Method
	Conventional Devices	DEP SOP - Section 4.3	Glass w/ PTFE-silicone Septum	6.1.2	4ºC	5035 - Sections 7.3.1 - 7.3.3	14 D	Any recognized VOC Method
Oily Waste	Conventional Devices	5035 - Section 6.2.4.2	Glass w/ PTFE-silicone Septum	6.1.4	4ºC	5035 - Sections 7.4.1 - 7.4.2	14 D	Any recognized VOC Method
	Conventional Devices	5035 - Section 6.2.4.1	Glass w/ PTFE-silicone Septum	6.1.4	Methanol/PEG + 4ºC	5035 - Sections 7.4.3	14 D	Any recognized VOC Method
Dry Wt.	Conventional Devices		Glass with Teflon liner		4ºC	5035 - Section 7.5		
Soil Screen	Conventional Devices	DEP SOP - Section 4.3	Glass w/ PTFE-silicone Septum		4ºC	5035 - Section 7.1	14 D	Any recognized VOC Method

Table FS 1000-7

Sample Handling, Preservation and Holding Time Table for SW 846 Method 5035

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① Maximum time allowable from time/date of collection to sample analysis.

② Eliminate 6.1.1.2; use only organic-free water.

③ Contents of sampling device must be transported to the laboratory at 4ºC and stored at -10ºC.

④ In order to ensure that vials do not break during freezing, they should be stored on their side or at a slanted angle to maximize surface area.

⑤ Maximum allowable time at 4ºC is 48 hours; maximum allowable time to sample analysis is 14 days (from time of sample collection).

⑥ Conducted in the laboratory.

⑦ Entire contents of sampling device are extruded into the sample analysis vial containing the appropriate solvent.

⑧ Procedures are limited only to those situations or programs in which the maximum contamination level does not exceed 200 ug/kg.

⑨ Methanolic preservation in the field is not recommended, but may be used if approved by an DEP program.

FS 1000-8
Preservation Methods and Holding Times for Drinking Water Samples that Differ from 40 CFR Part 136, Table II

Analyte	Preservation[1]	Holding Time[2]	Holding Time for Extract[3]	Container[4]
MICROBIOLOGICAL-BACTERIA	Cool < 10°C, $Na_2S_2O_3$[5]			P or G
Total Coliforms, fecal coliforms & *E. coli* in drinking water	Cool < 10°C[6], $Na_2S_2O_3$[5]	30 Hours[7]		P or G
Total coliforms and fecal coliforms in source water Heterotrophic bacteria in drinking water	Cool < 10°C, $Na_2S_2O_3$[5]	8 hours		P or G
Gross Alpha	Conc. HCl or HNO_3 to pH <2 [8,9]	6 mo		P or G
Gross beta	Conc. HCl or HNO to pH <2[8,9]	6 mo		P or G
Strontium-89	Conc. HCl or HNO to pH <2[8,9]	6 mo		P or G
Strontium-90	Conc. HCl or HNO to pH <2[8,9]	6 mo		P or G
Radium-226	Conc. HCl or HNO to pH <2[8,9]	6 mo		P or G
Radium-228	Conc. HCl or HNO to pH <2[8,9]	6 mo		P or G
Cesium-134	Concentrated HCl to pH <<2[8,9]	6 mo		P or G
Iodine-131	None	8 da		P or G
Tritium	None	6 months		G
Uranium	Conc. HCl or HNO_3 to pH <2[8,9]	6 mo		P or G
Photon emitters	Conc. HCl or HNO_3 to pH <2[8,9]	6 mo		P or G
Asbestos	Cool 4°C	48 hours		P or G
Bromate	Ethylenediamine (50mg/L)	28 days		P or G
Cyanide	Cool, 4C, Ascorbic acid (if chlorinated), NaOH pH>12	14 days		P or G
Nitrate	Cool, 4°C	48 hours		P or G
Nitrate (chlorinated source)	Cool, 4°C	14 days		P or G
Odor	Cool 4°C	24 hours		G
502.2	Sodium Thiosulfate or Ascorbic Acid, 4°C HCl pH<2 if Ascorbic Acid is used	14 days		Glass with PFTE Lined Septum

FS 1000-8
Preservation Methods and Holding Times for Drinking Water Samples that Differ from 40 CFR Part 136, Table II

Analyte	Preservation[1]	Holding Time[2]	Holding Time for Extract[3]	Container[4]
504.1	Sodium Thiosulfate Cool, 4°C,	14 days	4°C, 24 hours	Glass with PFTE-Lined Septum
505	Sodium Thiosulfate Cool, 4°C	14 days (7 days for Heptachlor)	4°C, 24 hours	Glass with PFTE-Lined Septum
506	Sodium Thiosulfate Cool, 4°C, Dark	14 days	4°C, dark, 14 days	Amber Glass with PFTE-lined Cap
507	Sodium Thiosulfate Cool, 4°C, Dark	14 days (see method for exceptions)	4°C, dark, 14 days	Amber Glass with PFTE-lined Cap
508	Sodium Thiosulfate Cool, 4°C, Dark	7 days (see method for exceptions)	4°C, dark, 14 days	Glass with PFTE-lined Cap
508A	Cool, 4°C	14 days	30 days	Glass with PFTE-lined Cap
508.1	Sodium Sulfite, HCl pH<2, Cool, 4°C	14 days (see method for exceptions)	30 days	Glass with PFTE-lined Cap
515.1	Sodium Thiosulfate Cool, 4°C, Dark	14 days	4°C, dark, 28 days	Amber Glass with PFTE-lined Cap
515.2	Sodium Thiosulfate HCl pH<2, Cool, 4°C, Dark	14 days	≤ 4°C, dark, 14 days	Amber Glass with PFTE-lined Cap
515.3	Sodium Thiosulfate HCl pH<2, Cool, 4°C, Dark	14 days	≤ 4°C, dark, 14 days	Amber Glass with PFTE-lined Cap
515.4	Sodium Sulfite, HCl pH<2, Cool, ≤10°C for first 48 hours ≤6°C thereafter, Dark	14 days	≤0°C, 21 days	
524.2	Ascorbic Acid, HCl pH<2, Cool 4°C	14 days		Glass with PFTE-lined Septum
525.2	Sodium Sulfite, Dark, Cool, 4°C, HCl pH<2	14 days (see method for exceptions)	≤ 4°C, 30 days from collection	Amber Glass with PFTE-lined Cap
531.1, 6610	Sodium Thiosulfate Monochloroacetic acid, pH<3, Cool, 4°C	Cool 4°C, 28 days		Glass with PFTE-lined Septum
531.2	Sodium Thiosulfate, Potassium Dihydrogen Citrate buffer to pH 4,	28 days		

FS 1000-8
Preservation Methods and Holding Times for Drinking Water Samples that Differ from 40 CFR Part 136, Table II

Analyte	Preservation[1]	Holding Time[2]	Holding Time for Extract[3]	Container[4]
	dark, ≤10°C for first 48 hr, ≤6°C thereafter			
547	Sodium Thiosulfate Cool, 4°C	14 days (18 mo. frozen)		Glass with PFTE-lined Septum
548.1	Sodium Thiosulfate (HCl pH 1.5-2 if high biological activity), Cool, 4°C, Dark	7 days	≤4°C 14 days	Amber Glass with PFTE-lined Septum
549.2	Sodium Thiosulfate (H_2SO_4 pH<2 if biologically active), Cool, 4°C, Dark	7 days	21 days	High Density Amber Plastic or Silanized Amber Glass
550, 550.1	Sodium Thiosulfate Cool, 4°C, HCl pH<2	7 days	550, 30 days 550.1, 40 days Dark, 4°C	Amber Glass with PFTE-lined Cap
551.1	Sodium Thiosulfate, Sodium Sulfite, Ammonium Chloride, pH 4.5-5.0 with phosphate buffer, Cool, 4°C	14 days		Glass with PFTE-lined Septum
552.1	Ammonium chloride, Cool, 4°C, Dark	14 days	≤4°C, dark 48 hours	Amber Glass with PFTE-lined cap
552.2	Ammonium chloride, Cool, 4°C, Dark	14 days	≤4°C, dark 7 days ≤-10°C 14 days	Amber Glass with PFTE-lined cap
555	Sodium Sulfite, HCl, pH ≤ 2, Dark, Cool 4°C	14 days		Glass with PFTE-lined cap
1613B	Sodium Thiosulfate, Cool, 0-4°C, Dark		Recommend 40 days	Amber Glass with PFTE-lined Cap

[1] Preservation, when required, must be done immediately upon sample collection.

[2] Stated values are the maximum regulatory holding times. Sample processing must begin by the stated time.

[3] Stated time is the maximum time a prepared sample extract may be held before analysis.

[4] (P) polyethylene or (G) or glass. For microbiology, plastic sample containers must be made of sterilizable materials (poly-propylene or other autoclavable plastic).

[5] Addition of sodium thiosulfate is only required if the sample has a detectable amount of residual chlorine, as indicated by a field test using EPA Method 330.4 or 330.2 or equivalent.

FS 1000-8
Preservation Methods and Holding Times for Drinking Water Samples that Differ from 40 CFR Part 136, Table II

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[6] Temperature requirement applies only to source water samples, however once received by the laboratory, if sample processing does not begin on the same working day, samples must be refrigerated.

[7] If samples are analyzed after 30 hours, but within 48 hours of collection, the laboratory is to indicate in the analytical report that the data may be invalid because of excessive delay in sample processing. No samples received after 48 hours are to be accepted or analyzed for compliance with the regulations of the Department of Environmental Protection or the Department of Health.

[8] It is recommended that the preservative be added at the time of collection unless suspended solids activity is to be measured. It is also recommended that samples be filtered, if suspended or settleable solids are present, prior to adding preservative, at the time of collection. However, if the sample has to be shipped to a laboratory or storage area, acidification of the sample (in its original container) may be delayed for a period not to exceed 5 days. A minimum of 16 hours must elapse between acidification and analysis.

[9] If HCl is used to acidify samples, which are to be analyzed for gross alpha or gross beta activities, the acid salts must be converted to nitrate salts before transfer of the samples to planchets.

Table FS 1000-9
Containers, Preservation and Holding Times for Biosolids Samples and Protozoans

ANALYTE NAME	*CONTAINER*	*PRESERVATION*	*MAX HOLDING TIME*
Fecal Coliform	Plastic or Glass	Cool 4°C	24 hours
Salmonella	Plastic or Glass	< 10°C	24 hours
Enteric Viruses	Plastic or Glass	Up to 25°C	2 hours
Enteric Viruses	Plastic or Glass	2 to 10°C	48 hours
Specific Oxygen Uptake Rate	Plastic or Glass	None	As Soon As Possible
Helminth OVA	Plastic or Glass	< 4°C (Do not Freeze)	24 hours
Cryptosporidium/Giardia	Plastic or Glass	0 - 8°C (Do not Freeze)*	96 Hours
Total Solids	Plastic or Glass	≤6°C (Do not Freeze)	7 days
Metallics	Plastic or Glass	See Tables FS 1000-4, FS 1000-5 and FS 1000-6	
Other Inorganic Pollutants	Plastic or Glass	See Tables FS 1000-4, FS 1000-5 and FS 1000-6	

***Dechlorinate bulk samples when applicable**

Table FS 1000-10
Container Materials, Preservation, and Holding Times for Fish and Shellfish

Analyte	Matrix	Sample Container	Field (Transport to Lab)		Laboratory	
			Preservation	Maximum Shipping Time	Storage	Holding Time
	Whole Organism (Fish, shellfish, etc.	Foil-wrap each organism (or composite for shellfish) and transport in waterproof plastic bag	Cool in wet ice or: – – – – – – – – – – – – Freeze on dry ice	24 hours – – – – – – – – – – – – 48 hours		
Mercury	Tissue (fillets and edible portions, homogenates)	Plastic, borosilicate glass, quartz, PTFE			Freeze at <-20°C	28 days
Other metals	Tissue (fillets and edible portions, homogenates)	Plastic, borosilicate glass, quartz, PTFE			Freeze at <-20°C	6 months
Organics	Tissue (fillets and edible portions, homogenates)	Borosilicate glass, PTFE, quartz, aluminum foil			Freeze at <-20°C	1 year
Dioxin	Tissue (fillets and edible portions, homogenates)	Amber containers: Borosilicate glass, PTFE, quartz, aluminum foil			Freeze at <-20°C	30 days until extraction, 15 days after extraction
Lipids	Tissue (fillets and edible portions, homogenates)	Plastic, borosilicate glass, quartz, PTFE			Freeze at <-20°C	1 year

PTFE = Polytetrafluoroethylene (Teflon)

Table FS 1000-11
Holding Times for SPLP or TCLP Extraction, Sample Preparation and Determinative Analysis

Holding Time (Days)				
	From: Field Collection To: SPLP or TCLP Extraction	From: SPLP or TCLP Extraction To: Preparative Extraction	From: Preparative Extraction To: Determinative Analysis	Total Elapsed Time
Volatiles	14	NA	14	28
Semi-Volatiles	14	7	40	61
Mercury	28	NA	28	56
Metals, except Mercury	180	NA	180	360

NA – Not Applicable

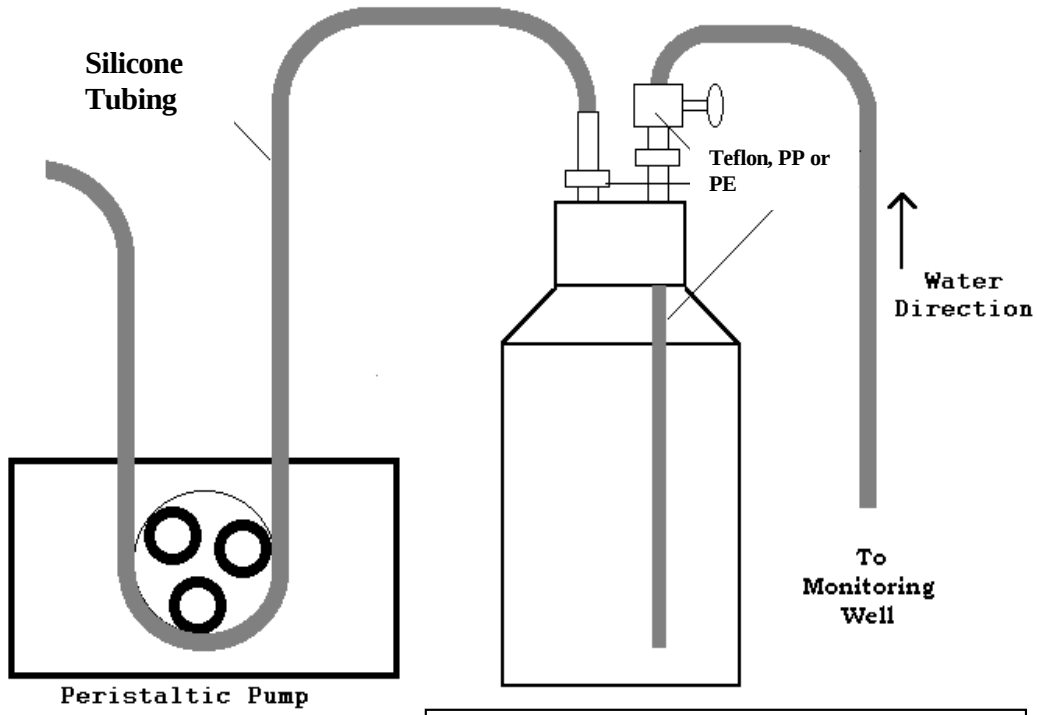
Table FS 1000-12
Preventive Maintenance Tasks

INSTRUMENT/ACTIVITY	FREQUENCY
REFRIGERATORS, INCUBATORS, OVENS	
Clean interior	Monthly
Check thermometer temperature against certified thermometer or equivalent	Annually
ANYTICAL BALANCES	
Clean pan and compartment	Daily[1]
Check with Class S weights	Monthly
Manufacturer cleaning and calibration	Annually
pH AND ION SELECTIVE ELECTRODES	
PROBE	
Check probe for cracks and proper levels of filling solution; check reference junction; clean electrode	Daily, Replace as necessary
Check response time	Daily[1]
METER	
Check batteries and electronics for loose connections and cracked leads	Daily[1], Replace as necessary
TURBIDIMETER	
Clean instrument housing	Monthly
Clean cells	Daily[1]
CONDUCTIVITY METER	
Check batteries and probe cables	Daily[1]
Replatinize Probe	Per manufacturer's recommendations
DISSOLVED OXYGEN METERS	
PROBE	
Check membrane for deterioration; check filling solution	Daily[1], Replace as necessary
METER	
Battery level and electronics checked	Daily[1], Replace as necessary
THERMOMETERS	
Check for cracks and gaps in the mercury	Daily[1], Replace as necessary
TEMPERATURE PROBE	
Check connections, cables	Daily[1]
Check against calibrated thermometer	Daily[1]
AUTOMATIC SAMPLE COLLECTION SYSTEMS (e.g., ISCO, Sigma)	
Check sampler operation (forward, reverse, automatic through three cycles of the purge-pump-purge cycle)	Daily[1]Prior to Sampling Event
Check purge-pump-purge cycle when sampler is installed	Daily[1]Prior to Sampling Event
Check the flow pacer that activates the sampler to assure proper operation	Daily[1]Prior to Sampling Event
Check desiccant	Daily[1], Replace as Necessary
Check batteries	Daily[1], Replace as Necessary
Check pumping rate against manufacturer's specifications	Daily[1], Replace as Necessary

[1]Daily is defined as prior to use or a 12-hour period if equipment is run continuously

Figure FS 1000-1

Organic Trap Configuration for Collecting Extractable Organics with a Peristaltic Pump



The glass sample bottle must be threaded to use a reusable sampling cap lined and installed with fittings made of Teflon, polypropylene or polyethylene, similar to the design shown.

FS 2200. Groundwater Sampling

1. INTRODUCTION AND SCOPE

1.1 Use these Standard Operating Procedures to collect groundwater samples. They are designed to ensure that the collected samples will be representative of water in the aquifer or target formation and that the samples have not been altered or contaminated by the sampling and handling procedures. These procedures apply to permanently and temporarily installed monitoring wells, wells constructed using "direct-push" techniques, wells with installed plumbing, remedial groundwater treatment systems and excavations where groundwater is present. Use of alternative, DEP-approved and properly documented procedures (e.g., Corporate SOP, ASTM Standards, alternative equipment, etc.) is acceptable if they meet the intent (e.g., sample representativeness and integrity) of this standard (see FA 1000).

1.2 The topics in this SOP include equipment and supply selection, equipment construction materials, and purging and sampling techniques.

1.3 Use the following DEP SOPs in conjunction with FS 2200:

- FA 1000 Regulatory Scope and Administrative Procedures for Use of DEP SOPs
- FC 1000 Cleaning/Decontamination Procedures
- FD 1000 Documentation Procedures
- FQ 1000 Field Quality Control Requirements
- FS 1000 General Sampling Procedures
- FS 2000 General Aqueous Sampling
- FT 1000 Field Testing and Measurement
- FT 1100 Field pH
- FT 1200 Field Specific Conductance
- FT 1400 Field Temperature
- FT 1500 Field Dissolved Oxygen
- FT 1600 Field Turbidity

2. Groundwater samples may be collected from a number of different configurations. Each configuration is associated with a unique set of sampling equipment requirements and techniques:

3. Wells without Plumbing: These wells require that equipment be brought to the well to purge and sample unless dedicated equipment is placed in the well.

4. Wells with In-Place Plumbing: Wells with in-place plumbing do not require that equipment be brought to the well to purge and sample. In-place plumbing is generally considered permanent equipment routinely used for purposes other than purging and sampling, such as for water supply. They are generally found at wellfields, industrial facilities, and private residences. See FS 2300 for procedures to sample potable water wells. Air Strippers or Remedial Systems: These types of systems are installed as remediation devices. Sample these wells like drinking water wells (see FS 2300).

FS 2201 *Equipment and Supplies*

Use groundwater purging and sampling equipment constructed of only non-reactive, non-leachable materials that are compatible with the environment and the selected analytes. In selecting groundwater purging and sampling equipment, give consideration to the depth of the well, the depth to groundwater, the volume of water to be evacuated, the sampling and purging technique, and the analytes of interest. Refer to Tables FS 1000-1, FS 1000-2, FS 1000-3 and FS 2200-1 for selection of appropriate equipment.

Additional supplies such as reagents, preservatives, and field measurement equipment are often necessary.

1. FLOW CONTAINER: DEP recommends using a flow-through cell or container when collecting measurements for purging stabilization. The design must ensure that fresh formation water continuously contacts the measuring devices and does not aerate the sample or otherwise affect the groundwater properties.

2. PUMPS: All pumps or pump tubing must be lowered and retrieved from the well slowly and carefully to minimize disturbance to the formation water. This is especially critical at the air/water interface. Avoid the resuspension of sediment particles (turbidity) at the bottom of the well or adhered to the well casing during positioning of the pump or tubing.

2.1 Above-Ground Pumps

2.1.1 Variable Speed Peristaltic Pump: Use a variable speed peristaltic pump to purge groundwater from wells when the static water level in the well is no greater than 20-25 feet below land surface (BLS). If the water levels are deeper than 18-20 feet BLS, the pumping velocity will decrease.

2.1.1.1 A variable speed peristaltic pump can be used for normal purging and sampling (see FS 2213 and FS 2221), sampling low permeability aquifers or formations (see FS 2222) and collecting filtered groundwater samples (see FS 2225, section 1).

2.1.1.2 Most analyte groups can be sampled with a peristaltic pump if the tubing and pump configurations are appropriate. See Table FS 1000-3 for proper tubing selection and pump configurations.

2.1.2 Variable Speed Centrifugal Pump: A variable speed centrifugal pump can be used to purge groundwater from 2-inch and larger internal diameter wells. Do not use this type of pump to collect groundwater samples.

2.1.2.1 When purging is complete, do not allow the water that remains in the tubing to fall back into the well. Install a check valve at the end of the purge tubing, and withdraw the tubing slowly from the well while the pump is still running.

2.1.2.2 See Table FS 1000-3 for proper tubing selection and allowable analyte groups.

2.2 Submersible Pumps

2.2.1 Variable Speed Electric Submersible Pump: A variable speed submersible pump can be used to purge and sample groundwater from 2-inch and larger internal diameter wells.

2.2.1.1 A variable speed submersible pump can be used for normal purging and sampling (see FS 2213 and FS 2221), sampling low permeability aquifers or

formations (see FS 2222) and collecting filtered groundwater samples (see FS 2225, section 1).

2.2.1.2 Make sure that the pump housing, fittings, check valves and associated hardware are constructed of stainless steel. Make sure that any other materials are compatible with the analytes of interest. See Table FS 1000-3 for restrictions.

2.2.1.3 Install a check valve at the output side of the pump to prevent backflow.

2.2.1.4 If purging and sampling for organics:

- The entire length of the delivery tube must be Teflon, Polyethylene or Polypropylene (PP) tubing.
- The electrical cord must be sealed in Teflon, Polyethylene or PP and any cabling must be sealed in Teflon, Polyethylene or PP, or be constructed of stainless steel.
- All interior components that contact the sample water (impeller, seals, gaskets, etc.) must be constructed of stainless steel or Teflon.

2.2.2 Variable Speed Bladder Pump: A variable speed positive displacement bladder pump (no-gas contact) can be used to purge and sample groundwater from 3/4-inch and larger internal diameter wells.

2.2.2.1 A variable speed bladder pump can be used for normal purging and sampling (see FS 2213 and FS 2221), sampling low permeability aquifers or formations (see FS 2222) and collecting filtered groundwater samples (see FS 2225, section 1).

2.2.2.2 The bladder pump system is composed of the pump, the compressed air tubing, the water discharge tubing, the controller and a compressor or compressed gas supply.

2.2.2.3 The pump consists of a bladder and an exterior casing or pump body that surrounds the bladder and two (2) check valves. These parts can be composed of various materials, usually combinations of polyvinyl chloride (PVC), Teflon, Polyethylene, PP and stainless steel. Other materials must be compatible with the analytes of interest. See Table FS 1000-3 for restrictions.

2.2.2.4 If purging and sampling for organics:

- The pump body must be constructed of stainless steel and the valves and bladder must be Teflon, Polyethylene or PP
- The entire length of the delivery tube must be Teflon, Polyethylene or PP.
- Any cabling must be sealed in Teflon Polyethylene or PP, or be constructed of stainless steel.
- Permanently installed pumps may have a PVC pump body as long as the pump remains in contact with the water in the well.

3. BAILERS:

3.1 Purging: DEP does not recommend using bailers for purging unless no other equipment can be used or purging with a bailer has been specifically authorized by a DEP program, permit, contract or order (see Table FS 2200-3). Use a bailer if there is non-aqueous phase liquid (free product) in the well or non-aqueous phase liquid is suspected to

be in the well. If in doubt about the appropriateness of using a bailer at a site or during a particular sampling event, contact the appropriate DEP program or project manager. If a bailer is used, follow FS 2213, section 4, with no deviations.

3.2 Sampling: Bailers may be used to routinely collect some analyte groups or under specific circumstances for other analyte groups (see Table FS 2200-3).

3.3 Construction and Type:

3.3.1 Bailers must be constructed of materials compatible with the analytes of interest. See Table FS 1000-3 for restrictions.

3.3.2 Stainless steel, Teflon, Polyethylene and PP bailers may be used to sample all analytes.

3.3.3 Use disposable bailers when sampling grossly contaminated sample sources.

3.3.4 DEP recommends using dual check valve bailers when collecting samples.

3.3.5 Use bailers with a controlled flow bottom when collecting volatile organic samples.

3.3.6 Use bailers that can be pressurized when collecting filtered samples for metals.

3.4 Contamination Prevention:

3.4.1 Keep the bailer wrapped (foil, butcher paper, etc.) until just before use.

3.4.2 Use protective gloves to handle the bailer once it is removed from its wrapping.

3.4.3 Handle the bailer by the lanyard to minimize contact with the bailer surface.

4. LANYARDS

4.1 Lanyards must be made of non-reactive, non-leachable material such as cotton twine, nylon, or stainless steel; or, coated with Teflon, Polyethylene or PP.

4.1.1 Evaluate the appropriateness of the lanyard material with analyses of equipment blanks for the analytes of interest, as necessary.

4.2 Discard cotton twine, nylon, and non-stainless steel braided lanyards after sampling each monitoring well.

4.3 Decontaminate stainless steel, coated Teflon, Polyethylene and PP lanyards between monitoring wells (see FC 1003). They do not need to be decontaminated between purging and sampling operations.

4.4 Securely fasten lanyards to downhole equipment (bailers, pumps, etc.).

4.5 Do not allow lanyards used for downhole equipment to touch the ground surface.

FS 2210. GROUNDWATER PURGING

Perform procedures in the following sections to calculate purging parameters and to purge groundwater from monitoring wells, wells with installed plumbing, high-volume wells, air stripper systems and other remedial treatment systems.

FS 2211 *Water Level and Purge Volume Determination*

Collect representative groundwater samples from the aquifer. The amount of water that must be purged from a well is determined by the volume of water and/or field parameter stabilization.

1. GENERAL EQUIPMENT CONSIDERATIONS

1.1 Selection of appropriate purging equipment depends on the analytes of interest, the well diameter, transmissivity of the aquifer, the depth to groundwater and other site conditions.

1.2 Use a pump to purge the well.

1.3 Use a bailer if there is non-aqueous phase liquid in the well or non-aqueous phase liquid is suspected to be in the well.

1.4 Bailers may be used if approved by a DEP program, or if bailer use is specified in a permit, contract or DEP order (see Table FS 2200-3). If used, bailers must be of appropriate type and construction, and the user must follow the procedure outlined in FS 2213, section 4, with no deviations. If in doubt about the appropriateness of using a bailer at a site or during a particular sampling event, contact the appropriate DEP program or project manager. DEP does not recommend using bailers because improper bailing:

1.4.1 Introduces atmospheric oxygen which precipitates metals (i.e., iron) or causes other changes in the chemistry of the water in the sample (i.e., pH)

1.4.2 Agitates groundwater which biases volatile and semi-volatile organic analyses due to volatilization

1.4.3 Agitates the water in the aquifer and resuspends fine particulate matter

1.4.4 Surges the well, loosening particulate matter in the annular space around the well screen

1.4.5 Introduces dirt into the water column if the sides of the casing wall are scraped

2. INITIAL INSPECTION

2.1 Verify the identification of the monitoring well by examining markings, sign plates, placards or other designations.

2.2 Remove the well cover and remove all standing water around the top of the well casing (manhole) before opening the well cap.

2.3 Inspect the exterior protective casing of the monitoring well for damage and document the results of the inspection if there is a problem.

2.4 It is recommended that you place a protective covering around the well head. Replace the covering if it becomes soiled or ripped.

2.5 Inspect the well lock and determine whether the cap fits tightly. Replace the cap if necessary.

3. WATER LEVEL MEASUREMENTS: Use an electronic probe or chalked tape to determine the water level.

3.1 General Procedures

Perform these steps using either the electronic probe or chalked tape method.

3.1.1 Decontaminate all equipment that will contact the groundwater in the well before use.

3.1.2 Measure the depth to groundwater from the top of well casing to the nearest 0.01 foot and always measure from the same reference point or survey mark on the well casing. If there is no reference mark, measure from the north side of the casing.

3.1.3 Record the measurement and the reference point.

3.2 Electronic Probe

3.2.1 Follow the manufacturer's instructions for use.

3.2.2 Record the measurement.

3.3 Chalked Line Method: This method is not recommended if collecting samples for organic or inorganic parameters.

3.3.1 Lower chalked tape into the well until the lower end is in the water (usually determined by the sound of the weight hitting the water).

3.3.2 Record the length of the tape relative to the reference point (see section 3.2 above).

3.3.3 Quickly remove the tape from the well.

3.3.4 Record the length of the wetted portion to the nearest 0.01 foot.

3.3.5 Determine the depth to water by subtracting the length of the wetted portion (see section 3.5.3 above) from the total length (see section 3.5.2 above). Record the result.

4. WATER COLUMN DETERMINATION

4.1 Do not determine the total depth of the well by lowering the probe to the bottom of the well immediately before purging and sampling. If the well must be sounded, delay purging and sampling activities for at least 24 hours after the well was sounded or for a time sufficient to meet the purge stabilization criterion for turbidity. Alternatively, collect samples before sounding the well.

4.2 Subtract the depth to the top of the water column from the total well depth to determine the length of the water column.

4.3 The total well depth depends on the well construction. Some wells may be drilled in areas of sinkhole or karst formations or rock leaving an open borehole. Attempt to find the total borehole depth in cases where there is an open borehole below the cased portion.

5. WELL WATER VOLUME

5.1 Calculate the total volume of water in gallons in the well using the following equation:

V = (0.041)d x d x h

Where: V = volume in gallons

d = well diameter in inches

h = height of the water column in feet

5.2 The total volume of water in the well may also be determined with the following equation by using a casing volume per foot factor (Gallons per Foot of Water) for the appropriate diameter well:

V = [Gallons per Foot of Water] x h

Where: V = volume in gallons

h = height of the water column in feet

Casing Internal Diameter	Approximate Gallons per Foot of Water
0.75”	0.02
1”	0.04
1.25”	0.06
2”	0.16
3”	0.37
4”	0.65
5”	1.02
6”	1.47
12”	5.88

5.3 Record all measurements and calculations in the field records.

6. Purging Equipment Volume

Calculate the total volume of the pump, associated tubing and container that is used for in situ measurements (flow container), if used, using the following equation:

V = p + ((0.041)d x d x l) + fc

Where: V = volume in gallons

p = volume of pump in gallons

d = tubing diameter in inches

l = length of tubing in feet

fc = volume of flow cell in gallons

7. When collecting samples from multiple wells on a site, if the groundwater elevation data are to be used to construct groundwater elevation contour maps, all water level measurements must be taken within the same 24-hour time interval unless a shorter time period is required by a DEP program. If the site is tidally influenced, complete the water level measurements within the time frame of an incoming or outgoing tide.

FS 2212 *Well Purging Techniques*

The selection of the purging technique and equipment is dependent on the hydrogeologic properties of the aquifer, especially depth to groundwater and hydraulic conductivity. The intent of proper purging is to stabilize the water level in the well and minimize the hydraulic stress to the hydrogeologic formation.

Every attempt must be made to match the pumping rate with the recharge rate of the well before evaluating the purging completion criteria.

A flowchart which summarizes purging procedure options is presented in Figure FS 2200-2.

Select equipment using the construction and configuration requirements specified in Table FS 2200-1. See the discussions in FS 2201.

1. MEASURING THE PURGE VOLUME: The volume of water that is removed during purging must be recorded. Measure the volume during the purging operation.

1.1 Collect the water in a graduated container and multiply the number of times the container was emptied by the volume of the container, or

1.2 Estimate the volume based on pumping rate. Use this technique only if the pumping rate is constant. Determine the pumping rate by measuring the amount of water that is pumped for a fixed period of time or use a flow meter.

1.2.1 Calculate the amount of water that is discharged per minute:

$$D = \frac{\text{Measured amount}}{\text{Total time in minutes}}$$

1.2.2 Calculate the time needed to purge one (1) well volume or one (1) purging equipment volume:

$$\text{Time} = \frac{V}{D}$$

Where: V = well volume determined from FS 2211, section 5, or purging equipment volume

D = discharge rate calculated in section 1.2.1. above

1.2.3 Make new measurements (see section 1.2.1 above) each time the pumping rate is changed, or

1.3 Use a totalizing flow meter.

1.3.1 Record the reading on the totalizer prior to purging.

1.3.2 Record the reading on the totalizer at the end of purging.

1.3.3 Subtract the reading on the totalizer prior to purging from the reading on the totalizer at the end of purging to obtain the volume purged.

1.4 Record in the field records the times that purging begins and ends.

2. Stabilization Measurement Frequency

2.1 Begin to record stabilization measurements after pumping the minimum volume as prescribed in options 2.3 – 2.5 below. Every attempt must be made to match the pumping rate with the recharge rate of the well before evaluating the purging criteria.

2.2 If the well screened interval is not known, use option 2.3, below.

2.3 <u>Wells with Fully Submerged Screen and Pump or Intake Tubing Placed at the Top of the Water Column (conventional purge):</u> Purge until the water level has stabilized (well recovery rate equals the purge rate), then purge a minimum of one (1) well volume prior to collecting measurements of the stabilization parameters. Allow at least one quarter (1/4) well volume to purge between subsequent measurements.

2.4 <u>Wells with Fully Submerged Screen and Pump or Intake Tubing Placed Within the Screened Interval (minimizing purge volume):</u> Purge until the water level has stabilized (well recovery rate equals the purge rate), then purge a minimum of one (1) volume of the pump, associated tubing and flow container (if used) prior to collecting measurements of the stabilization parameters. Take measurements of the stabilization parameters no sooner

than two (2) minutes apart. Purge at least three (3) volumes of the pump, associated tubing and flow container, if used, prior to collecting a sample.

If the water level drops into the screened interval during purging, lower the pump or tubing intake as in FS 2213, section 1.3 below and follow purging procedures for partially submerged well screens (2.5 below).

2.5 Wells with a Partially Submerged Well Screen: Purge until the water level has stabilized (well recovery rate equals the purge rate), then purge a minimum of one (1) well volume prior to collecting measurements of the stabilization parameters. Take measurements of the stabilization parameters no sooner than two (2) minutes apart.

3. PURGING COMPLETION: DEP recommends the use of a flow-through container to measure the stabilization parameters discussed below. Alternatively, measure all parameters *in situ* by inserting measurement probes into the well at the depth appropriate for the purging option. Purging is considered complete if the criteria in section 3.1, 3.2 or 3.3 below are satisfied. Make every attempt to satisfy the criteria in section 3.1. Every attempt must be made to match the pumping rate with the recharge rate of the well before evaluating the purging criteria.

3.1 Three (3) consecutive measurements of the five (5) parameters listed below must be within the stated limits. The measurements evaluated must be the last three consecutive measurements taken before purging is stopped. The range between the highest and the lowest values for the last three measurements of temperature, pH and specific conductance cannot exceed the stated limits. The last three consecutive measurements of dissolved oxygen and turbidity must all be at or below the listed thresholds.

- Temperature: ± 0.2° C
- pH: ± 0.2 Standard Units
- Specific Conductance: ± 5.0% of reading
- Dissolved Oxygen: ≤20% Saturation
- Turbidity: ≤20 NTU

3.2 Naturally occurring conditions may prevent attaining the ≤20% saturation criterion for dissolved oxygen, typically in surficial aquifers. See section 3.5, below.

3.3 Naturally occurring conditions may prevent attaining the ≤20 NTU criterion for turbidity. However, when collecting groundwater samples for metals or certain inorganic (e.g., phosphorus forms) or extractable organic (e.g. polynuclear aromatic hydrocarbons) chemicals, make every attempt to reduce turbidity to ≤20 NTU to avoid a potential turbidity-associated bias for these analytes. See section 3.5, below.

3.4 Document and report the following, as applicable, except that the last four (4) items only need to be submitted once:

- Purging rate.
- Drawdown in the well, if any.
- Pump or tubing intake placement.
- Length and location of the screened interval.
- A description of the process and the data used to design the well.
- The equipment and procedure used to install the well.

- The well development procedure.
- Pertinent lithologic or hydrogeologic information.

3.5 If the criteria in section 3.1 above for dissolved oxygen and/or turbidity cannot be met, then three (3) consecutive measurements of the five (5) parameters listed below must be within the stated limits.

3.5.1 The measurements evaluated must be the last three consecutive measurements taken before purging is stopped. The range between the highest and the lowest values for the last three measurements cannot exceed the stated limits.

- Temperature: ± 0.2° C
- pH: ± 0.2 Standard Units
- Specific Conductance: ± 5.0% of reading
- Dissolved Oxygen: ± 0.2 mg/L or 10%, whichever is greater
- Turbidity: ± 5 NTUs or 10%, whichever is greater

3.5.2 Additionally, document and report the following, as applicable, except that the last four (4) items only need to be submitted once:

- Purging rate.
- Drawdown in the well, if any.
- Pump or tubing intake placement.
- Length and location of the screened interval.
- A description of conditions at the site that cause the dissolved oxygen to be high and/or dissolved oxygen measurements made within the screened or open borehole portion of the well with a downhole dissolved oxygen probe.
- A description of conditions at the site that cause the turbidity to be high and any procedures that will be used to minimize turbidity in the future.
- A description of the process and the data used to design the well.
- The equipment and procedure used to install the well.
- The well development procedure.
- Pertinent lithologic or hydrogeologic information.

3.5.3 If from review of the submitted data the Department determines that both the elevated Dissolved Oxygen and Turbidity measurements are due to naturally occurring conditions, then only the first four (4) items are required to be submitted in future reports. However, if the Department cannot determine if the Dissolved Oxygen or Turbidity is elevated due to naturally occurring conditions, then in addition to the first four (4) items, a description of the conditions at the site that caused the affected parameter(s) to be high is required to be submitted in future reports.

3.6 If the stabilization parameters in either section 3.1 or 3.2 cannot be met, and all attempts have been made to minimize the drawdown, check the instrument condition and calibration, purging flow rate and all tubing connections to determine if they might be affecting the ability to achieve stable measurements. All measurements that were made during the attempt must be documented. The sampling team leader may decide whether or

not to collect a sample or to continue purging after five (5) well volumes (conventional purge section 2.1 or 2.3 above) or five (5) volumes of the screened interval (minimizing purge volumes in section 2.2 above).

Further, the report in which the data are submitted must include the following, as applicable, except that the last four (4) items only need to be submitted once:

- Purging rate.
- Pump or tubing intake placement.
- Length and location of the screened interval.
- Drawdown in the well, if any.
- A description of conditions at the site that caused the dissolved oxygen to be high and/or dissolved oxygen measurements made within the screened or open borehole portion of the well with a downhole dissolved oxygen probe.
- A description of conditions at the site that caused the turbidity to be high and any procedures that will be used to minimize turbidity in the future.
- A description of the process and the data used to design the well.
- The equipment and procedure used to install the well.
- The well development procedure.
- Pertinent lithologic or hydrogeologic information.

If from review of the submitted data the DEP determines that both the elevated Dissolved Oxygen and Turbidity measurements are due to naturally occurring conditions, then only the first four (4) items are required to be submitted in future reports. However, if the DEP cannot determine if the Dissolved Oxygen or Turbidity is elevated due to naturally occurring conditions, then in addition to the first four (4) items, a description of the conditions at the site that caused the affected parameter(s) to be high is required to be submitted in future reports.

3.7 One fully dry purge (not recommended). This criterion applies only if purging was attempted per FS 2212, FS 2213, and section 3.4.1 below, and if it is impossible to balance the pumping rate with the rate of recharge at very low pumping rates (< 100 mL/minute).

3.7.1 If wells have previously and consistently purged dry, when purged according to FS 2212 and FS 2213, and the current depth to groundwater indicates that the well will purge dry during the current sampling event, minimize the amount of water removed from the well by using the same pump to purge and collect the sample:

3.7.1.1 Place the pump or tubing intake within the well screened interval.

3.7.1.2 Use very small diameter Teflon, Polyethylene or PP tubing and the smallest possible pump chamber volume to minimize the total volume of water pumped from the well and to reduce drawdown.

3.7.1.3 Select tubing that is thick enough to minimize oxygen transfer through the tubing walls while pumping.

3.7.1.4 Pump at the lowest possible rate (100 mL/minute or less) to reduce drawdown to a minimum.

3.7.1.5 Purge at least two (2) volumes of the pumping system (pump, tubing and flow cell, if used).

3.7.1.6 Measure pH, Specific Conductance, Temperature, Dissolved Oxygen and Turbidity and begin to collect the samples (see FS 2222).

4. Collect samples immediately after purging is complete.

4.1 The time period between completing the purge and sampling cannot exceed six (6) hours.

4.2 If sample collection does not occur within one (1) hour of purging completion, re-measure the five (5) field parameters Temperature, pH, Specific Conductance, Dissolved Oxygen and Turbidity just prior to collecting the sample.

4.2.1 If the measured values are not within 10 percent of the previous measurements, re-purge the well.

4.2.2 See section 3.4 above when collecting samples from wells that have purged dry.

FS 2213 *Purging Wells Without Plumbing (Monitoring Wells)*

1. TUBING/PUMP PLACEMENT

1.1 Do not lower the pump or intake hose (tubing) to the bottom of the well. Pump or tubing placement procedures will be determined by the purging option selected in FS 2212, section 2 above or FS 2214 below.

1.1.1 Minimizing Purge Volume: If the following conditions can be met, position the intake hose (tubing) or pump in the screened or open borehole interval.

- The same pump must be used for both purging and sampling,
- The well screen or borehole interval must be less than or equal to 10 feet, and
- The well screen or borehole must be fully submerged.

1.1.2 If the position or length of the screened interval or open borehole is unknown or estimated, place the intake hose (tubing) or pump to perform conventional purging in 1.2 below.

1.1.3 Position the pump or intake hose when purging large-diameter deep wells with open boreholes using the procedure in FS 2214 below.

1.2 Conventional Purging: Position the pump or intake tubing in the top one foot of the water column or no deeper than necessary for the type of pump.

1.2.1 If purging with a bailer, see section 4 below.

1.3 Partially Submerged Screened Interval: If the well screen or open borehole is partially submerged, and the pump will be used for both purging and sampling, position the pump or intake hose (tubing) in the portion of the water column within the submerged screened or open borehole interval.

1.3.1 If the position or length of the screened interval or open borehole is unknown or estimated, place the intake hose (tubing) or pump to perform conventional purging in 1.2 above.

1.3.2 Purge large-volume, high-recharge wells as in FS 2214 below.

1.3.3 If purging with a bailer, see section 4 below.

2. NON-DEDICATED (PORTABLE) PUMPS

2.1 Variable Speed Peristaltic Pump

2.1.1 Install a new, 1-foot maximum length of silicone tubing in the peristaltic pump head.

2.1.2 Attach a short section of tubing to the discharge side of the pump-head silicone tubing and into a graduated container.

2.1.3 Attach one end of a length of new or precleaned transport tubing to the intake side of the pump head silicone tubing.

2.1.4 Place the transport tubing in the monitoring well per one of the options in FS 2213, section 1 above.

2.1.5 Measure the depth to groundwater at frequent intervals.

2.1.6 Record these measurements.

2.1.7 Adjust the purging rate so that it is equivalent to the well recovery rate to minimize drawdown.

2.1.8 If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdrawal rate with the recharge rate.

2.1.9 If the water table continues to drop during pumping, lower the tubing at the approximate rate of drawdown so that the water is removed from the top of the water column.

2.1.10 Record the purging rate each time the rate changes.

2.1.11 Measure the purge volume by one of the methods outlined in FS 2212, section 1.

2.1.12 Record this measurement.

2.1.13 Decontaminate the pump and tubing between wells (see FC 1000) or only the pump if precleaned tubing is used for each well.

2.2 Variable Speed Centrifugal Pump

2.2.1 Position fuel powered equipment **downwind** and at least 10 feet from the well head. Make sure that the exhaust faces downwind.

2.2.2 Place the decontaminated suction hose so that water is always pumped from the top of the water column.

2.2.3 Equip the suction hose with a foot valve to prevent purge water from re-entering the well.

2.2.4 Measure the depth to groundwater at frequent intervals.

2.2.5 Record these measurements.

2.2.6 Adjust the purging rate so that it is equivalent to the well recovery rate to minimize drawdown.

2.2.7 If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdrawal rate with the recharge rate.

2.2.8 If the water table continues to drop during pumping, lower the tubing at the approximate rate of drawdown so that the water is removed from the top of the water column.

2.2.9 Record the purging rate each time the rate changes.

2.2.10 Measure the purge volume by one of the methods outlined in FS 2212, section 1.

2.2.11 Record this measurement.

2.2.12 Decontaminate the pump and tubing between wells (see FC 1000) or only the pump if precleaned tubing is used for each well.

2.3 Variable Speed Electric Submersible Pump

2.3.1 Position fuel powered equipment downwind and at least 10 feet from the well head. Make sure that the exhaust faces downwind.

2.3.2 Carefully position the decontaminated pump per one of the options in FS 2213, section 1 above.

2.3.3 Measure the depth to groundwater at frequent intervals.

2.3.4 Record these measurements.

2.3.5 Adjust the purging rate so that it is equivalent to the well recovery rate to minimize drawdown.

2.3.6 If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdrawal rate with the recharge rate.

2.3.7 If the water table continues to drop during pumping, lower the tubing or pump at the approximate rate of drawdown so that the water is removed from the top of the water column.

2.3.8 Record the purging rate each time the rate changes.

2.3.9 Measure the purge volume by one of the methods outlined in FS 2212, section 1.

2.3.10 Record this measurement.

2.3.11 Decontaminate the pump and tubing between wells (see FC 1000) or only the pump if precleaned tubing is used for each well.

2.4 Variable Speed Bladder Pump

2.4.1 Position fuel powered equipment **downwind** and at least 10 feet from the well head. Make sure that the exhaust faces downwind.

2.4.2 Attach the tubing and carefully position the pump per one of the options in FS 2213, section 1 above.

2.4.3 Measure the depth to groundwater at frequent intervals.

2.4.4 Record these measurements.

2.4.5 Adjust the purging rate so that it is equivalent to the well recovery rate to minimize drawdown.

2.4.6 If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdrawal rate with the recharge rate.

2.4.7 If the water table continues to drop during pumping, lower the tubing or pump at the approximate rate of drawdown so that the water is removed from the top of the water column.

2.4.8 Record the purging rate each time the rate changes.

2.4.9 Measure the purge volume by one of the methods outlined in FS 2212, section 1.

2.4.10 Record this measurement.

2.4.11 Decontaminate the pump and tubing between wells (see FC 1000) or only the pump if precleaned tubing is used for each well.

3. DEDICATED PORTABLE PUMPS: Place dedicated pumps per one of the options in FS 2213, section 1 above.

3.1 Variable Speed Electric Submersible Pump

3.1.1 Position fuel powered equipment **downwind** and at least 10 feet from the well head. Make sure that the exhaust faces downwind.

3.1.2 Measure the depth to groundwater at frequent intervals.

3.1.3 Record these measurements.

3.1.4 Adjust the purging rate so that it is equivalent to the well recovery rate to minimize drawdown.

3.1.5 If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdrawal with the recharge rate.

3.1.6 Record the purging rate each time the rate changes.

3.1.7 Measure the purge volume by one of the methods outlined in FS 2212, section 1.

3.1.8 Record this measurement.

3.2 Variable Speed Bladder Pump

3.2.1 Position fuel powered equipment **downwind** and at least 10 feet from the well head. Make sure that the exhaust faces downwind.

3.2.2 Measure the depth to groundwater at frequent intervals.

3.2.3 Record these measurements.

3.2.4 Adjust the purging rate so that it is equivalent to the well recovery rate to minimize drawdown.

3.2.5 If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdrawal with the recharge rate.

3.2.6 Record the purging rate each time the rate changes.

3.2.7 Measure the purge volume by one of the methods outlined in FS 2212, section 1.

3.2.8 Record this measurement.

4. BAILERS: DEP recommends against using bailers for purging except as a last contingency, or if free product is present in the well or suspected to be in the well. However, they may be used if approved by a DEP program, or specified in a permit, contract or DEP order (see Table FS 2200-3 and FS 2211, section 1.3). If in doubt about the appropriateness of using a bailer at a site or during a particular sampling event, contact the appropriate DEP program or project manager.

4.1 Minimize handling the bailer as much as possible.

4.1.1 Remove the bailer from its protective wrapping just before use.

4.1.2 Attach a lanyard of appropriate material (see FS 2201, section 4).

4.1.3 Use the lanyard to move and position the bailer.

4.2 Lower and retrieve the bailer slowly and smoothly.

4.3 Lower the bailer carefully into the well to a depth approximately a foot above the water column.

4.3.1 Do not lower the top of the bailer more than one (1) foot below the top of the water table so that water is removed from the top of the water column. Ensure that the length of the bailer does not exceed the length of the water column.

4.3.2 Allow time for the bailer to fill with aquifer water as it descends into the water column.

4.4 Carefully raise the bailer.

4.4.1 Retrieve the bailer at the same rate of 2 cm/sec until the bottom of the bailer has cleared to top of the water column.

4.5 Measure the purge volume by one of the methods outlined in FS 2212, section 1.

4.5.1 Record the volume of the bailer.

4.6 Continue to carefully lower and retrieve the bailer as described above until the purging completion conditions specified in FS 2212, section 3, have been satisfied.

4.6.1 Remove at least one (1) well volume before collecting measurements of the field parameters. Take each subsequent set of measurements after removing at least one quarter (1/4) well volume between measurements.

FS 2214 *Purging Large-Volume, High-Recharge Wells With Portable Pumps*

If a well originally constructed for high-flow-rate pumping will be sampled as a monitoring well, use these guidelines to develop a purging procedure applicable to the specific details of the well construction. Typical wells constructed for this purpose may be deep, large-diameter wells with a section of open borehole. Evaluate each well on a case-by-case basis and consider any available information on the construction and hydraulic performance of the well.

1. PURGING PROCEDURE

1.1 Place the pump at the top of the open borehole segment of the well.

1.2 Start purging while monitoring stabilization parameters as in FS 2212, section 3 above.

1.3 Purge at least one equipment volume before measuring stabilization parameters.

1.4 If the well is being purged for the first time using these guidelines, monitor stabilization parameters for an extended period until confident that sufficient volume has been pumped from the open borehole to draw fresh formation water into the pump tubing and flow-through container. Use the information obtained from the first-time purging of the well to determine the pumping rate and duration of purging required for future sampling events at the well.

1.5 Purge at least three equipment volumes before evaluating purging completion.

2. PURGING COMPLETION

2.1 Complete the purging of the well when the last three consecutive measurements of the purge stabilization parameters have met the applicable criteria specified in FS 2212, section 3 above.

3. Collect samples from the well using the procedures in FS 2221, section 1 below.

FS 2215. *Purging Wells With Plumbing (production wells or permanently installed pumps equipped with sampling ports or sampling spigots)*

Wells with in-place plumbing are commonly found at municipal water treatment plants, industrial water supplies, private residences, etc. Depending on the sampling objective for collecting samples using installed plumbing, purge the system and collect samples closest to the point of consumption, or, as close to the source well as possible. When purging is required and the purge volume of the plumbing system is not known, purge the system until the purging completion criteria in FS 2212, section 3, have been met.

1. CONTINUOUSLY RUNNING PUMPS

1.1 Select the spigot that is closest to the pump and before any storage tanks (if possible).

1.2 Remove all hoses, aerators and filters (if possible).

1.3 Open the spigot and purge at maximum flow.

1.4 If a storage tank is located between the pump and the spigot, purge the volume of the tank, lines and spigot.

1.5 If the spigot is before any storage tank, purge until sufficient volume is removed to flush the stagnant water from the spigot and the tap line to the spigot.

1.6 Reduce the flow rate to ≤ 500 mL/minute (a 1/8” stream) or approximately 0.1 gal/minute before collecting samples. When sampling for volatile organic compounds, reduce the flow to ≤100 mL/minute before collecting the samples.

2. INTERMITTENTLY RUNNING PUMPS

2.1 Select the spigot that is closest to the pump and before any storage tanks (if possible).

2.2 Remove all hoses, aerators and filters (if possible).

2.3 Open the spigot and purge sufficient volume at a maximum, practical flow rate to flush the spigot and lines and until the purging completion criteria in FS 2212, section 3, have been met.

2.4 If a storage tank is located between the pump and the spigot, purge the volume of the tank, lines and spigot.

2.5 Ensure that the purge stabilization measurement of dissolved oxygen is not biased with aeration of the sample by a high flow rate in the flow-through container.

2.6 Reduce the flow rate to ≤ 500 mL/minute (a 1/8” stream) or approximately 0.1 gal/minute before collecting samples. When sampling for volatile organic compounds, reduce the flow to ≤ 100 mL/minute before collecting the samples.

FS 2216. *Purging Airstrippers and Remedial Treatment Systems*

If collecting samples for groundwater contamination monitoring, follow FS 2215above.

FS 2220. GROUNDWATER SAMPLING TECHNIQUES

1. Purge wells using the techniques outlined in FS 2210.

2. Replace the protective covering around the well if it is soiled or torn after completing the purging operations.

3. EQUIPMENT CONSIDERATIONS

Follow all notes and restrictions as indicated in Table FS 2200-1 and as discussed in FS 2201.

NOTE: The only pumps that are currently approved for use in collecting volatile organic samples through the pump are stainless steel and Teflon variable speed submersible pumps, stainless steel and Teflon or Polyethylene variable speed bladder pumps, and permanently installed PVC bodied pumps (variable speed bladder or submersible pumps) as long as the pump remains in contact with the water in the well at all times.

3.1 Collect the sample into the sample container from the sampling device. **Do not** use intermediate containers.

3.2 In order to avoid contaminating the sample or loss of analytes from the sample:

3.3 Handle the sampling equipment as little as possible.

3.3.1 Minimize the equipment that is exposed to the sample.

3.3.2 Minimize aeration of samples collected for VOC analysis.

3.3.3 Reduce sampling pump flow rates to $\leq$ 100 mL/minute when collecting VOC samples.

3.4 Dedicated Sampling Equipment

3.4.1 Whenever possible, use dedicated equipment because it significantly reduces the chance of cross-contamination.

3.4.2 Dedicated is defined as equipment that is to be used solely for one location for the life of that equipment (e.g., permanently mounted pump).

3.4.3 All material construction and restrictions from Table FS 2200-1 also apply to dedicated equipment. Purchase equipment with the most sensitive analyte of interest in mind.

3.5 Cleaning/Decontamination

3.5.1 Clean or ensure dedicated pumps are clean before installation. They do not need to be cleaned prior to each use but must be cleaned if they are withdrawn for repair or servicing.

3.5.2 Clean or make sure any permanently mounted tubing is clean before installation.

3.5.3 Change or clean tubing when the pump is withdrawn for servicing.

3.5.4 Clean any replaceable or temporary parts as specified in FC 1000.

3.5.5 Collect equipment blanks on dedicated pumping systems when the tubing is cleaned or replaced.

3.5.6 Clean or ensure dedicated bailers are clean before placing them into the well.

3.5.7 Collect an equipment blank on dedicated bailers before introducing them into the water column.

3.5.8 Suspend dedicated bailers above the water column if they are stored in the well.

FS 2221. *Sampling Wells Without Plumbing*

1. SAMPLING WITH PUMPS: Variable speed stainless steel and Teflon submersible pumps and stainless steel, Teflon or Polyethylene bladder pumps, and permanently installed PVC-bodied variable speed submersible or bladder pumps, as long as the pump remains in contact with the water in the well at all times, may be used to sample for all organics. The delivery tubing must be Teflon, Polyethylene or PP. **Extractable organics** may be collected through a peristaltic pump if ≤ 1 foot of silicone tubing is used in the pump head or a vacuum trap is used (see Figure FS 2200-1 for specific configuration). Follow all notes and restrictions as defined in Table FS 2200-1 and discussed in Equipment and Supplies (FS 2201) when using pumps to collect samples.

Do not lower the pump or tubing to the bottom of the well.

1.1 Peristaltic Pump

1.1.1 Volatile Organics Using Manual Fill and Drain Method: Collect volatile organics last. If the pump tubing is placed within the screened interval, the tubing cannot be reinserted into the well, and steps 1.1.1.3 through 1.1.1.6 below are prohibited.

1.1.1.1 Ensure that there is sufficient tubing volume to fill the requisite number of VOC vials.

1.1.1.2 Remove the drop tubing from the inlet side of the pump.

1.1.1.3 Submerse the drop tubing into the water column and allow it fill.

1.1.1.4 Remove the drop tubing from the well.

1.1.1.5 Prevent the water in the tubing from flowing back into the well.

1.1.1.6 Carefully allow the groundwater to drain by gravity into the sample vials. Avoid turbulence. Do not aerate the sample. The flow rate must be ≤ 100 mL/minute.

1.1.1.7 Repeat steps 1.1.1.3 - 1.1.1.6 until enough vials are filled.

1.1.2 Volatile Organics Using the Pump to Fill and Drain the Tubing: Collect volatile organics last. If the pump tubing is placed within the screened interval, the tubing cannot be reinserted into the well, and steps 1.1.2.2 through 1.1.2.8 below are prohibited.

1.1.2.1 Ensure that there is sufficient tubing volume to fill the requisite number of VOC vials.

1.1.2.2 Submerse the drop tubing into the water column.

1.1.2.3 Use the pump to fill the drop tubing.

1.1.2.4 Quickly remove the tubing from the pump.

1.1.2.5 Prevent the water in the tubing from flowing back into the well.

1.1.2.6 Remove the drop tubing from the well and fill the vials using the pump or gravity-drain methods in steps 1.1.2.7 or 1.1.2.8 below.

1.1.2.7 Reverse the flow on the peristaltic pump to deliver the sample into the vials at a slow, steady rate. The flow rate must be ≤ 100 mL/minute.

1.1.2.8 Or, remove the drop tubing from the inlet side of the pump and carefully allow the groundwater to drain into the sample vials. Avoid turbulence. Do not aerate the sample. The flow rate must be ≤ 100 mL/minute.

1.1.2.9 Repeat steps 1.1.2.2 through 1.1.2.8 until enough vials are filled.

1.1.3 Extractable Organics Collected Through Silicone Pump-Head Tubing:

1.1.3.1 Ensure that a 1-foot maximum length of new silicone tubing was installed in the peristaltic pump head assembly before the well was purged if the same pump is being used to purge and sample the well. Otherwise, install a new length of tubing as described above.

1.1.3.2 Collect extractable organic samples directly from the effluent delivery tubing (attached to discharge side of the silicone pump head tubing) into the sample container.

1.1.3.3 If there is a concern that sample analytes are absorbed, adsorbed, leached or otherwise affected or lost by pumping through the silicone pump-head tubing, sample the well using the organic trap assembly in 1.1.4 below.

1.1.4 Extractable Organics Using an Optional Organic Trap Assembly

1.1.4.1 Assemble the components of the pump and trap according to Figure FS 2200-1.

1.1.4.2 The sample container should be the trap bottle.

1.1.4.3 All equipment that contacts the groundwater **before** the sample container must be constructed of Teflon, Polyethylene, PP, stainless steel or glass, including the transport tubing to and from the sample container, the interior liner of the container cap and all fittings. **Do not use a rubber stopper as a cap.**

1.1.4.4 Connect the outflow tubing from the container to the influent side of the peristaltic pump.

1.1.4.5 Prevent the water in the down-hole delivery tubing from flowing back into the well while performing this connection.

1.1.4.6 Turn the pump on and reduce the flow rate to a smooth and even flow.

1.1.4.7 Discard a small portion of the sample to allow an air space.

1.1.4.8 Preserve (if required), label and complete the field notes.

1.1.5 Inorganics

1.1.5.1 Inorganic samples may be collected from the effluent tubing.

1.1.5.2 If samples are collected from the pump, decontaminate all tubing (including the tubing in the head) or change it between wells.

1.1.5.3 Preserve (if required), label and complete field notes.

1.2 Variable Speed Bladder Pump

1.2.1 If sampling for organics the pump body must be constructed of stainless steel and the valves and bladder must be Teflon. All tubing must be Teflon, Polyethylene, or PP and any cabling must be sealed in Teflon, Polyethylene or PP, or made of stainless steel.

1.2.2 After purging to a smooth even flow, reduce the flow rate.

1.2.3 When sampling for volatile organic compounds, reduce the flow rate to 100 mL/minute or less, if possible.

1.3 Variable Speed Submersible Pump

1.3.1 The housing must be stainless steel.

1.3.2 If sampling for organics, the internal impellers, seals and gaskets must be constructed of stainless steel, Teflon, Polyethylene or PP. The delivery tubing must be Teflon, Polyethylene or PP and the electrical cord must be sealed in Teflon and any cabling must be sealed in Teflon or constructed of stainless steel.

1.3.3 After purging to a smooth even flow, reduce the flow rate.

1.3.4 When sampling for volatile organic compounds, reduce the flow rate to 100 mL/minute or less, if possible.

2. SAMPLING WITH BAILERS: A high degree of skill and coordination are necessary to collect representative samples with a bailer. When properly used, bailers may be used to collect samples for certain analyte groups and under specific conditions (see Table FS 2200-3). They must be of an appropriate type and construction (see FS 2201, section 3), and must be used as outlined below. If in doubt about the appropriateness of using a bailer at a site or during a particular sampling event, contact the appropriate DEP program or project manager.

2.1 General Considerations

2.1.1 Minimize handling the bailer as much as possible.

2.1.1.1 Wear sampling gloves.

2.1.1.2 Remove the bailer from its protective wrapping just before use.

2.1.1.3 Attach a lanyard of appropriate material (see FS 2201, section 4).

2.1.1.4 Use the lanyard to move and position the bailers.

2.1.2 Do not allow the bailer or lanyard to touch the ground.

2.1.3 Rinsing

2.1.3.1 If the bailer is certified precleaned, no rinsing is necessary.

2.1.3.2 If both a pump and a bailer are to be used to collect samples, rinse the exterior and interior of the bailer with sample water from the pump before removing the pump.

2.1.3.3 If the purge pump is not appropriate for collecting samples (e.g., non-inert components), rinse the bailer with by collecting a single bailer of the groundwater to be sampled. Use the technique described in section 2.2, Bailing Technique, below.

2.1.3.4 Discard the water appropriately.

2.1.3.5 **Do not** rinse the bailer if Oil & Grease, TRPHs, etc., (see FS 2006) are to be collected.

2.2 Bailing Technique

2.2.1 Collect all samples that are required to be collected with a pump before collecting samples with the bailer.

2.2.2 Raise and lower the bailer gently to minimize stirring up particulate matter in the well and the water column which can increase sample turbidity.

2.2.3 Lower the bailer carefully into the well to a depth approximately a foot above the water column. Ensure that the length of the bailer does not exceed the length of the water column.

2.2.3.1 When the bailer is in position, lower the bailer into the water column at a rate of 2 cm/sec until the desired depth is reached (see section 2.2.3 above).

2.2.4 Do not lower the top of the bailer more than one (1) foot below the top of the water table so that water is removed from the top of the water column.

2.2.5 Allow time for the bailer to fill with aquifer water as it descends into the water column.

2.2.6 Do not allow the bailer to touch the bottom of the well or particulate matter will be incorporated into the sample.

2.2.6.1 Carefully raise the bailer (see section 2.2.2 above). Retrieve the bailer at the same rate of 2 cm/sec until the bottom of the bailer has cleared to top of the water column.

2.2.7 Lower the bailer to approximately the same depth each time.

2.2.8 Collect the sample.

2.2.8.1 Install a device to control the flow from the bottom of the bailer and discard the first few inches of water. Reduce the flow to $\leq$ 100 mL/minute when collecting VOC samples.

2.2.8.2 Fill the appropriate sample containers by allowing the sample to slowly flow down the side of the container. Minimize aeration of VOC samples.

2.2.8.3 Discard the last few inches of water in the bailer.

2.2.9 Repeat steps 2.2.1 through 2.2.8.3 for additional samples.

2.2.10 Measure the DO, pH, temperature, turbidity and specific conductance after the final sample has been collected.

2.2.10.1 Record all measurements and note the time that sampling was completed.

3. SAMPLING WELLS WITH FLOATING NON-AQUEOUS PHASE LIQUID: DEP does not recommend the sampling of wells with floating non-aqueous phase liquid for trace contaminants. This concerns primarily petroleum related sites, but includes any chemical product (e.g., solvent) that floats on the water table. Sampling is acceptable if the information is to be used for the purpose of remedial design.

Sample data from such wells cannot provide useful information regarding the level of contamination. Furthermore, these wells typically do not provide legitimate data because of permanent chemical contamination from product contact with the well casing for an extended period of time.

DEP does reserve the right to require sampling of these wells, not for levels of trace contaminants, but for confirmation of an appropriate remediation technique. This type of sampling is performed **below** the non-aqueous phase layer (see section 3.2 below).

3.1 Non-Aqueous Phase Liquid Sampling: Non-aqueous phase liquid may be evident in a cased monitoring well or in an open excavation.

3.1.1 Non-aqueous phase liquid is normally sampled for two reasons:

- Documentation for its existence and thickness; and
- Determination of the type of product so that the proper analyses can be performed to determine extent. This is only feasible for relatively recent releases as it may not be possible to identify weathered product.

3.1.2 Disposable plastic (acrylic, clear PVC) bailers are recommended for sampling. Disposable Polyethylene and PP bailers are also acceptable. Other wide mouth vessels may be used for sampling non-aqueous phase liquid in an excavation.

3.1.3 Monitoring Well

3.1.3.1 If a non-aqueous phase liquid is identified in a monitoring well during the water level measurement, measure its thickness in the well. If the thickness of the non-aqueous phase liquid is greater than 0.01 foot or product globules are present, collect a sample using a precleaned disposable bailer.

3.1.3.2 Measure the product thickness to the nearest 0.01 foot after withdrawing the bailer.

3.1.3.3 Pour a portion of the product into a glass sample container.

3.1.3.4 This sample is considered a concentrated waste. Therefore, package the container in protective wrapping to prevent breakage, isolate from other samples, and ice to 4°C.

3.1.4 Excavation

3.1.4.1 If non-aqueous phase liquid is observed in an open excavation, a glass sample container or a precleaned intermediate vessel may be used to collect the sample.

3.1.4.2 Securely tie a lanyard to the container and lower it into the excavation.

3.1.4.3 Gently lower and retrieve the container so that no solid material is released or collected.

3.1.4.4 If sufficient water is available, a bailer can be used.

3.1.4.5 Although not recommended, screened casing can be placed (or augered and placed) in the bottom of the excavation and the product sampled with a bailer.

3.1.4.6 Avoid dangerous situations, such as standing too close to the edge of an excavation, riding in the backhoe bucket, or entering a trench or excavation that may collapse.

3.1.4.7 Follow all applicable OSHA regulations.

3.2 Sampling Below Product

3.2.1 This type of depth-specific sampling to attempt to sample the dissolved constituents in the water column below the product layer is performed only at the request of DEP or its designee.

3.2.2 These data provide information that helps define adequate groundwater treatment. Without these data, incorrect (and sometimes unnecessarily expensive) remediation techniques may be designed for a situation where they are not required.

3.2.3 There are some substantial logistical problems involved with sending a sampler through non-aqueous phase liquid to sample the groundwater below. Although there are some products designed specifically for this type of sampling, they are expensive and the results may not be commensurate with their cost. The use of "self-engineered" equipment or coverings may be the best option.

3.2.4 These data are only to be used for qualitative use and will aid in deciding on an appropriate remediation technique.

3.2.5 Wrapping bailers and tubing in plastic seems to be the most popular technique in getting past the product layer.

3.2.6 Although not recommended, some have wrapped submersible pumps in several layers of plastic and retrieved each layer by a separate lanyard. One suggestion would be to use a rigid piece of stainless steel tubing wrapped in plastic.

3.2.6.1 Once the covered tubing is past the layer, pull up on the plastic, piercing the plastic and exposing the (somewhat) clean tubing inlet.

3.2.6.2 Introduce the wrapped hose slowly to not entrain any more product into the dissolved layer located below.

3.2.6.3 Also, perform this procedure with a peristaltic pump or a vacuum pump linked to a trap bottle. To use this setup, the water table must be no deeper than 15-20 feet, realizing that actual sampling may be occurring several feet below the product layer.

FS 2222. *Sampling Low Permeability Aquifers or Wells That Have Purged Dry*

1. Collect the sample(s) after the well has been purged according to FS 2212, section 3.4. Minimize the amount of water removed from the well by using the same pump to purge and collect the sample. If the well has purged dry, collect samples as soon as sufficient sample water is available.

2. Measure the five (5) field parameters Temperature, pH, Specific Conductance, Dissolved Oxygen and Turbidity at the time of sample collection.

3. Advise the analytical laboratory and the client that the usual amount of sample for analysis may not be available.

FS 2223. *Sampling Wells With In-Place Plumbing*

1. If a storage tank is present, locate a cold water spigot, valve or other sampling point close to the well head between the pump and the storage tank. If there is no sampling location between the pump and the storage tank, locate the spigot, valve or other sampling point closest to the tank.

1.1 Depending on the sampling objective for collecting samples using installed plumbing, purge the system and collect samples closest to the point of consumption, or, as close to the source well as possible.

2. Remove all screens or aerators and reduce the flow rate to no more than 500 mL/minute. If collecting samples for volatile organic compounds, reduce the flow rate to 100 mL/minute or less. Collect the samples directly into the appropriate containers.

FS 2224. *Sampling Airstripper and Remedial Treatment System Sampling*

1. Reduce the flow rate to less than 500 mL/minute and begin sample collection.

2. If collecting samples for volatile organic compounds, reduce the flow rate to 100 mL/minute or less.

3. Collect the samples directly into the appropriate containers.

FS 2225. *Filtering Groundwater Samples*

Filtered groundwater samples can only be collected after approval from the DEP program or project manager. If filtering is approved, the DEP program or permit condition may require both filtered and unfiltered samples to be collected, analyzed and reported.

1. FILTERING GROUNDWATER FOR METALS:

1.1 Unless specified otherwise by the DEP program, use a new, disposable, high capacity, 1-µm in-line filter.

1.2 Use a variable speed peristaltic, bladder or submersible pump with the in-line filter fitted on the outlet end.

1.2.1 Peristaltic pumps, bladder pumps or submersible pumps can be used when water levels are no greater than 20 to 25 feet deep.

1.2.2 Bladder pumps or submersible pumps must be used when water levels are greater than 20 to 25 feet deep.

1.3 Ensure that a 1-foot maximum length of new, silicone tubing was installed in the peristaltic pump head assembly before the well was purged if the same pump is being used to purge and sample the well. Otherwise, install a new length of tubing as described above.

1.4 Ensure that new or precleaned delivery tubing was assembled with the peristaltic pump before the well was purged if the same pump is being used to purge and sample the well. Otherwise, assemble the pump with new or precleaned delivery tubing and the new filter.

1.5 Insert the filter on the high pressure side (i.e., on the delivery side) of the pump.

1.5.1 Flush the filter before attaching to the pump tubing assembly with 30-50 mL of analyte free water or an inert gas (nitrogen) to remove atmospheric oxygen;

1.5.2 Or, with the filter attached to the pump tubing assembly, hold the filter upright with the inlet and outlet in the vertical position and pump water from the aquifer through the filter until all atmospheric oxygen has been removed.

1.6 Collect the filtered samples directly into the sample container from the high-pressure (delivery) side of the pump tubing assembly.

1.6.1 Collect filtered samples by either of the methods in 1.6.1.3 or 1.6.1.4 below if the static water level in the well is too deep for a variable speed peristaltic pump and a variable speed electric submersible pump or variable speed bladder pump is not available.

1.6.1.1 Do not agitate the sample or expose it to atmospheric oxygen.

1.6.1.2 **Do not** pour the sample into any intermediate vessel for subsequent filtration.

1.6.1.3 Collect the sample in a Polyethylene, Teflon or PP bailer that can be pressurized. When the bailer has been retrieved, immediately connect the filter and begin to pressurize the bailer;

1.6.1.4 Or, collect the sample with a bailer and immediately place the intake tube of the peristaltic pump into the full bailer and begin pumping the water through the filter as described in section 1.2 above.

1.7 **Do not** use the following equipment for filtering groundwater samples for metals:

1.7.1 Any pump and apparatus combination in which the filter is on the vacuum (suction) side of the pump.

1.7.2 Any type of syringe or barrel filtration apparatus.

1.7.3 Any filter that is not encased in a one-piece, molded unit.

2. Filtering groundwater for non-metallic analytes

2.1 The following analytes cannot be filtered:

- Oil and Grease
- Total Recoverable Petroleum Hydrocarbons (TRPH)
- FL-PRO
- Volatile Organic Compounds (VOC)
- Microbiological Analytes
- Volatile Inorganic Compounds (e.g., Hydrogen Sulfide)

2.2 Unless specified otherwise by the regulatory program, use a new, disposable, high capacity, 0.45 µm in-line filter.

2.3 Assemble the pump, tubing and filter as in 1.2 – 1.5 above.

2.4 Flush the filter as in 1.5.1 or 1.5.2 above.

2.5 Collect the samples as in 1.6 – 1.6.1.4 above.

Appendix FS 2200

Tables, Figures and Forms

Table FS 2200-1 Equipment for Collecting Groundwater Samples
Table FS 2200-2 Dissolved Oxygen Saturation
Table FS 2200-3 Allowable Uses for Bailers
Figure FS 2200-1 Pump and Trap for Extractable Organics
Figure FS 2200-2 Groundwater Purging Procedure
Form FD 9000-24 Groundwater Sampling Log

Table FS 2200-1
Equipment for Collecting Groundwater Samples

Activity	Equipment Type
Well Purging	Variable speed centrifugal pump Variable speed submersible pump Variable speed bladder pump Variable speed peristaltic pump Bailer with lanyard: Not Recommended
Well Stabilization	pH meter DO meter Conductivity meter Thermometer/Thermistor Turbidimeter Flow-through cell Multi-function meters
Sample Collection	Variable speed peristaltic pump Variable speed submersible pump Variable speed bladder pump Bailer with lanyard (See Table FS 2200-3)
Filtration	Variable speed peristaltic pump Variable speed submersible pump Variable speed bladder pump Pressurized bailer 1.0 µm high capacity molded filter 0.45 µm high capacity molded filter
Groundwater Level	Electronic sensor Chalked tape

Table FS 2200-2
Dissolved Oxygen Saturation

TEMP	D.O.	mg/L	TEMP	D.O.	mg/L	TEMP	D.O.	mg/L	TEMP	D.O.	mg/L
deg C	SAT.	20%	deg C	SAT.	20%	deg C	SAT.	20%	deg C	SAT.	20%
15.0	10.084	2.017	19.0	9.276	1.855	23.0	8.578	1.716	27.0	7.968	1.594
15.1	10.062	2.012	19.1	9.258	1.852	23.1	8.562	1.712	27.1	7.954	1.591
15.2	10.040	2.008	19.2	9.239	1.848	23.2	8.546	1.709	27.2	7.940	1.588
15.3	10.019	2.004	19.3	9.220	1.844	23.3	8.530	1.706	27.3	7.926	1.585
15.4	9.997	1.999	19.4	9.202	1.840	23.4	8.514	1.703	27.4	7.912	1.582
15.5	9.976	1.995	19.5	9.184	1.837	23.5	8.498	1.700	27.5	7.898	1.580
15.6	9.955	1.991	19.6	9.165	1.833	23.6	8.482	1.696	27.6	7.884	1.577
15.7	9.934	1.987	19.7	9.147	1.829	23.7	8.466	1.693	27.7	7.870	1.574
15.8	9.912	1.982	19.8	9.129	1.826	23.8	8.450	1.690	27.8	7.856	1.571
15.9	9.891	1.978	19.9	9.111	1.822	23.9	8.434	1.687	27.9	7.842	1.568
16.0	9.870	1.974	20.0	9.092	1.818	24.0	8.418	1.684	28.0	7.828	1.566
16.1	9.849	1.970	20.1	9.074	1.815	24.1	8.403	1.681	28.1	7.814	1.563
16.2	9.829	1.966	20.2	9.056	1.811	24.2	8.387	1.677	28.2	7.800	1.560
16.3	9.808	1.962	20.3	9.039	1.808	24.3	8.371	1.674	28.3	7.786	1.557
16.4	9.787	1.957	20.4	9.021	1.804	24.4	8.356	1.671	28.4	7.773	1.555
16.5	9.767	1.953	20.5	9.003	1.801	24.5	8.340	1.668	28.5	7.759	1.552
16.6	9.746	1.949	20.6	8.985	1.797	24.6	8.325	1.665	28.6	7.745	1.549
16.7	9.726	1.945	20.7	8.968	1.794	24.7	8.309	1.662	28.7	7.732	1.546
16.8	9.705	1.941	20.8	8.950	1.790	24.8	8.294	1.659	28.8	7.718	1.544
16.9	9.685	1.937	20.9	8.932	1.786	24.9	8.279	1.656	28.9	7.705	1.541
17.0	9.665	1.933	21.0	8.915	1.783	25.0	8.263	1.653	29.0	7.691	1.538
17.1	9.645	1.929	21.1	8.898	1.780	25.1	8.248	1.650	29.1	7.678	1.536
17.2	9.625	1.925	21.2	8.880	1.776	25.2	8.233	1.647	29.2	7.664	1.533
17.3	9.605	1.921	21.3	8.863	1.773	25.3	8.218	1.644	29.3	7.651	1.530
17.4	9.585	1.917	21.4	8.846	1.769	25.4	8.203	1.641	29.4	7.638	1.528
17.5	9.565	1.913	21.5	8.829	1.766	25.5	8.188	1.638	29.5	7.625	1.525
17.6	9.545	1.909	21.6	8.812	1.762	25.6	8.173	1.635	29.6	7.611	1.522
17.7	9.526	1.905	21.7	8.794	1.759	25.7	8.158	1.632	29.7	7.598	1.520
17.8	9.506	1.901	21.8	8.777	1.755	25.8	8.143	1.629	29.8	7.585	1.517
17.9	9.486	1.897	21.9	8.761	1.752	25.9	8.128	1.626	29.9	7.572	1.514
18.0	9.467	1.893	22.0	8.744	1.749	26.0	8.114	1.623	30.0	7.559	1.512
18.1	9.448	1.890	22.1	8.727	1.745	26.1	8.099	1.620	30.1	7.546	1.509
18.2	9.428	1.886	22.2	8.710	1.742	26.2	8.084	1.617	30.2	7.533	1.507
18.3	9.409	1.882	22.3	8.693	1.739	26.3	8.070	1.614	30.3	7.520	1.504
18.4	9.390	1.878	22.4	8.677	1.735	26.4	8.055	1.611	30.4	7.507	1.501
18.5	9.371	1.874	22.5	8.660	1.732	26.5	8.040	1.608	30.5	7.494	1.499
18.6	9.352	1.870	22.6	8.644	1.729	26.6	8.026	1.605	30.6	7.481	1.496
18.7	9.333	1.867	22.7	8.627	1.725	26.7	8.012	1.602	30.7	7.468	1.494
18.8	9.314	1.863	22.8	8.611	1.722	26.8	7.997	1.599	30.8	7.456	1.491
18.9	9.295	1.859	22.9	8.595	1.719	26.9	7.983	1.597	30.9	7.443	1.489

Derived using the formula in Standard Methods for the Examination of Water and Wastewater, Page 4-101, 18th Edition, 1992

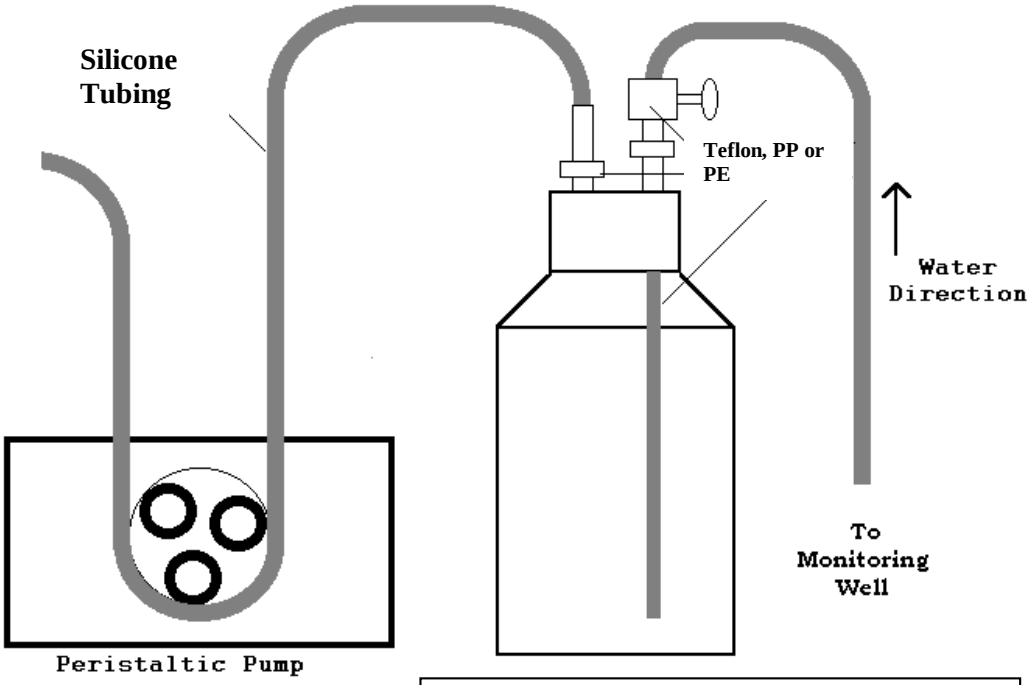
Table FS 2200-3
Allowable Uses for Bailers

• **ANALYTE GROUP(S)**	• **PURGING** (Not Recommended)	• **SAMPLING**	
	Use:	Use:	Not Recommended:
Volatile Organics Extractable Organics Radionuclides, including Radon Metals Volatile Sulfides	If allowed by permit, program, contract or order or If operated by a skilled individual with documented training in proper techniques. Field documentation must demonstrate that the procedure in FS 2213, section 4 was followed without deviation.	If concentrations exceed action levels, the purpose is to monitor effective treatment, and the DEP program allows the use of bailers; or If specified by DEP permit, program, contract or order. or If operated by a skilled individual with documented training in proper techniques and using appropriate equipment. Field documentation must demonstrate that the procedure in FS 2221, section 2 was followed without deviation.	If concentrations are near or below the stated action levels; or If a critical decision (e.g., clean closure) will be made based on the data; or If data are to demonstrate compliance with a permit or order.
Petroleum Hydrocarbons (TRPH) & Oil & Grease	If allowed by permit, program, contract or order or If operated by a skilled individual with documented training in proper techniques. Field documentation must demonstrate that the procedure in FS 2213, section 4 was followed without deviation.	Only if allowed by permit, program, contract or order as samples should be collected into the container without intermediate devices.	Unless allowed by permit, program, contract or order.

• **ANALYTE GROUP(S)**	• **PURGING** (Not Recommended)	• **SAMPLING**	
	Use:	Use:	Not Recommended:
Biologicals Inorganic Non-Metallics Aggregate Organics Microbiological Physical and Aggregate Properties	If allowed by permit, program, contract or order or If operated by a skilled individual with documented training in proper techniques. Field documentation must demonstrate that the procedure in FS 2213, section 4 was followed without deviation.	If all analytes collected from the well can be collected with a bailer; or If collected <u>after</u> collecting all analytes that require the use of a pump.	Before collecting any analytes that must be collected with a pump.
Ultra-Trace Metals	Never	Never	

Figure 2200-1

Pump and Trap for Extractable Organics



The glass sample bottle must be threaded to use a reusable sampling cap lined and installed with fittings made of Teflon, polypropylene or polyethylene, similar to the design shown.

Scenario 1: WELL SCREEN COMPLETELY SUBMERGED

Option 1a: Minimal Purge Volume: Pump or tubing is placed within the middle of the screen interval. The following conditions must be met to use this option:

1. The well screen interval is ≤ 10 feet.
2. Although drawdown may occur in the well when purging is initiated, the drawdown has to stabilize (Aquifer Recovery Rate = Purge Rate).
3. The samples will be obtained with the same equipment that was used to purge the well. Therefore, centrifugal pumps and bailers are not suitable for use in Option 1a.

If one or more of these conditions do not apply, use Option 1b.

Option 1b: Conventional Purge: Pump, tubing, or bailer [1] is placed above the screen at the top of the water column.

[1] DEP does not recommend the use of a bailer for purging; however, if a bailer is used it shall be lowered and raised at the rate of 2 cm/sec in the top of the water column.

Scenario 2: WELL SCREEN PARTIALLY SUBMERGED

Option 2a: A bailer [1] is placed at the top of the water column and is used to purge and sample the well.

Option 2b: Pump or tubing is placed within the middle of the saturated portion of the screen interval.

If the pump or tubing that was used for purging will not be used to obtain the sample, then position the pump or tubing at the top of the water column for purging.

Purging Procedure #1

1. After the drawdown in the well stabilizes, purge at least one equipment volume then collect the first set of stabilization parameters.
2. Thereafter, collect stabilization parameters ≥ 2 to 3 minutes apart.
3. Purge at least three equipment volumes before sampling.

Purging Procedure #2

1. Purge at least one well volume then collect first set of stabilization parameters.
2. Thereafter, collect stabilization parameters ≥ every 1/4 well volume.

Purging Procedure #3

1. Purge at least one well volume then collect first set of stabilization parameters.
2. Thereafter, collect stabilization parameters ≥ 2 to 3 minutes apart.

Purging Completion

If Dissolved Oxygen is ≤ 20% of saturation for the measured temperature and Turbidity is ≤ 20 NTUs, then purging is complete when three consecutive readings of the parameters listed below are within the following ranges:

Temperature ± 0.2 °C
pH ± 0.2 Standard Units
Specific Conductance ± 5.0% of reading

If Dissolved Oxygen (DO) is > 20% of saturation for the measured temperature and/or Turbidity is > 20 NTUs after every attempt has been made to reduce DO and/or turbidity, then purging is complete when three consecutive readings of the parameters listed below are within the following ranges:

Temperature ± 0.2 °C
pH ± 0.2 Standard Units
Specific Conductance ± 5.0% of reading
Dissolved Oxygen ± 0.2 mg/L or readings are within 10% (whichever is greater).
Turbidity ± 5 NTUs or readings are within 10% (whichever is greater).

If the well is expected to purge dry, position the pump or tubing within the screened interval and purge at ≤ 100 mL/minute until two equipment volumes are removed. Use the same pump for purging and sampling.

If the well purges dry at the lowest achievable flow rate (pumping at 100 mL/minute or less), then after a sufficient amount of water recharges in the well, collect the samples.

In either case listed above, before samples are collected, measure (once) pH, temperature, specific conductance, dissolved oxygen, and turbidity.

If one or more parameters do not stabilize after 5 volumes of the screened interval (purging procedure #1) or 5 well volumes (purging procedure #s 2 & 3) are removed, purging may be discontinued at the discretion of the sampling team leader.

FT 1000. GENERAL FIELD TESTING AND MEASUREMENT

Use the following SOPs in conjunction with FT 1000:

- FD 1000 Documentation Procedures
- FM 1000 Field Planning and Mobilization
- FS 1000 General Sampling Procedures
- FT 1100 through FT 3000 Specific Field Testing Procedures

1. INTRODUCTION

1.1. Scope and Applicability: SOPs FT 1100 to FT 3000 outline procedures to conduct field testing measurements and observations. They include the parameters that are measured *in-situ* or in a field-collected sample. Additionally some samples with allowable extended holding times may be collected for laboratory measurement, as described in the specific FT-series SOPs. Included in SOPs FT 1100 to FT 3000 are:

- FT 1100 Field Measurement of Hydrogen Ion Activity (pH)
- FT 1200 Field Measurement of Specific Conductance (Conductivity)
- FT 1300 Field Measurement of Salinity
- FT 1400 Field Measurement of Temperature
- FT 1500 Field Measurement of Dissolved Oxygen (DO)
- FT 1600 Field Measurement of Turbidity
- FT 1700 Field Measurement of Light Penetration (Secchi Depth and Transparency)
- FT 1800 Field Measurement of Water Flow and Velocity
- FT 1900 Continuous Monitoring with Installed Meters
- FT 2000 Field Measurement of Residual Chlorine
- FT 3000 Aquatic Habitat Characterization

1.2. Exclusions: **If proposed for experimental purposes, field-screening procedures employing techniques not addressed in these SOPs** must be submitted to the DEP site or project manager. Such procedures must be addressed for each program or project dealing specifically with the planning and design of sampling events. Data quality objectives for quantitative assessment preclude the use of field-screening procedures for regulatory purposes.

1.3. Expectations and Requirements:

1.3.1. In some cases, specific instruments are identified in the SOP, with detailed instruction provided on their use. If you are using a different instrument from that identified in the SOP, follow the manufacturer's instructions for assembly, operation, and maintenance.

1.3.2. When required, the FT-series SOPs outline the instrument specifications. A field instrument must meet the stated requirements.

1.3.3. The FT-Series SOPs specify the calibration requirements for each method. Although instruments may vary in configuration or operation, the specified calibration requirements must be met.

1.3.3.1. Where applicable to the FT-series SOP, use the minimum number of calibration standards specified.

1.3.3.2. Do not establish the lower limit of the quantitative calibration bracket with "zero" solutions, quality control blanks or reagent dilution water.

1.3.4. Ensure that all equipment is in proper working condition, calibrated, and that batteries are properly charged before using the equipment for field testing measurements.

1.3.5. If reagents or standards are prepared from stock chemicals, they must be analytical reagent grade or better. Some procedures may specify a higher grade or assay of reagent or standard.

1.4. Recommendations for Use of Grab Samples or *in situ* Field Testing Measurements:

1.4.1. Use *in situ* readings where practical for field measurements in surface water and wastewater.

1.4.2. Use *in situ* readings or flow-through containers for field measurements for groundwater stabilization during purging and for other applications where groundwater monitoring measurements are required.

1.4.3. If grab samples are collected for measurement where allowed in the individual FT-series SOP, measure samples within fifteen (15) minutes of collection when immediate analysis is specified per Table FS 1000-4 and FS 1000-5. Otherwise, analyze grab samples within the applicable holding times specified in Table FS 1000-4 and FS 1000-5.

2. MINIMUM CALIBRATION REQUIREMENTS:

2.1. Calibration Definitions: This section outlines the essential calibration concepts that must be applied to each field test. Specific requirements for calibration are addressed in the individual SOPs.

2.1.1. Initial Calibration (IC): The instrument or meter electronics are adjusted (manually or automatically) to a theoretical value (e.g., dissolved oxygen saturation) or a known value of a calibration standard.

2.1.2. Initial Calibration Verification (ICV): The instrument or meter calibration is checked or verified directly following initial calibration by measuring a calibration standard of known value as if it were a sample and comparing the measured result to the calibration acceptance criteria listed in the SOP.

2.1.3. Continuing Calibration Verification (CCV): The instrument or meter calibration is checked or verified by measuring a calibration standard of known value as if it were a sample and comparing the measured result to the calibration acceptance criteria listed in the SOP.

2.1.4. Chronological Calibration Bracket: The interval of time between verifications within which environmental sample measurements must occur. The instrument or meter

is calibrated or verified before and verified after the time of environmental sample measurement(s).

2.1.5. Quantitative Calibration Bracket: The instrument or meter is calibrated or verified at two known values that encompass the range of observed environmental sample measurement(s).

2.1.6. Acceptance Criteria: The numerical limits within which calibration verifications are acceptable.

2.2. Calibration Activities: Specific calibration procedures are given in the individual SOPs.

2.2.1. Chronological Calibration Bracket:

2.2.1.1. Ensure that the field test result is preceded by an acceptable ICV or CCV and followed by an acceptable CCV.

2.2.1.2. Specific requirements for chronological bracketing are addressed in the individual FT-series SOPs.

2.2.2. Quantitative Calibration Bracket:

2.2.2.1. Choose two standards that bracket the range of sample measurements. These standards may be used for initial calibrations or for verifications.

2.2.2.2. Specific requirements for quantitative bracketing are addressed in the individual FT-series SOPs.

2.2.3. Initial Calibration: Calibrate if no initial calibration has been performed or if a calibration verification does not meet acceptance criteria. Do not reuse standards for initial calibrations.

Table FT 1000-1: Field Testing Acceptance Criteria

Parameter	Acceptance Criteria
pH (FT 1100)	**± 0.2 Standard pH Units of buffer or more stringent program criteria**
Specific Conductance (FT 1200)	**± 5% of standard value**
Temperature (FT 1400)	**± 0.2°C of NIST-traceable value (with correction factors) Verification over range of applicable values**
Dissolved Oxygen (FT 1500)	**± 0.3 mg/L of theoretical value (see Table FT 1500-1)**
Turbidity (FT 1600)	**0.1-10 NTU: ± 10% of standard value 11-40 NTU: ± 8% of standard value 41-100 NTU: ± 6.5% of standard value > 100 NTU: ± 5% of standard value**
Total Residual Chlorine (FT 2000)	**0.995 calibration curve correlation coefficient ± 10% of primary standard value ± 10% of secondary standard value Color comparator acceptance criterion: ± 10% of primary standard value**

2.2.4. Initial Calibration Verification:

2.2.4.1. Perform an ICV immediately after calibration. All ICVs must meet the calibration acceptance criteria specified in the applicable FT-series SOP. See Table FT 1000-1 for a list of acceptance criteria for the most common field testing procedures.

2.2.4.2. If an ICV fails to meet acceptance criteria, immediately recalibrate the instrument using the applicable initial calibration procedure or remove it from service.

2.2.5. Continuing Calibration Verification: Perform a CCV at no more than 24-hour intervals from previous verification, except where noted for individual FT-series SOPs.

2.2.5.1. If historically generated data demonstrate that a specific instrument remains stable for longer periods of time, the time interval between calibration verifications may be increased.

2.2.5.2. Base the selected time interval on the shortest interval that the instrument maintains stability. If CCVs consistently fail, shorten the time period between verifications or replace/repair the instrument.

2.2.5.3. All CCVs must meet the calibration acceptance criteria specified in the applicable FT-series SOP. See Table FT 1000-1 for a list of acceptance criteria for the most common field testing procedures.

2.2.5.4. If a CCV fails to meet acceptance criteria perform one or more of the following procedures as necessary:

- Reattempt the CCV again within the chronological bracket time interval without changing the instrument calibration. Do not perform maintenance, repair, or cleaning of the instrument or probe. Probes may be rinsed with analyte-free water or fresh verification standard. The CCV may be reattempted with a fresh aliquot of verification standard.
- Perform the initial calibration, perform an ICV, re-analyze the sample(s), and perform a CCV.
- Report all results between the last acceptable calibration verification and the failed calibration verification as estimated (report the value with a "J"). Include a narrative description of the problem in the field notes.

2.2.5.5. For installed instruments that are deployed for extended periods of time or used for continuous monitoring, see FT 1900.

2.2.5.6. Shorten the time period between verification checks or replace/repair the instrument.

2.2.6. Determining the Values of Secondary Standards: Use only those standards recommended by the manufacturer for a specific instrument. Only use secondary standards for continuing calibration verifications. See the individual FT-series SOPs for specific procedures for use of secondary standards. At documented intervals, determine or verify the values of secondary standards immediately after performing an initial calibration or after verifying the calibration with primary standards. Read each secondary standard as a sample. This result must be within the manufacturer's stated tolerance range and +/- 10% of the stated standard value. If the +/- 10% criterion is not

met, assign this reading as the value of the standard. If the reading is outside the manufacturer's stated tolerance range, discard the secondary standard.

2.2.7. **More frequent calibration verifications may be required for discharge permit compliance measurements or other regulatory requirements.**

3. PREVENTIVE MAINTENANCE: Record all maintenance and repair notes in the maintenance logbook for each meter (see FS 1007). If rental equipment is used, a log is not required. However, the origin (i.e., rental company), rental date, equipment type, model number, and identification number (if applicable) must be entered into the field notes or a rental equipment notebook.

4. DOCUMENTATION

4.1. Standard and Reagent Documentation: Document information about standards and reagents used for calibrations, verifications, and sample measurements.

4.1.1. Note the date of receipt, the expiration date and the date of first use for all standards and reagents.

4.1.1.1. Document acceptable verification of any standard used after its expiration date.

4.1.2. Record the concentration or other value for the standard in the appropriate measurement units.

4.1.2.1. Note vendor catalog number and description for pre-formulated solutions as well as for neat liquids and powdered standards.

4.1.2.2. Retain vendor assay specifications for standards as part of the calibration record.

4.1.3. Record the grade of standard or reagent used.

4.1.4. When formulated in-house, document all calculations used to formulate calibration standards.

4.1.4.1. Record the date of preparation for all in-house formulations.

4.1.5. Describe or cite the procedure(s) used to prepare any standards in-house (DEP SOP or internal SOP).

4.2. <u>Field Instrument Calibration Documentation</u>: Document acceptable calibration and calibration verification for each instrument unit and field test or analysis, linking this record with affected sample measurements.

4.2.1. Retain vendor certifications of all factory-calibrated instrumentation.

4.2.2. Designate the identity of specific instrumentation in the documentation with a unique description or code for each instrument unit used.

4.2.2.1. Record the manufacturer name, model number, and identifying number such as a serial number for each instrument unit.

4.2.3. Record the time and date of all initial calibrations and all calibration verifications.

4.2.4. Record the instrument reading (value in appropriate measurement units) of all calibration verifications.

4.2.5. Record the name of the analyst(s) performing the calibration.

4.2.6. Document the specific standards used to calibrate or verify the instrument or field test with the following information:

- Type of standard or standard name (e.g., pH buffer)
- Value of standard, including correct units (e.g., pH = 7.0 SU)
- Manufacturer's tolerance range for secondary standards
- Link to information recorded according to section 4.1 above

4.2.7. Retain manufacturers' instrument specifications.

4.2.8. Document whether successful initial calibration occurred.

4.2.9. Document whether each calibration verification passed or failed.

4.2.10. Document any corrective actions taken to correct instrument performance according to records requirements of FD 3000.

4.2.10.1. Document the date and time of any corrective actions.

4.2.10.2. Note any incidence of discontinuation of use of the instrument due to calibration failure.

4.2.11. Describe or cite the specific calibration or verification procedure performed (DEP SOP or internal SOP).

4.3. Record all field-testing measurement data, to include the following:

- Project name
- Date and time of measurement or test (including time zone, if applicable)
- Source and location of the measurement or test sample (e.g., monitoring well identification number, outfall number, station number or other description)
- Latitude and longitude of sampling source location (if required)
- Analyte or parameter measured
- Measurement or test sample value
- Reporting units
- Initials or name of analyst performing the measurement
- Unique identification of the specific instrument unit(s) used for the test(s)

Appendix FT 1000
Tables, Figures and Forms

Table FT 1000-1 Field Testing Acceptance Criteria

Table FT 1000-1: Field Testing Acceptance Criteria	
Parameter	**Acceptance Criteria**
pH (FT 1100)	**± 0.2 Standard pH Units of buffer or more stringent program criteria**
Specific Conductance (FT 1200)	**± 5% of standard value**
Temperature (FT 1400)	**± 0.2°C of NIST-traceable value (with correction factors) Verification over range of applicable values**
Dissolved Oxygen (FT 1500)	**± 0.3 mg/L of theoretical value (see Table FT 1500-1)**
Turbidity (FT 1600)	**0.1-10 NTU: ± 10% of standard value 11-40 NTU: ± 8% of standard value 41-100 NTU: ± 6.5% of standard value > 100 NTU: ± 5% of standard value**
Total Residual Chlorine (FT 2000)	**0.995 calibration curve correlation coefficient ± 10% of primary standard value ± 10% of secondary standard value Color comparator acceptance criterion: ± 10% of primary standard value**

FT 1100. Field Measurement of Hydrogen Ion Activity (pH)

Use in conjunction with:

- FT 1000 General Field Testing and Measurement
- FQ 1000 Field Quality Control Requirements
- FS 1000 General Sampling Procedures
- FD 1000 Documentation Procedures

1. Equipment and Supplies

1.1. Field Instrument: Use any pH meter consisting of a potentiometer, a glass electrode, a reference electrode, and a temperature-compensating device.

1.1.1. For routine fieldwork use a pH meter accurate and reproducible to at least 0.2-unit in the range of 0.0 to 14.0 units, and equipped with temperature-compensation adjustment. Record the pH value in pH units to one decimal place.

1.1.2. Advanced silicon chip pH sensors (with digital meters) may be used if demonstrated to yield equivalent performance to glass electrode sensors for the intended application.

1.2. Standards: Purchased or laboratory-prepared standard buffer solutions of pH values that bracket the expected sample pH range. Use buffers with nominal values of 4.0, 7.0 and 10.0 units for most situations. If the sample pH is outside the range of 4.0 to 10.0, then use two buffers that bracket the expected range with the pH 7 buffer being one of the two buffers. Alternatively, prepare appropriate standards per table I in method SM4500-H^+-B.

1.3. Recordkeeping and Documentation Supplies:

- Field notebook (w/ waterproof paper is recommended) or forms
- Indelible pens

2. Calibration and Use

2.1. General Concerns

2.1.1. The acceptance criterion for the initial calibration or the calibration verification is a reading of the standard within +/- 0.2-unit of the expected value.

2.1.2. On a weekly basis, check the calibration to ensure the % theoretical slope is greater than 90% (if applicable to your instrument type).

2.1.2.1. Note the % slope in the calibration records.

2.1.2.2. A % slope of less than 90% indicates a bad electrode that must be changed or repaired.

2.1.2.3. If % slope cannot be determined on your meter, or the manufacturer's optimum specifications are different, follow the manufacturer's recommendation for maintaining optimum meter performance.

2.2. Interferences

2.2.1. Sodium at pH $\geq$ 10.0 units can be reduced or eliminated by using a low sodium error electrode.

2.2.2. Coatings of oils, greases, and particles may impair the electrode's response. Pat the electrode bulb dry with lint-free paper or cloth and rinse with de-ionized water. For cleaning hard-to-remove films, use acetone very sparingly so that the electronic surface is not damaged.

2.2.3. Temperature effects on the electrometric measurement of pH are controlled by using instruments having temperature compensation or by calibrating the meter at the temperature of the samples.

2.2.4. Poorly buffered solutions with low specific conductance (< 200 μmhos/cm) may cause fluctuations in the pH readings. Equilibrate electrode by immersing in several aliquots of sample before taking pH.

2.2.5. Ensure stable sample and sensor temperature before calibrating or taking sample readings. Drifting sensor or sample temperature may produce erroneous sample measurements, calibrations, or verifications.

2.2.6. Thoroughly rinse the pH sensor with deionized water or fresh buffer standard when calibrating or verifying the calibration or when taking sample measurements. For in-situ measurements, ensure adequate flushing of the sensor with fresh sample water prior to taking measurements. Any residual standard, sample or deionized water remaining on the sensor may affect the measurement of the subsequent standard or sample. This is especially true when samples or standards of widely different pH value are successively measured.

2.2.7. Drifting readings or an inability to calibrate the sensor may also indicate a fouled electrode. Clean the electrode per the manufacturer's instructions or replace.

2.3. Calibration: Follow the manufacturer's calibration instructions specific to your meter. Most instruments allow for a two-point calibration and a few models can perform a three-point calibration. Use the appropriate number of standard buffer solutions for calibration. Do not reuse buffers for initial calibrations.

2.3.1. Rinse the probe with de-ionized water (DI) before and between each standard buffer solution.

2.3.2. Follow the calibration activities specified in FT 1000, section 2.2.

2.3.2.1. Perform an initial calibration using at least two buffers. Always use a pH 7 buffer first.

2.3.2.2. If the pH sample range is expected to be wider than the range established by a two-point calibration (e.g., some samples at pH 4 and others at pH 8), then add a third calibration point. If the instrument cannot be calibrated with three buffers, the third buffer may be used as the initial calibration verification to extend the range.

2.3.2.3. After initial calibration, immediately perform an initial calibration verification (ICV). Read a buffer as a sample. To be acceptable, a calibration verification must be within +/- 0.2 pH units of the stated buffer value. For example, if reading the pH 4.0 buffer, the result must be in the 3.8 to 4.2 range. Certain regulatory programs may have more stringent acceptance criteria.

2.3.2.4. After sample measurement(s), perform a continuing calibration verification (CCV). Read a buffer as a sample. To be acceptable, a

calibration verification must be within +/- 0.2 pH units of the stated buffer value. This CCV (if within acceptance criteria) can be used as the beginning of the chronological bracket. Certain regulatory programs may have more stringent acceptance criteria.

2.4. Measuring pH *in situ*: After calibrating the multi-probe sensors as outlined in 2.3 above, follow the meter's instructions to select the display for reading the pH of the sample. Immerse the probe at the desired depth in the water and wait for stabilization of the reading before recording the measurement.

2.5. Measuring pH in Flow-through Cells: When using a flow-through cell, the procedure described above in section 2.4 is applicable.

2.6. Measuring pH in Samples: After an acceptable initial calibration or calibration verification, follow these procedures to take a pH reading of a freshly collected sample (within 15 minutes of collection).

2.6.1. Pour enough of the fresh sample into a clean cup to take the reading.

2.6.2. Place the pH electrode in the sample (in the cup) and swirl the electrode.

2.6.3. Wait for stabilization, and read the pH value.

2.6.4. Turn the meter off after the last sample reading, rinse the electrode thoroughly with de-ionized water and replace the electrode's cap.

3. PREVENTIVE MAINTENANCE: Refer to FT 1000, section 3.

4. DOCUMENTATION

4.1. Standard and Reagent Documentation: Document information about standards and reagents used for calibrations, verifications, and sample measurements.

4.1.1. Note the date of receipt, the expiration date and the date of first use for all standards and reagents.

4.1.1.1. Document acceptable verification of any standard used after its expiration date.

4.1.2. Record the concentration or other value for the standard in the appropriate measurement units.

4.1.2.1. Note vendor catalog number and description for preformulated solutions as well as for neat liquids and powdered standards.

4.1.2.2. Retain vendor assay specifications for standards as part of the calibration record.

4.1.3. Record the grade of standard or reagent used.

4.1.4. When formulated in-house, document all calculations used to formulate calibration standards.

4.1.4.1. Record the date of preparation for all in-house formulations.

4.1.5. Describe or cite the procedure(s) used to prepare any standards in-house (DEP SOP or internal SOP).

4.2. Field Instrument Calibration Documentation: Document acceptable calibration and calibration verification for each instrument unit and field test or analysis, linking this record with affected sample measurements.

4.2.1. Retain vendor certifications of all factory-calibrated instrumentation.

4.2.2. Designate the identity of specific instrumentation in the documentation with a unique description or code for each instrument unit used.

4.2.2.1. Record manufacturer name, model number, and identifying number such as a serial number for each instrument unit.

4.2.3. Record the time and date of all initial calibrations and all calibration verifications.

4.2.4. Record the instrument reading (value in appropriate measurement units) of all calibration verifications.

4.2.5. Record the name of the analyst(s) performing the calibration.

4.2.6. Document the specific standards used to calibrate or verify the instrument or field test with the following information:

- Type of standard or standard name (e.g., pH buffer)
- Value of standard, including correct units (e.g., pH = 7.0 SU)
- Link to information recorded according to section 4.1 above

4.2.7. Retain manufacturers' instrument specifications.

4.2.8. Document whether successful initial calibration occurred.

4.2.9. Document whether each calibration verification passed or failed.

4.2.10. Document any corrective actions taken to correct instrument performance according to records requirements of FD 3000.

4.2.10.1. Document date and time of any corrective action.

4.2.10.2. Note any incidence of discontinuation of use of the instrument due to calibration failure.

4.2.11. Describe or cite the specific calibration or verification procedure performed (DEP SOP or internal SOP).

4.3. Record all field-testing measurement data, to include the following:

- Project name
- Date and time of measurement or test (including time zone, if applicable)
- Source and location of the measurement or test sample (e.g., monitoring well identification number, outfall number, station number or other description)
- Latitude and longitude of sampling source location (if required)
- Analyte or parameter measured
- Measurement or test sample value
- Reporting units
- Initials or name of analyst performing the measurement
- Unique identification of the specific instrument unit(s) used for the test(s)

FT 1200. Field Measurement of Specific Conductance (Conductivity)

Use in conjunction with:

- FT 1000 General Field Testing and Measurement
- FQ 1000 Field Quality Control Requirements
- FS 1000 General Sampling
- FD 1000 Documentation Procedures

1. INTRODUCTION: Specific conductance is a useful method to approximate the total amount of inorganic dissolved solids.

1.1. Conductivity varies with temperature. For example, the conductivity of salt water increases 3%/degree C at 0°C, and only 2%/degree C at 25°C.

1.2. Record the sample temperature or adjust the temperature of the samples prior to measuring specific conductance if the conductivity instrument does not employ automatic temperature compensation and correction of the instrument display value.

2. EQUIPMENT AND SUPPLIES

2.1. Field Instrument: Any self-contained conductivity instrument suitable for field work, accurate and reproducible to 5% or better over the operational range of the instrument, and preferably equipped with temperature-compensation adjustment. See references in FT 1210 below for additional information about instruments.

2.2. Standards: Purchased or laboratory-prepared standard potassium chloride (KCl) solutions with conductivity values that bracket the expected samples' range. In the laboratory, prepare standards of appropriate conductivities per SM2510 (Conductivity, in *Standard Methods for the Examination of Water and Wastewater, American Public Health Association*). Do not reuse standards for initial calibrations.

2.3. Recordkeeping and Documentation Supplies:

- Field notebook (w/ waterproof paper is recommended) or forms
- Indelible pens

3. CALIBRATION AND USE

3.1. General Concerns

3.1.1. Follow the instrument manufacturer's instructions for the details of operating the instrument.

3.1.2. For instruments without automatic temperature compensation, attempt to adjust the temperature of the samples to 25°C. If the temperature cannot be adjusted, measure the temperature with a calibrated device (see FT 1400), record the temperature, correct for temperature (per section 3.4 below) and report the results corrected to 25°C. See references in FT 1210 below for further information about temperature correction.

3.1.3. Ensure stable sample and sensor temperature before calibrating or taking sample readings. Drifting sensor or sample temperature may produce erroneous sample measurements, calibrations or verifications.

3.1.4. Thoroughly rinse the conductivity sensor with deionized water and fresh standard when calibrating or verifying the calibration or when taking sample measurements. For in-situ measurements, ensure adequate flushing of the sensor with fresh sample water prior to taking measurements. Any residual standard, sample or deionized water remaining on the sensor may affect the measurement of the subsequent standard or sample. This is especially true when samples or low-concentration standards are measured subsequent to measuring high-concentration standards.

3.1.5. Drifting readings or an inability to calibrate the sensor may also indicate a fouled electrode. Clean the electrodes per the manufacturer's instructions.

3.1.6. When successful calibration and verification cannot be achieved after ensuring that temperatures have stabilized and the sensor electrodes are clean and free of residual sample or standard from the previous measurement, suspect opened containers of standards, especially after repeated openings, when near the manufacturer's expiration date or when little standard volume remains in the container. Low-concentration conductivity standards are seldom stable for an extended period after opening.

3.2. Calibration and Calibration Verification:

3.2.1. Follow the calibration activities specified in FT 1000, section 2.2.

3.2.2. Initial Calibration: Calibrate the meter prior to use according to the following steps:

3.2.2.1. **Do not "zero" in the meter using analyte-free water or air.**

3.2.2.2. When the sample measurements are expected to be 100 μmhos/cm or greater, use two standard potassium chloride solutions that bracket the range of expected sample conductivities. A single standard at 100 μmhos/cm standard potassium chloride solution is acceptable for situations in which all sample measurements are expected to be less than 100 μmhos/cm.

3.2.2.3. Calibrate the instrument with one of the two standards to create an upper or lower boundary for the quantitative bracket.

3.2.2.4. Verify the calibration of the instrument with the second standard, quantitatively bracketing the range of expected sample values.

3.2.2.5. If the instrument can be calibrated with more than one standard, choose additional calibration standards within the range of expected sample values. The second standard in section 3.2.2.3 above may be used as an additional calibration standard.

3.2.2.6. Note: If all samples are expected to be less than 100 μmhos/cm, only one standard at 100 μmhos/cm standard potassium chloride solution is required.

3.2.3. Acceptability: Accept the calibration if the meter reads within +/- 5% of the value of any calibration standard used to verify the calibration. For example, the acceptance range for a 100 μmhos/cm standard is 95 to 105 μmhos/cm. If the meter does not read within +/- 5% of each calibration verification standard, determine the cause of the problem and correct before proceeding.

3.2.4. Temperature Correction: Most field instruments read conductivity directly. If the meter does not automatically correct values to 25°C, calculate correction factors using

the procedure in section 3.4 below. Record all readings and calculations in the calibration records.

3.2.5. Continuing Calibration Verification: Check the meter in read mode with at least one KCl standard with a specific conductance which quantitatively brackets the conductivity measured in environmental samples. The reading for the calibration verification must also be within +/- 5% of the standard value (see 3.2.3 above).

3.2.5.1. If new environmental samples are encountered outside the range of the initial calibration in 3.2.2 above, verify the instrument calibration with an additional standard that brackets the range of new sample values. If these calibration verifications fail, recalibrate the instrument as in 3.2.2.

3.2.5.2. **More frequent calibration verifications may be required for discharge permit compliance measurements or other regulatory requirements.**

3.3. Measuring Specific Conductance of Samples:

3.3.1. Follow manufacturer's instructions for sample measurement.

3.3.2. Immerse or place the conductivity probe or sensor in situ at a measuring location representative of the sampling source.

3.3.3. Allow the conductivity instrument to stabilize.

3.3.4. Measure the water temperature (if necessary for manual temperature compensation) and record the temperature. See FT 1400 for temperature measurement procedures.

3.3.5. If the meter is equipped with manual temperature compensation, adjust the conductivity meter to the water temperature per manufacturer's instructions.

3.3.6. If the conductivity meter has a set of positions that multiply the reading by powers of ten in order to measure the full range of potential conductivities, set this dial to the correct range in order to take a reading.

3.3.7. Record the sample conductivity measurement reading within 15 minutes of water sample collection.

3.3.8. Rinse off the probe with de-ionized water. Follow manufacturer's instructions for probe storage between use.

3.4 Calculations for Temperature Compensation

If the meter does not automatically correct for temperature (manual or automatic adjustment), or if a probe with a cell constant other than 1 is used, the following formula must be used to normalize the data to 25°C:

$$K = \frac{(K_m)(C)}{1 + 0.0191(T-25)}.$$

Where: K = conductivity in μmhos/cm at 25°C

K_m = measured conductivity in μmhos/cm at T degrees C

C = cell constant

T = measured temperature of the sample in degrees C

If the cell constant is 1, the formula for determining conductivity becomes:

$$K = \frac{(K_m)}{1 + 0.0191(T-25)}.$$

Refer to SM2510B, 20th edition, if other calculations (i.e., determining cell constant, etc.) are required. See FT 1210 below.

3.5 *In situ* Measurements at Depth or With Flow-through Cells: After calibrating the instrument as outlined in 3.2 above, follow the manufacturer's instructions to measure the conductivity of the sample.

3.5.1. For *in situ* measurements immerse the probe at the desired depth and wait for stabilization of the reading and record its value. Follow a similar procedure when using a flow-through cell.

3.5.1.1 Preferably measure groundwater sample conductivity *in situ* with a downhole probe or in a flow-through system.

4. PREVENTATIVE MAINTENANCE: Refer to FT 1000, section 3.

5. DOCUMENTATION

5.1. Standard and Reagent Documentation: Document information about standards and reagents used for calibrations, verifications and sample measurements.

5.1.1. Note the date of receipt, the expiration date and the date of first use for all standards and reagents.

5.1.1.1. Document acceptable verification of any standard used after its expiration date.

5.1.2. Record the concentration or other value for the standard in the appropriate measurement units.

5.1.2.1. Note vendor catalog number and description for preformulated solutions as well as for neat liquids and powdered standards.

5.1.2.2. Retain vendor assay specifications for standards as part of the calibration record.

5.1.3. Record the grade of standard or reagent used.

5.1.4. When formulated in-house, document all calculations used to formulate calibration standards.

5.1.4.1. Record the date of preparation for all in-house formulations.

5.1.5. Describe or cite the procedure(s) used to prepare any standards in-house (DEP SOP or internal SOP).

5.2. Field Instrument Calibration Documentation: Document acceptable calibration and calibration verification for each instrument unit and field test or analysis, linking this record with affected sample measurements.

5.2.1. Retain vendor certifications of all factory-calibrated instrumentation.

5.2.2. Designate the identity of specific instrumentation in the documentation with a unique description or code for each instrument unit used.

5.2.2.1. Record manufacturer name, model number, and identifying number such as a serial number for each instrument unit.

5.2.3. Record the time and date of all initial calibrations and all calibration verifications.

5.2.4. Record the instrument reading (value in appropriate measurement units) of all calibration verifications.

5.2.5. Record the name of the analyst(s) performing the calibration.

5.2.6. Document the specific standards used to calibrate or verify the instrument or field test with the following information:

- Type of standard or standard name (e.g., conductivity standard)
- Value of standard, including correct units (e.g., conductivity = 100 µmhos/cm)
- Link to information recorded according to section 5.1 above

5.2.7. Retain manufacturers' instrument specifications.

5.2.8. Document whether successful initial calibration occurred.

5.2.9. Document whether each calibration verification passed or failed.

5.2.10. Document any corrective actions taken to correct instrument performance according to records requirements of FD 3000.

5.2.10.1. Document date and time of any corrective action.

5.2.10.2. Note any incidence of discontinuation of use of the instrument due to calibration failure.

5.2.11. Describe or cite the specific calibration or verification procedure performed (DEP SOP or internal SOP).

5.3. Record all field-testing measurement data, to include the following:

- Project name
- Date and time of measurement or test (including time zone, if applicable)
- Source and location of the measurement or test sample (e.g., monitoring well identification number, outfall number, station number or other description)
- Latitude and longitude of sampling source location (if required)
- Analyte or parameter measured
- Measurement or test sample value
- Reporting units
- Initials or name of analyst performing the measurement
- Unique identification of the specific instrument unit(s) used for the test(s)

FT 1300. Field Measurement of Salinity

Use in conjunction with:

- FT 1000 General Field Testing and Measurement
- FQ 1000 Field Quality Control Requirements
- FS 1000 General Sampling Procedures
- FD 1000 Documentation Procedures

1. INTRODUCTION: Salinity is an important property of industrial and natural waters. This field parameter is also important for assessing the source or origin of effluents and of the mixing between fresh and marine waters in coastal regions, in both surface water and groundwater.

1.1. Salinity is a unit-less parameter since by definition it is the ratio of the mass of dissolved salts to the total mass of a given volume of water. Thus, salinity values are commonly expressed as "grams of salt/kilograms of water" or $^{o}/_{oo}$.

1.2. Salinity is determined by using indirect methods involving the measurement of a related physical property such as conductivity, density, sound speed, or refractive index. The commonly used procedures in the field are determination of <u>conductivity</u> or <u>density</u> of the sample.

1.3. The sample salinity is calculated from an empirical relationship between salinity and the physical property as determined from a standard solution. Refer to the referenced method SM2520 for further discussions on these topics.

1.4. Because of its high sensitivity and easy of measurement, the conductivity method is most often used to determine the salinity. (Note – using a hydrometer to measure the density or the specific gravity to obtain an approximate salinity value is not recommended for reporting purposes.)

2. EQUIPMENT AND SUPPLIES

2.1. <u>Field Instrument</u>: Depending on the chosen method, use:

2.1.1. Any self-contained conductivity instrument with a platinum or graphite electrode type cell, and a temperature sensor. Some conductivity instruments have meter scales pre-calibrated for salinity and are sometimes referred to as Salinometers. For routine fieldwork use a conductivity meter accurate and reproducible to at least 5% or 1 μmho/cm (whichever is greater), and equipped with temperature-compensation adjustment; <u>or</u>

2.1.2. A precision "vibrating flow densimeter" (see Millero & Poisson, 1981) and a field thermometer.

2.2. <u>Standards</u>:

2.2.1. Purchased or laboratory-prepared Standard Seawater and/or potassium chloride (KCl) standards of appropriate equivalent salinities.

2.2.1.1. In the laboratory, prepare the Standard Seawater per recipe in method SM2520 and SM8010 (Table III), and standard KCl solutions per recipe in method SM2510 (American Public Health Association, American Water Works Association, Water Pollution Control Federation, <u>*Standard Methods for the Examination of Water and Wastewater)*</u>.

2.2.2. De-ionized water for calibration of the densimeter (if used).

2.3. Recordkeeping and Documentation Supplies:

- Field logbook (w/ waterproof paper is recommended) or field forms
- Indelible pens

3. CALIBRATION AND USE

3.1. Conductivity Method

3.1.1. Calibration: - Calibrate the instrument per manufacturer's instructions using one calibration standard, either standard seawater or a KCl solution, as applicable. The acceptance criterion for initial calibration or a calibration verification is that the instrument reading is within +/- 5% of the standard value. For example, when calibrating with standard seawater, S = 35, the meter must read in the 34 to 36 range in order to be acceptable.

3.1.1.1. Use standard seawater (S = 35) when measuring salinity in the open ocean or estuaries with a predominance of seawater.

3.1.1.2. KCl may be used in estuarine waters with low salinity (S = 0 – 40).

3.1.1.3. If verifying or calibrating with a "zero" standard, do not use analyte-free water or air check (dry electrode) as the blank.

3.1.1.4. If the meter does not provide a direct reading of salinity, use the equation found in SM2520B to convert the readings to salinity.

3.1.1.5. Follow the calibration activities in FT 1000, section 2.2.

3.1.1.6. Do not reuse standards for initial calibrations.

3.1.2. Field Use: - Rinse the probe with DI water after calibration and before each sample measurements. Follow the manufacturer's instructions for temperature compensation, if needed. Report salinities with only one decimal figure.

3.1.3. General Concerns for Conductivity Method

3.1.3.1. Ensure stable sample and sensor temperature before calibrating or taking sample readings. Drifting sensor or sample temperature may produce erroneous sample measurements, calibrations, or verifications.

3.1.3.2. Thoroughly rinse the conductivity (salinity) sensor with deionized water and fresh standard when calibrating or verifying the calibration or when taking sample measurements. For in-situ measurements, ensure adequate flushing of the sensor with fresh sample water prior to taking measurements. Any residual standard, sample, or deionized water remaining on the sensor may affect the measurement of the subsequent standard or sample. This is especially true when samples or low-concentration standards are measured subsequent to measuring high-concentration standards.

3.1.3.3. Drifting readings or an inability to calibrate the sensor may also indicate a fouled electrode. Clean the electrodes per the manufacturer's instructions.

3.1.3.4. When successful calibration and verification cannot be achieved after ensuring that temperatures have stabilized and the sensor electrodes are clean and free of residual sample or standard from the previous measurement, suspect opened containers of standards, especially after repeated openings, when near the

manufacturer's expiration date or when little standard volume remains in the container. Low-concentration conductivity standards are seldom stable for an extended period after opening.

3.2. Density Method

The vibrating flow densimeter is an instrument that allows for precise and rapid measurements of the density of a liquid, such as water. The principle of operation is the effect of the density of the sample on the frequency of a vibrating tube encased in a constant-temperature jacket. The measurement is made by passing the water (sample) through the vibrating tube and reading the period of vibration that is electronically sensed and displayed by the densimeter. The sample density (D) is proportional to the square of the period of vibration (T):

$$D = a + bT^2$$

Where a and b are terms determined by calibration, b being determined by calibration of the densimeter with Standard Seawater. The difference between the density of the sample (D) and that of pure water (D_0) is given by:

$$D - D_0 = b\,(T^2 - T_0^2)$$

Where T and T_0 are, respectively, the periods of the sample and that of pure (de-ionized) water. Using this second equation, you only have to deal with the term b for calibration purposes. Hence, the system can be calibrated with two liquids: pure water and Standard Seawater. Follow the manufacturer's instruction for calibration of the densimeter.

The salinity of the sample is determined by the one-atmosphere international equation of state for seawater. This equation relates the difference ($D - D_0$) to the practical salinity as a function of the temperature of the sample (which is also measured by the densimeter or the field thermometer). For further details on this calculation read the referenced method SM2520C.

4. PREVENTIVE MAINTENANCE: Refer to FT 1000, section 3.

5. DOCUMENTATION

5.1. Standard and Reagent Documentation: Document information about standards and reagents used for calibrations, verifications, and sample measurements.

5.1.1. Note the date of receipt, the expiration date and the date of first use for all standards and reagents.

5.1.1.1. Document acceptable verification of any standard used after its expiration date.

5.1.2. Record the concentration or other value for the standard in the appropriate measurement units.

5.1.2.1. Note vendor catalog number and description for preformulated solutions as well as for neat liquids and powdered standards.

5.1.2.2. Retain vendor assay specifications for standards as part of the calibration record.

5.1.3. Record the grade of standard or reagent used.

5.1.4. When formulated in-house, document all calculations used to formulate calibration standards.

5.1.4.1. Record the date of preparation for all in-house formulations.

5.1.5. Describe or cite the procedure(s) used to prepare any standards in-house (DEP SOP or internal SOP).

5.2. Field Instrument Calibration Documentation: Document acceptable calibration and calibration verification for each instrument unit and field test or analysis, linking this record with affected sample measurements.

5.2.1. Retain vendor certifications of all factory-calibrated instrumentation.

5.2.2. Designate the identity of specific instrumentation in the documentation with a unique description or code for each instrument unit used.

5.2.2.1. Record manufacturer name, model number, and identifying number such as a serial number for each instrument unit.

5.2.3. Record the time and date of all initial calibrations and all calibration verifications.

5.2.4. Record the instrument reading (value in appropriate measurement units) of all calibration verifications.

5.2.5. Record the name of the analyst(s) performing the calibration.

5.2.6. Document the specific standards used to calibrate or verify the instrument or field test with the following information:

- Type of standard or standard name (e.g., salinity standard)
- Value of standard, including correct units (e.g., salinity = 20 $^{o}/_{oo}$)
- Link to information recorded according to section 5.1 above

5.2.7. Retain manufacturers' instrument specifications.

5.2.8. Document whether successful initial calibration occurred.

5.2.9. Document whether each calibration verification passed or failed.

5.2.10. Document any corrective actions taken to correct instrument performance according to records requirements of FD 3000.

5.2.10.1. Document date and time of any corrective action.

5.2.10.2. Note any incidence of discontinuation of use of the instrument due to calibration failure.

5.2.11. Describe or cite the specific calibration or verification procedure performed (DEP SOP or internal SOP).

5.3. Record all field-testing measurement data, to include the following:

- Project name
- Date and time of measurement or test (including time zone, if applicable)
- Source and location of the measurement or test sample (e.g., monitoring well identification number, outfall number, station number or other description)
- Latitude and longitude of sampling source location (if required)

- Analyte or parameter measured
- Measurement or test sample value
- Reporting units
- Initials or name of analyst performing the measurement
- Unique identification of the specific instrument unit(s) used for the test(s)

FT 1400. Field Measurement of Temperature

The use of this SOP is not required when using field temperature measurement devices to monitor groundwater stabilization during the purging of groundwater monitoring wells. Field temperature measurement devices used for temperature compensation (correction) for other measurements such as dissolved oxygen, specific conductance or pH are also exempted from the requirements of this SOP. FT 1400 must be used for all other field temperature measurements required by DEP.

Use this SOP in conjunction with the following DEP SOPs:

- FT 1000 General Field Testing and Measurement
- FQ 1000 Field Quality Control Requirements
- FS 1000 General Sampling Procedures
- FD 1000 Documentation Procedures

1. EQUIPMENT AND SUPPLIES

1.1. Field Instruments: Use any of the following instrument types for performing field measurements:

- Digital thermistor (thermocouple type) and meter typical of field instruments
- Glass bulb, mercury-filled thermometer (not recommended for field ruggedness)
- Glass bulb, alcohol-filled thermometer with protective case
- Bi-metal strip/dial-type thermometer
- Advanced silicon chip temperature sensor and digital meter

1.1.1. Field instruments must be capable of measuring temperature in 0.1^{o}C increments.

1.2. Standard Thermometer: NIST-traceable Celsius certified thermometer with scale marks for every 0.1^{o}C increment, a range of 0°C to 100°C (or a range bracketing expected sample temperatures) and correction chart supplied with certification. The standard thermometer must have a valid certification for the period of measurement.

1.3. Recordkeeping and Documentation Supplies:

- Field notebook or forms \
- Indelible pens

2. CALIBRATION AND USE

2.1. General Concerns

2.1.1. Select a temperature measuring device meeting the requirements of section 1.1 above.

2.1.2. Dial-type and thermocouple-type devices with meters are preferred over the glass thermometers for fieldwork because of their durability and ease of reading.

2.1.2.1. Transport glass thermometers in protective cases.

2.1.2.2. Inspect glass thermometers for liquid separation. Do not use a thermometer if the liquid has separated.

2.1.2.3. Most instruments with digital display will provide more decimal figures than are significant. Record the temperature reading with only one rounded decimal figure (e.g., 25.9 instead of 25.86^{o}C).

2.2. Calibration

2.2.1. Follow the calibration activities specified in FT 1000, section 2.2.

2.2.2. Verify all thermistor (meter) devices and field thermometers against the NIST-traceable standard thermometer at several temperatures in the expected sample measurement range, using any correction factor indicated by the certificate supplied with the NIST-traceable thermometer.

2.2.2.1. See the US Geological Survey, National Field Manual for the Collection of Water-Quality Data, Book 9, Chapter A6, Field Measurements, Section 6.1, Temperature, Techniques of Water-Resources Investigations, 4/98 for additional guidance about making temperature comparisons with the standard thermometer.

2.2.2.2. Make note of the calibration in the calibration records. See section 4 below.

2.2.2.3. The field measurement device may be used with a linear correction factor provided that the observed temperature difference with the standard thermometer is documented at incremental temperatures over the range of expected sample temperatures.

2.2.2.4. Use the resulting correction factor when making temperature measurements of samples with the field measurement device.

2.2.2.5. Prominently display the correction factor on the field measurement device, with the date last verified. A calibration correction curve or plot may also be used.

2.2.2.6 To be acceptable, a calibration verification must be within +/- 0.5^{o}C of the corrected reading of the NIST-traceable thermometer.

2.2.2.7 Properly dispose of glass-bulb thermometers that do not meet the above calibration acceptance criteria.

2.2.3. Continuing Calibration Verifications:

2.2.3.1. Determine the maximum time between continuing calibration verifications for the specific field temperature measurement device based on instrument stability.

2.2.3.2. Verify the field measurement device against the standard NIST-traceable thermometer as in section 2.2.2 above.

2.2.4. Refer to additional calibration requirements in FT 1000, section 2.2.

2.2.5. **More frequent calibration verifications may be required for discharge permit compliance measurements or other regulatory requirements.**

2.3. Measuring Sample Temperature

2.3.1. Insert or place the thermometer or sensor *in situ* at a measuring location representative of the sampling source.

2.3.2. Allow the thermometer or temperature sensor to equilibrate to ambient *in situ* temperature.

2.3.2.1. Groundwater samples must be measured *in situ* with a downhole probe or in a flow-through container. Do not measure bailed or pumped samples in an intermediate container containing static sample.

2.3.3. Record the temperature to the nearest 0.1^{o}C after the reading stabilizes and remains constant.

3. PREVENTIVE MAINTENANCE: Refer to FT 1000, section 3.

4. DOCUMENTATION

4.1. Standards Documentation: Document information about the NIST-traceable standard thermometer in the calibration record, including:

- Unique identification for the thermometer
- Vendor certificate of calibration, including any correction factor
- Vendor's expiration date for the certificate of calibration

4.2. Field Instrument Calibration Documentation: Document acceptable calibration and calibration verification for each instrument unit and field test or analysis, linking this record with affected sample measurements.

4.2.1. Retain vendor certifications of all factory-calibrated instrumentation.

4.2.2. Designate the identity of specific instrumentation in the documentation with a unique description or code for each instrument unit used.

4.2.2.1. Record manufacturer name, model number, and identifying number such as a serial number for each instrument unit.

4.2.3. Record the time and date of all initial calibrations and all calibration verifications.

4.2.4. Record the instrument reading (value in appropriate measurement units) of all calibration verifications.

4.2.5. Record the name of the analyst(s) performing the calibration.

4.2.6. Document the following information about initial calibration and calibration verifications and link to information recorded according to section 4.1 above:

- Details of the method used to compare the field measurement device to the NIST-traceable standard thermometer.
- Results of each calibration verification, including the expected reading (per the NIST-traceable standard thermometer)
- The actual reading of the field measurement device, using any established correction factors and correct units.

4.2.7. Retain manufacturers' instrument specifications.

4.2.8. Document whether successful initial calibration occurred.

4.2.9. Document whether each calibration verification passed or failed.

4.2.10. Document any corrective actions taken to correct instrument performance (such as a new correction factor) according to records requirements of FD 3000.

4.2.10.1. Document date and time of any corrective action.

4.2.10.2. Note any incidence of discontinuation of use of the instrument due to calibration failure.

4.2.11. Describe or cite the specific calibration or verification procedure performed (DEP SOP or internal SOP).

4.3. Record all field-testing measurement data, to include the following:

- Project name
- Date and time of measurement or test (including time zone, if applicable)
- Source and location of the measurement or test sample (e.g., monitoring well identification number, outfall number, station number or other description)
- Latitude and longitude of sampling source location (if required)
- Analyte or parameter measured
- Measurement or test sample value
- Reporting units
- Initials or name of analyst performing the measurement
- Unique identification of the specific instrument unit(s) used for the test(s)

FT 1500. Field Measurement of Dissolved Oxygen (DO)

Use in conjunction with:

- FT 1000 General Field Testing and Measurement
- FS 1000 General Sampling Procedures
- FD 1000 Documentation Procedures

1. EQUIPMENT AND SUPPLIES

1.1. Field Instruments

1.1.1. Membrane-type polarographic or galvanic electrode DO sensor with dedicated meter or configured with multi-parameter sonde

1.1.2. Luminescence-based DO sensor with dedicated meter or configured with multi-parameter sonde (see American Society for Testing and Materials, *Standard Test Methods for Dissolved Oxygen in Water*, Test Method C-Luminescence-based Sensor, D 888-05).

1.1.3. Select instrument assemblies that provide minimum precision of +/- 0.2 mg DO/L and a minimum accuracy of +/- 0.2 mg DO/L.

1.1.4. Compensate for temperature dependence of DO measurements by using instruments employing automatic temperature compensation or by manually correcting measurements in accordance with SM 4500-O G (see *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, American Water Works Association, Water Pollution Control Federation).

1.1.4.1. Calibrate on-board temperature sensors as described in FT 1400.

1.2. Standards

1.2.1. NIST-traceable Celsius thermometer with a scale marked for every 0.1^{o}C and a range of 0 to 100°C.

1.2.2. Access to an organization with capability to perform the Winkler titration procedure is recommended but not mandatory.

1.2.3. A “zero-DO standard”, prepared on-site with an aliquot of the sample water, is optional. Prepare by adding excess sodium sulfite and a trace of cobalt chloride to bring the DO to zero.

1.3. Recordkeeping and Documentation Supplies:

- Field notebook (w/ waterproof paper is recommended) or forms
- Indelible pens

2. CALIBRATION AND USE: the electrode method is predominantly used *in-situ* for dissolved oxygen determinations.

2.1. General Concerns

2.1.1. Turbulence is necessary to keep a constant flow of water across the membrane-sample interface. Make sure the appropriate mechanism is working before using the probe.

2.1.2. Follow instrument manufacturer's instructions for probe storage. For example, store the probe with a cover that creates a saturated atmosphere. A cap, with a wet sponge in it, will suffice for single-parameter probes. If the sensor is in a multi-probe device, keep the protective cap chamber moist during storage.

2.1.3. Before mobilizing, check to make sure there are no bubbles beneath the probe membrane, or any wrinkles or tears in the probe membrane. If so, replace the membrane and KCL solution. Check the leads, contacts, etc. for corrosion and/or shorts if meter pointer remains off-scale, does not calibrate, or drifts.

2.1.4. Dissolved inorganic salts interfere with the performance of DO probes. For example, DO readings in salt water are affected by the salinity and must be corrected. The DO meter may adjust automatically based on readings taken from the specific conductivity/salinity probe. If corrections are not automatic the appropriate calculations must be used to correct for salinity. If automatic adjustments are used the specific conductivity/salinity probe calibration must be verified or calibrated in accordance with FT1200.

2.1.5. Reactive gases, which pass through the membrane, may interfere. For example, chlorine will depolarize the cathode and cause a high probe output. Long-term exposures to chlorine will coat the anode with the chloride of the anode metal and eventually desensitize the probe. Sulfide (from H_2S) will undergo oxidation if high enough potential (voltage) is applied, creating current flow, yielding faulty readings. If such interferences are suspected, change the membrane electrode more frequently and calibrate at more frequent intervals.

2.1.6. Ensure that the temperature of the sensor and sample are stable. Unstable temperatures will produce erroneous calibrations, verifications or sample measurements.

2.1.7. Erroneous calibrations or verifications may result if the saturated air chamber is not vented to atmospheric pressure, properly humidified and protected from temperature fluctuations produced by common field conditions such as evaporation or fluctuation in sunlight intensity.

2.2. Follow the quality control requirements for calibration (see activities in FT 1000, section 2.2).

2.3. <u>Initial Calibration and Initial Calibration Verification</u>

2.3.1. <u>Air Calibration and Initial Calibration Verification (ICV)</u>: Calibrate the meter at 100% saturation. Before use, verify the meter calibration in water-saturated air to make sure it is properly calibrated and operating correctly. Make a similar verification at the end of the day or sampling event. Follow the manufacturer's instructions for your specific instrument.

2.3.1.1. Allow an appropriate warm up period before initial field calibration.

2.3.1.2. Wet the inside of the calibration chamber with water, pour out the excess water (leave a few drops), wipe any droplets off the membrane/sensor and insert the sensor into the chamber (this ensures 100% humidity).

2.3.1.3. Allow adequate time for the DO sensor and the air inside the calibration chamber to equilibrate.

2.3.1.4. Once the probe/calibration chamber is stable at ambient temperature, check the air temperature and determine, from the DO versus temperature table, what the DO saturation value should be at the observed temperature (see Table FT

1500-1, below). A stable and accurate temperature is required for a valid calibration. The acceptance criterion for DO calibration verification is +/- 0.3 mg DO/L at the observed temperature of the verification.

2.4. Continuous Calibration Verification

2.4.1. Air-Calibration Verification: DO sensor or instrument is calibrated against air that is saturated with water at a known temperature and ambient atmospheric pressure. Use Table FT 1500-1 below to verify calibration at specified temperature.

2.4.1.1. Wet the inside of the calibration chamber with water, pour out the excess water (leave a few drops) and insert the sensor into the chamber (this ensures 100-percent humidity)

2.4.1.2. Allow adequate time for the DO sensor and the air inside the calibration chamber to equilibrate.

2.4.1.3. Measure the temperature in the calibration chamber and observe the readings until the instrument stabilizes.

2.4.1.4. Use the oxygen solubility Table FT 1500-1 below to determine the DO saturation at a measured temperature and atmospheric pressure. Calculate values to the nearest tenth degree by interpolation or use an expanded version of this table found in FS 2200, which provides saturation data in 0.1 ^{o}C increments for a selected temperature range (see Table FS 2200-2).

2.4.1.5. Compare DO meter reading with value obtained from Table FT 1500-1 below to verify continuous calibration.

2.5. Additional Verifications: The following methods may be used as additional checks to verify calibration. These additional checks may be required as part of a specific permit.

2.5.1. Winkler method: This check is useful to assess the condition of the DO sensor (i.e., its degradation with time/use) and that the instrument can still maintain a valid calibration (see SM 4500-O C).

2.5.1.1. **Perform the Winkler method when required by permit or other regulation at the required calendar frequency.**

2.5.1.2. For an accuracy calibration verification using the Winkler method, follow SM 4500-O C.

2.5.1.3. Fill a clean bucket with uncontaminated or de-ionized water and place the probe into the bucket (with stirrer or equivalent mechanism turned off). Fill at least two biological oxygen demand (BOD) bottles without entraining atmospheric oxygen into the bottles. Carefully submerge the bottom of the bottle (one at a time) into the water and allow the water to fill the bottle. Place the bottle on the bottom of the bucket and carefully place stopper into it without adding atmospheric oxygen. Retrieve the bottles and determine their DO by the Winkler method (see SM4500-O-C for more details). Turn the stirrer or equivalent mechanism on and read the DO of the water in the bucket.

2.5.1.4. Adjust the DO meter according to manufacturer's instructions. Be sure to adjust the meter to the temperature of water in the bucket, and then calibrate the DO meter to read the average DO concentration of the two samples determined by the Winkler test.

2.5.2. Zero-DO Verification: The air calibration and the interfering effects of the sample can be further checked in the field by means of a "zero-DO standard"(SM 4500-O G).

2.5.2.1. Prepare this standard on-site with an aliquot of the sample by adding excess sodium sulfite and a trace of cobalt chloride to bring the DO to zero. Prepare this zero-DO standard in a beaker or a large-mouth sample container of appropriate size to insert the DO probe.

2.5.2.2. After adding the chemicals, gently swirl the water and let it sit for about 30 seconds before inserting the probe.

2.5.2.3. Read the DO of the sample. If the reading is outside the acceptance interval, the instrument must be recalibrated and/or zero-adjusted if the meter allows for this adjustment.

2.5.3. Air-Saturated Water: The DO sensor or instrument system is calibrated against water that is saturated with oxygen at a known temperature and ambient atmospheric pressure.

2.5.3.1. The temperature and conductivity of water used for calibration should be about the same as the temperature and conductivity of the water to be measured.

2.5.3.2. Place DO sensor and calibration water in a large beaker or open-mouth container.

2.5.3.3. Aerate the water for an adequate amount of time.

2.5.3.4. Determine if the water is 100 percent saturated with oxygen, and take a temperature reading. Temperature must be calibrated or verified for accuracy before DO calibration verification.

2.5.3.5. Use Table FT 1500-1 above to determine the DO saturation value at the measured water temperature. Compare DO meter reading with value obtained from Table FT 1500-1 to ensure continuous calibration.

2.6. Measuring DO in Samples:

2.6.1. Insert or place the DO probe *in situ* at a measuring location representative of the sampling source:

2.6.1.1. Take the DO of an effluent just before it enters the receiving water. If the effluent aerated prior to entering the surface water, take the DO reading in the receiving water right where it enters.

2.6.1.2. For well mixed surface waters, e.g., fast flowing streams, take the DO reading at approximately 1-2 feet below the surface or at mid-depth.

2.6.1.3. For still or sluggish surface waters, take a reading at one foot below the surface, one foot above the bottom, and at mid-depth.

2.6.1.4. If it is shallow surface waters, (less than two feet) take the reading at mid-depth.

2.6.1.5. Do not take a reading in frothy or aerated water unless required by the sampling plan.

2.6.1.6. Groundwater samples must be measured *in situ* with a downhole probe or in a flow-through container. Do not measure bailed or pumped samples in an intermediate container containing static sample.

2.6.2. Rinse probe with de-ionized water and keep the probe in the saturated atmosphere (see 2.1.2 above) between sites and events.

2.6.3. If the readings show distinct, unexplainable changes in DO levels, or when the probe has been in waters with high sulfides, recalibrate or perform maintenance per manufacturer's instructions. While taking a reading, if it is very low (e.g., below 1.0 mg/L), allow the meter to stabilize, record it and then, remove and rinse the probe, as the environment is very likely anoxic and may contain hydrogen sulfide, which can damage the probe.

2.6.4. Salinity and Temperature corrections may be necessary. Follow manufacturer instructions for automatic corrections or perform manual calculations (SM 4500-O G).

3. PREVENTIVE MAINTENANCE: Refer to FT 1000, section 3.

4. DOCUMENTATION

4.1. Standard and Reagent Documentation: Document information about standards and reagents used for verifications.

4.1.1. Note the date of receipt, the expiration date and the date of first use for all standards and reagents.

4.1.1.1. Document acceptable verification of any standard used after its expiration date.

4.1.2. Record the concentration or other value for the standard in the appropriate measurement units.

4.1.2.1. Note vendor catalog number and description for pre-formulated solutions as well as for neat liquids and powdered standards.

4.1.2.2. Retain vendor assay specifications for standards as part of the calibration record.

4.1.3. Record the grade of standard or reagent used.

4.1.4. When formulated in-house, document all calculations used to formulate calibration standards.

4.1.4.1. Record the date of preparation for all in-house formulations.

4.1.5. Describe or cite the procedure(s) used to prepare any standards in-house (DEP SOP or internal SOP).

4.2. Field Instrument Calibration Documentation: Document acceptable calibration and calibration verification for each instrument unit and field test or analysis, linking this record with affected sample measurements.

4.2.1. Retain vendor certifications of all factory-calibrated instrumentation.

4.2.2. Designate the identity of specific instrumentation in the documentation with a unique description or code for each instrument unit used.

4.2.2.1. Record the manufacturer name, model number and identifying number such as a serial number for each instrument unit.

4.2.3. Record the time and date of all initial calibrations and all calibration verifications.

4.2.4. Record the instrument reading (value in appropriate measurement units) of all calibration verifications.

4.2.5. Record the temperature associated with all calibration verifications.

4.2.6. Record the name of the analyst(s) performing the calibration.

4.2.7. Document the specific standards used to calibrate or verify the instrument or field test with the following information:

- Type of standard or standard name (e.g., saturation)
- Value of standard, including correct units (e.g., mg/L at ^{o}C)
- Link to information recorded according to section 4.1 above

4.2.8. Retain manufacturers' instrument specifications.

4.2.9. Document whether successful initial calibration occurred.

4.2.10. Document whether each calibration verification passed or failed.

4.2.11. Document any corrective actions taken to correct instrument performance according to records requirements of FD 3000.

4.2.11.1. Document the date and time of any corrective action.

4.2.11.2. Note any incidence of discontinuation of use of the instrument due to calibration failure.

4.2.12. Describe or cite the specific calibration or verification procedure performed (DEP SOP or internal SOP).

4.3. Record all field-testing measurement data, to include the following:

- Project name
- Date and time of measurement or test (including time zone, if applicable)
- Source and location of the measurement or test sample (e.g., monitoring well identification number, outfall number, station number or other description)
- Latitude and longitude of sampling source location (if required)
- Analyte or parameter measured
- Measurement or test sample value
- Reporting units
- Initials or name of analyst performing the measurement
- Unique identification of the specific instrument unit(s) used for the test(s)

Appendix FT 1500
Tables, Figures and Forms

Table FT 1500-1 Solubility of Oxygen in Water

Table FT 1500-1: Solubility of Oxygen in Water at Atmospheric Pressure[1,2]			
Temperature °C	Oxygen Solubility mg/L	Temperature °C	Oxygen Solubility mg/L
0.0	14.621	26.0	8.113
1.0	14.216	27.0	7.968
2.0	13.829	28.0	7.827
3.0	13.460	29.0	7.691
4.0	13.107	30.0	7.559
5.0	12.770	31.0	7.430
6.0	12.447	32.0	7.305
7.0	12.139	33.0	7.183
8.0	11.843	34.0	7.065
9.0	11.559	35.0	6.950
10.0	11.288	36.0	6.837
11.0	11.027	37.0	6.727
12.0	10.777	38.0	6.620
13.0	10.537	39.0	6.515
14.0	10.306	40.0	6.412
15.0	10.084	41.0	6.312
16.0	9.870	42.0	6.213
17.0	9.665	43.0	6.116
18.0	9.467	44.0	6.021
19.0	9.276	45.0	5.927
20.0	9.092	46.0	5.835
21.0	8.915	47.0	5.744
22.0	8.743	48.0	5.654
23.0	8.578	49.0	5.565
24.0	8.418	50.0	5.477
25.0	8.263		

1. The table provides three decimal places to aid interpolation

2. Under equilibrium conditions, the partial pressure of oxygen in air-saturated water is equal to that of the oxygen in water-saturated

FT 1600. Field Measurement of Turbidity

Use in conjunction with:

- FT 1000 General Field Testing and Measurement
- FS 1000 General Sampling Procedures
- FD 1000 Documentation Procedures

1. INTRODUCTION: Turbidity measures the scattering effect that suspended solids have on the propagation of light through a body of water (surface or ground waters). The higher the effect (i.e., intensity of scattered light), the higher the turbidity value. Suspended and colloidal matter such as clay, silt, finely divided organic and inorganic matter, and plankton and other microscopic organisms cause turbidity in water.

This SOP describes the use of true nephelometric measurement using instruments meeting the specifications outlined in 2.1.

Exceptions to the requirements specified in 2.1 below include:

1.1. *In situ* probes with turbidity sensors used for screening purposes (e.g., groundwater purge stabilization measurements).

1.2. Non standard light sources, detectors or other turbidity measuring devices may be proposed for use in studies that entail comparison measurements (dredge and fill) or unattended deployment for monitoring purposes.

1.3. **Do not report results from "non standard" sensors or configurations for regulatory purposes such as permit compliance unless the Department has approved the use for the specific project.**

1.4. All "non standard" instrument must be calibrated/check according to the principles outlined in this SOP.

2. EQUIPMENT AND SUPPLIES

2.1. Field Instrument: Use a turbidimeter (nephelometer) or a spectrophotometer consisting of a light source and one or more photoelectric detectors with a readout device to indicate the intensity of light. The instrument must meet these specifications:

2.1.1. The light source must have a tungsten-filament lamp operated at a color temperature between 2000 and 3000 K.

2.1.2. The distance traversed by the incident light and scattered light within the sample tube must not exceed 10 cm.

2.1.3. The light detector, positioned at 90° to the incident light, must have an acceptance angle that does not exceed $\pm$ 30° from 90°.

2.1.4. The detector and any filter system must have a spectral peak response between 400 and 600 nanometers.

2.1.5. The instrument sensitivity must permit detection of a turbidity difference of 0.02 NTU at the 0 – 1.0 NTU scale.

2.1.6. Note: using the appropriate equipment and following the procedures in this SOP, the field accuracy of this measurement is close to %R = 100 ± 10% for turbidities in the range of 1 to 100 NTU.

2.2. Sample Cells (cuvettes): Use sample cells or tubes of clear, colorless glass or plastic.

2.2.1. Keep cells clean, both inside and out, and discard if scratched or etched.

2.2.1.1. Never handle them where the light beam strikes the sample.

2.2.1.2. Clean sample cells by thorough washing with laboratory soap (inside and out) followed by multiple rinses with distilled or de-ionized water, and let air-dry.

2.2.2. Use a very thin layer of silicone oil on the outside surfaces to mask minor imperfections or scratches in the cells.

2.2.2.1. Use silicone oil with the same refractive index of the glass; making sure the cell appear to be nearly dry with little or no visible signs of oil.

2.2.3. Because small differences between cells significantly impact measurement, use either matched pairs or the same cell for standardization and sample measurement.

2.3. Standards:

2.3.1. Primary standards: Use these standards for initial calibration.

2.3.1.1. Formazin standards can be either obtained commercially or prepared according to method SM 2130B, section 3.b. See *Standard Methods for the Examination of Water and Wastewater* (American Public Health Association, American Water Works Association, Water Pollution Control Federation).

2.3.1.2. Some instruments may require the use of styrene divinylbenzene (SDVB) standards for calibration.

2.3.2. Secondary Standards: Use only those certified by the manufacturer for a specific instrument. Secondary standards must only be used for continuing calibration verifications according to the procedures in section 3.4 below. Determine or verify the values of secondary standards according to the procedure in section 3.3 below.

2.3.3. Turbidity-free water: Use filtered, laboratory reagent water demonstrated to be free of measurable turbidity (<0.01 NTU) or purchase commercially prepared turbidity-free water.

3. Calibration and Use

3.1. General Concerns

3.1.1. Light absorption by dissolved and suspended matter may cause a negative bias on the turbidity measurement. When present in significant concentrations, particles of light-absorbing materials such as activated carbon will cause a negative interference. Likewise, the presence of dissolved, color-causing substances that absorb light may also cause a negative interference. Some commercial instruments may have the capability of either correcting for slight color interference or optically blanking out the color effect.

3.1.2. Handle samples with natural effervescence as described in 3.5.5.1 below.

3.2. Calibration and Initial Calibration Verification

3.2.1. Follow the calibration activities in FT 1000, section 2.2.

3.2.2. Perform an initial calibration using at least two primary standards.

3.2.2.1. If the instrument cannot be calibrated with two standards, calibrate the instrument with one standard and verify with a second standard per 3.2.3 below.

3.2.2.2. For measurement of samples of very low turbidity, select the lowest standard commercially available for bracketing the lower end of the anticipated sample turbidity range or dilute higher turbidity standards with turbidity-free water.

3.2.2.3. Do not use turbidity-free water as a calibration verification standard.

3.2.3. Perform an initial calibration verification by reading at least one primary standard as a sample. The acceptance criterion for the initial calibration verification depends on the range of turbidity of the standard value:

- Standard Value = 0.1-10 NTU: the response must be within 10% of the standard;
- Standard Value = 11-40 NTU: the response must be within 8% of the standard;
- Standard Value = 41-100 NTU: the response must be within 6.5% of the standard; and
- Standard Value > 100 NTU: the response must be within 5% of the standard.

3.3. Determining the Values of Secondary Standards

3.3.1. Use only those standards certified by the manufacturer for a specific instrument.

3.3.2. Use verified secondary standards only for continuing calibration verifications.

3.3.3. Determining the initial value(s) of secondary standard(s):

3.3.3.1. Calibrate or verify the instrument with primary standards. Select primary standards that bracket the range of the secondary standards.

3.3.3.2. Immediately after the an initial calibration with primary standards or verification with a primary standard, read each secondary standard as a sample use the reading from the instrument as the first assigned value.

3.3.4. Verifying Secondary Standards

3.3.4.1. At least once per quarter or at other documented intervals (see 3.3.5 below), determine or verify the values of secondary standards immediately after the instrument has been calibrated or verified with primary standards.

3.3.4.2. Read each secondary standard as a sample. This reading must be within the manufacturer's stated tolerance range and within the acceptance ranges of the assigned standard value as listed in 3.2.3., above. If the criteria in section 3.2.3., above are not met, assign this reading as the value of the standard. If the reading is outside the manufacturer's stated tolerance range, discard the secondary standard.

3.3.5. **More frequent calibration verifications may be required for discharge permit compliance measurements or other regulatory requirements.**

3.4. Continuing Calibration Verification: Perform a continuing calibration verification using at least one primary or secondary standard. The calibration acceptance criteria are the same as those listed in section 3.2.3 above.

3.5. Measuring Turbidity in Samples

3.5.1. Gently agitate the sample and wait until air bubbles disappear.

3.5.2. Double-rinse the sample cell or cuvette with a small amount of the sample. Discard, and pour an aliquot into the sample cell or cuvette.

3.5.3. Gently dry out its external surface with lint-free paper.

3.5.4. Insert the cell in the instrument and read the turbidity directly from the meter display.

3.5.5. Do not use vacuum degassing, ultrasonic bath or other devices to remove bubbles from the sample. If the sample contains visible bubbles or if it effervesces (as in groundwater, with changes in pressure and temperature), make a note of this in the field records and collect a sample for laboratory measurement.

3.5.5.1. If effervescing samples are collected for laboratory analysis collect the sample without leaving headspace in the container and ship it as soon as possible to the laboratory (the holding time for this measurement is only 48 hrs). Ship this sample in wet ice at 4°C.

3.5.6. Pour out the sample, double-rinse the cuvette with de-ionized water in preparation for the next sample.

4. PREVENTIVE MAINTENANCE: Refer to FT 1000, section 3.

5. DOCUMENTATION

5.1. Standard and Reagent Documentation: Document information about standards and reagents used for calibrations, verifications, and sample measurements.

5.1.1. Note the date of receipt, the expiration date and the date of first use for all standards and reagents.

5.1.1.1. Document acceptable verification of any standard used after its expiration date.

5.1.2. Record the concentration or other value for the standard in the appropriate measurement units.

5.1.2.1. Note vendor catalog number and description for preformulated solutions as well as for neat liquids and powdered standards.

5.1.2.2. Retain vendor assay specifications for standards as part of the calibration record.

5.1.3. Record the grade of standard or reagent used.

5.1.4. When formulated in-house, document all calculations used to formulate calibration standards.

5.1.4.1. Record the date of preparation for all in-house formulations.

5.1.5. Describe or cite the procedure(s) used to prepare any standards in-house (DEP SOP or internal SOP).

5.2. Field Instrument Calibration Documentation: Document acceptable calibration and calibration verification for each instrument unit and field test or analysis, linking this record with affected sample measurements.

5.2.1. Retain vendor certifications of all factory-calibrated instrumentation.

5.2.2. Designate the identity of specific instrumentation in the documentation with a unique description or code for each instrument unit used.

5.2.2.1. Record manufacturer name, model number, and identifying number (such as a serial number) for each instrument unit.

5.2.3. Record the time and date of all initial calibrations and all calibration verifications.

5.2.4. Record the instrument reading (value in appropriate measurement units) of all calibration verifications.

5.2.5. Record the name of the analyst(s) performing the calibration.

5.2.6. Document the specific standards used to calibrate or verify the instrument or field test with the following information:

- Type of standard or standard name (e.g., formazin)
- Value of standard, including correct units (e.g., 20 NTU)
- Link to information recorded according to section 5.1 above

5.2.7. Retain manufacturers' instrument specifications.

5.2.8. Document whether successful initial calibration occurred.

5.2.9. Document whether each calibration verification passed or failed.

5.2.10. Document any corrective actions taken to correct instrument performance according to records requirements of FD 3000.

5.2.10.1. Document date and time of any corrective action.

5.2.10.2. Note any incidence of discontinuation of use of the instrument due to calibration failure.

5.2.11. Describe or cite the specific calibration or verification procedure performed (DEP SOP or internal SOP).

5.3. Record all field-testing measurement data, to include the following:

- Project name
- Date and time of measurement or test (including time zone, if applicable)
- Source and location of the measurement or test sample (e.g., monitoring well identification number, outfall number, station number or other description)
- Latitude and longitude of sampling source location (if required)
- Analyte or parameter measured
- Measurement or test sample value
- Reporting units
- Initials or name of analyst performing the measurement
- Unique identification of the specific instrument unit(s) used for the test(s)

APPENDIX B

DQO MEETING MINUTES

UFP SAP QAPP Project Team Kick-Off Meeting
Meeting Minutes

August 13, 2009

Attendance:

Art Sanford – BRAC PMO RPM
Ron Kotun – Tetra Tech DQO UFP Facilitator
Doyle Brittian – US EPA
Dave Grabka - FDEP
Rob Simcik – Tetra Tech NUS Project Manager (note taker)
Kara Wimble – Tetra Tech NUS Petroleum Lead
Mark Jonnet – Tetra Tech NUS EGIS
Mike Halil – CH2MHill RAC PM BCT Team Member

Additional Tetra Tech project team members not in attendance:
Joe Samchuck – Project Chemist
Megan Ritchie – IR Site SAP Lead

DQO Process Overview.
Ron provided an overview of the process and goals of today's presentation/discussion. Worksheets 10 and 11 will be reviewed for the 10 sites currently scoped for UFP (Uniform Federal Policy) SAPs (Sampling Analysis Plans).

Worksheet 10: Problem Definition
- Site Description and History
- History of Environmental Investigations and Actions
- Conceptual Site Model
- Potential Sources of Contamination
- Potential Contamination Migration Mechanisms
- Land Use and Problem Definitions
- Problem Definition

Worksheet 11: Identification of Study Goals
- Decision Statement
- Information Inputs
- Study Boundaries
- Analytic Approach
- Decision Rule
- Performance Criteria
- Plan for Sampling

There are five IR sites and five Petroleum sites scoped to have UPF SAPs prepared. The information for the worksheets 10 and 11 has been pulled together. Each site will be discussed.

It was identified that all of these sites are in long term monitoring programs and that the process for decision-making are already in place and the objective of this effort is to take the process that is working for Cecil field in put it in the UFP format. Doyle identified that the national guidance identified for QAPP is and has been followed. These procedures will now be put into the UFP format.

QAPP Discussion:

Petroleum Sites:

<u>Tank 81 a,b,c</u>
Problem Definition

- Contaminant plumes of isopropyl benzene are located northwest of the original site in the intermediate (30-35' bls) and deep (45-55' bls) zones of the aquifer.
- Long-term monitoring is necessary to ensure that the plume location is stable for an extended period of time.
- Once the plume location is stable, consistent data over a certain period of time is necessary to consider an RMO II award.

COCs

- Isopropyl benzene (cumene)
    - USEPA Method 8260
    - GCTL = 0.8 µg/L
    - NADC = 8.0 µg/L
    - PQL = 2.0 ug/L

Decision Statement

- Determine whether the groundwater COC concentration exceeds its GCTL and if the plume location is stable.
- If the COC exceeds its action level or the plume location moves as determined by compliance wells, the exceedence will be verified, and if confirmed to exceed then further delineation of the plume boundaries will be required.
- If the COC does not exceed its GCTL for 2 consecutive events in all wells being monitored, an NFA will be recommended.
- Typically if the COC incerased to mor than its Natural Attenuation Default Concentrations (NADC) remediation would be evaluated however because the isopropylbenzene GCTL is based on organoleptic concerns, it was identified that FDEP would be agreeable to continue groundwater monitoring even if its NADC was exceeded in source wells.

Decision Rule

- If the isopropyl benzene concentration is greater than its GCTL in non-compliance/source wells, long-term monitoring will continue.
- If any sign that concentration of isopropyl benzene is greater than its GCTL in the compliance wells, then additional delineation will be required.

- If any isopropyl benzene concentration exceeds the GCTL, but no migration is detected outside of the compliance wells for four consecutive monitoring events, then a permanent groundwater restriction can be considered (RMO II).
- If all concentrations of isopropyl benzene are below action levels for 2 consecutive quarters in all wells, then an NFA will be recommended.

Discussion on Boundary

- Wells to be included in sampling plan will be: CEF-81-04I; CEF-81-22I; CEF-81-24I; CEF-81-25I; CEF-81-26I; CEF-81-27D; and CEF-81-28D
- Delineation of the plume will continue as needed within the boundaries of the former NAS Cecil Field property.

<u>Hangar 815 Wash Rack</u>

Problem Definition

- Naphthalene groundwater contamination remains in the area of the former wash rack to the north of Building 815.
- Long-term monitoring verified no contaminant migration is occurring.
- The source of contamination is no longer contributing to the plume.

COCs

- Naphthalene
    - USEPA Method 8270
    - GCTL = 14 µg/L
    - NADC = 140 µg/L
    -

Decision Statement

- Determine whether the groundwater COC concentration exceeds its GCTL and if the plume location is stable.
- If the COC exceeds its action levels or the plume location moves as determined by compliance wells, then further delineation of the plume boundaries will be required
- If the COC does not exceed its GCTL for 2 consecutive events, then an NFA will be recommended.
- If the COC increases to above the NADCs, then in accordance with 62-770 rule, the well will be resample to verify the exceedance. Then there are 3 options: supplemental assessment (attempt to locate a previously undetected source), continue monitoring (with different concentrations as triggers), or pursue active remediation by submitting a RAP.

Decision Rule

- If the naphthalene concentration is greater than its GCTL in non-compliance/source wells, long-term monitoring will continue.
- If any sign that concentration of naphthalene is greater than the GCTL in the compliance wells, then additional delineation will be required.

- If any naphthalene concentration exceeds the GCTL, but no migration is detected outside of the compliance wells for four consecutive monitoring events, then a permanent groundwater restriction will be considered (RMO II).
- If all concentrations of naphthalene are below action levels for 2 consecutive quarters in all wells, then an NFA will be recommended.

<u>North South Apron Plume (NSAP)</u>

Problem Definition

- Benzene groundwater contamination remains in the area of the North-South Apron Site. Concentrations exceed FDEP GCTLs.
- Long-term monitoring verified no contaminant migration is occurring.
- Source of contamination is unknown and the plume appears to be contained.
- Frequency of groundwater monitoring is semi-annual

COCs

- Benzene
    - USEPA Method 8260
    - GCTL = 1 µg/L
    - NADC = 100 µg/L

Decision Statement

- Determine whether the groundwater COC concentration exceeds its GCTL and if the plume location is stable.
- If the COC exceeds action levels or the plume location moves as determined by compliance wells, further delineation of the plume boundaries will be required
- If the COC does not exceed its GCTL for 2 consecutive events, an NFA will be recommended.
- If the COC increases to above the NADCs, then in accordance with 62-770 rule, the well will be resample to verify the exceedance. Then there are 3 options: supplemental assessment (attempt to locate a previously undetected source), continue monitoring (with different concentrations as triggers), or pursue active remediation by submitting a RAP.

Decision Rule

- If the benzene concentration is greater than the GCTLs in non-compliance/source wells, long-term monitoring will continue.
- If any sign that concentration of benzene is greater than the GCTL in the compliance well, then additional delineation will be required.
- If any benzene concentration exceeds the GCTL, but no migration is detected outside of the compliance wells for four consecutive quarters, then a permanent groundwater restriction will be considered (RMO III).
- If all concentrations of benzene are below action levels for 2 consecutive quarters in all wells, then an NFA will be recommended.

Tank G82

Problem Definition

- Contaminant concentrations in source area wells (CEF-G82-2S) exceed action levels.
- There is still soil contamination remaining at this site that exceeds leachability. This impacted soil was not accessible for removal due to proximity to Building 82 and is now capped with concrete handicap ramp.

Concentrations of the following contaminants exceeded their respective GCTLs at the site:

- Benzene
- naphthalene
- isopropyl benzene
- 1,2,4-trimethylbenzene
- 1-methylnaphthalene
- and 2-methylnaphthlene

COCs

COCs	**Method**	**GCTLs (µg/L)**	**NADCs (µg/L)**
Benzene	EPA 8260	1	100
Naphthalene	EPA 8270	14	140
Isopropyl benzene PQL = 2.0 µg/L	EPA 8260	0.8	8
1,2,4-Trimethylbenzene	EPA 8260	10	100
1-Methylnaphthalene	EPA 8270	28	280
2-Methylnaphthalene	EPA 8270	28	280

Decision Statement

- Determine whether groundwater COC concentrations exceed their respective GCTLS and if the plume location is stable.
- If COCs exceed action levels in the compliance wells, further delineation of the plume boundaries will be required
- If COCs do not exceed GCTLs for 2 consecutive events, an NFA will be recommended
- If the COC increases to above the NADCs, then in accordance with 62-770 rule, the well will be resample to verify the exceedance. Then there are 3 options: supplemental assessment (attempt to locate a previously undetected source), continue monitoring (with different concentrations as triggers), or pursue active remediation by submitting a RAP.

Decision Rule

- If any COC concentrations are greater than the GCTLs in the source wells, long-term monitoring will continue.
- If any sign that any COC concentrations are greater than their respective GCTLs in the compliance wells, then additional delineation will be required.
- If COC concentrations exceed the GCTLs, but no migration is detected outside of the compliance wells for four consecutive quarters, then a permanent groundwater restriction will be considered (RMO III).
- If all COC concentrations are below action levels for 2 consecutive quarters in all wells, then an NFA will be recommended.

<u>BP Wells</u>

Problem Definition

- The COCs exceeded their action levels (GCTLs and NADCs)
- Contaminant concentrations appear to be increasing and migrating downgradient.
- The current downgradient well (CEF-BP-6S) exceeded the GCTL from July 2008 to July 2009 and has not shown GCTL exceedances prior to July 2008.

COCs

COC	**Method**	**GCTL (µg/L)**	**NADC (µg/L)**
Ethylbenzene	EPA 8260	30	300
2-Methylnaphthalene	EPA 8270	28	280
Isopropyl benzene PQL = 2 µg/L	EPA 8260	0.8	8
Naphthalene	EPA 8270	14	140
1,2,4-Trimethylbenzene	EPA 8260	10	100
1,3,5-Trimethylbenzene	EPA 8260	10	100
Total Xylenes	EPA 8260	20	200

Decision Statement

- Determine whether groundwater COC concentrations exceed action levels (GCTLs and NADCs) and if the plume location is stable.
- If COCs exceed action levels or the plume location moves as determined by compliance wells, further delineation of the plume boundaries will be required.
- Currently at the point of verifying the exceedance at the compliance well.
- If COCs do not exceed GCTLs for 2 consecutive events, an NFA will be recommended

- If the COC increases to above the NADCs, then in accordance with 62-770 rule, the well will be resample to verify the exceedance. Then there are 3 options: supplemental assessment (attempt to locate a previously undetected source), continue monitoring (with different concentrations as triggers), or pursue active remediation by submitting a RAP.
- If COCs are between GCTLs and NADCs in the source wells, then a Monitoring Only Plan will be developed.

Decision Rule

- If any COC concentrations are greater than the GCTLs in the source wells, long-term monitoring will continue;
- If any sign that any COC concentrations are greater than its GCTL in the compliance well, then additional delineation will be required.
- If COC concentration exceed the GCTLs, but no migration is detected outside of the compliance wells for four consecutive quarters, then a permanent groundwater restriction will be considered (RMO III).
- If all COC concentrations are below action levels for 2 consecutive quarters in all wells, then an NFA will be recommended.
- If COCs are between GCTLs and NADCs in the source wells, then a Monitored Natural Attenuation Plan will be developed.

Installation Restoration (IR) Sites:

<u>Site 1&2 - Old Landfill and Recent Landfill</u>

Problem Definition

- Land use controls have been implemented to prevent the disturbance of the landfill area, the Site 2 tributary, Rowell Creek, and the site's adjacent wetlands.
- The selected remedial alternative allows contaminants to remain on site.
- A detailed evaluation of the site is conducted every 5 years. Annual monitoring is conducted to verify contaminants do not migrate off site in the interim.

Decision Statements

- Determine whether the landfills are adversely impacting the surface water and/or sediments of Rowell Creek. If the surface water and/or sediments of Rowell Creek are not adversely impacted then monitoring will continue as identified in the monitoring plan. If the surface water and/or sediments in Rowell Creek are adversely impacted then additional actions will be evaluated.

Surface Water Inputs (Annual Events)

- Collect SW samples from 3 locations; RR-08, RR-10, and RR-17.
- Analyze for aluminum, cadmium, chromium, copper, cyanide, iron, lead, manganese, vanadium, and zinc by SW-846 6010B.
- Compare SW results to:
  - -EPA Region 4 Surface Water Screening Levels
  - -Florida Surface Water Quality Standards
  - -EPA Tier II value

-IBDS values

Surface Water Inputs (5-Year Event)

- Collect SW samples from 11 locations; RR-01, RR-02, RR-03, RR-04, RR-07, RR-08, RR-09, RR-10, RR-11, RR-14, and RR-17.
- Analyze for 4,4-DDD, 4,4-DDE, 4,4-DDT, Dieldrin, Endrin, Chlordane, gamma-Chlordane, gamma-BHC (Lindane), and Toxaphene by SW-846 8081.
- Analyze for Aroclor-1254 and Aroclor-1260 by SW-846 8082.
- Analyze for Arsenic, Barium, Cadmium, Chromium, Copper, Iron, Lead, and Zinc by SW-846 6010B.
- Compare SW results to the same action levels as the annual event.

Sediment Inputs (Annual Event)

- Collect sediment samples from 3 locations; RR-08, RR-10, and RR-17.
- Analyze for acetone by SW-846 8260B.
- Analyze for PAHs by SW-846 8270C.
- Analyze for 4,4-DDD, 4,4-DDE, 4,4-DDT, Dieldrin, Endrin, Chlordane, gamma-Chlordane, gamma-BHC (Lindane), and Toxaphene by SW-846 8081.
- Analyze for Aroclor-1254 and Aroclor-1260 by SW-846 8082.
- Analyze for Arsenic, Barium, Cadmium, Chromium, Copper, Iron, Lead, and Zinc by SW-846 6010B.
- Compare sediment results to:

-EPA Region 4 Sediment Screening Levels --Sediment Quality in Florida Coastal Groundwater (every five years)

-ORNL Screening Levels

-IBDS Values

-EPA Sediment Quality Benchmarks

Sediment Inputs (5- Year Event)

- Collect sediment samples from 11 locations; RR-01, RR-02, RR-03, RR-04, RR-07, RR-08, RR-09, RR-10, RR-11, RR-14, and RR-17.
- Analyze for the same analytes as the annual monitoring.
- Compare sediment results to the same action levels as the annual event.

Decision Rules

- If the surface water and/or sediment concentration in the compliance points of Rowell Creek are less than or equal to the action level (as identified above), the monitoring will continue on an annual or five-year basis.
- If the surface water and/or sediment concentration in the compliance points of Rowell Creek is greater than or equal to the action level (as identified above), then resampling will be conducted to verify the exceedance. If the exceedences are verified then appropriate actions may be taken to mitigate adverse impact on Rowell Creek and downgradient receptors.

<u>Site 32 – Hazardous Material Warehouse Storage Area</u>

Problem Definition

- PAHs, 4-methylphenol, and metals contamination remains in the paved area soil. Contaminants of concern are limited to only those which exceed leachability

which includes 4-methylphenol and specific metals (antimony, arsenic, barium, cadmium, lead, nickel, selenium, and vanadium).
- Concentrations of contaminants in soil exceed leachability FDEP SCTLs.
- Exposure to contaminants is limited by the asphalt cap.
- Long-term monitoring will consist of the periodic collection and analysis of groundwater samples to verify that no soil contaminant migration to groundwater is occurring.

Decision Statement
- Determine if contaminated soil beneath the asphalt parking lot is impacting groundwater.
- If COCs in groundwater exceed action levels, then soil contaminant migration to groundwater may be occurring, so the BCT will determine the next course of action to delineate the impact or mitigate the contamination.
- If COCs are below action levels, no action is required, so groundwater monitoring will continue on a five-year basis as outlined in the ROD.

Inputs to the Decision
- Collect groundwater samples from onsite monitoring well CEF-1032-01 and down gradient monitoring well CEF-1033-02.
- In accordance with the FTMR the analyze was revised 4-Methylphenol by SW-846 Method 8270C and seleced metals (antimony, arsenic, barium, cadmium, lead, nickel, selenium, and vanadium by SW-846 Method 6010B).
- Compare results to FDEP GCTLs and IBDS.

Decision Rules
- If any COC concentration in groundwater exceeds the greater of the IBDS or FDEP GCTL, then soil contaminant migration to groundwater may be occurring, so the BCT will determine the next course of action to delineate the impact or mitigate the contamination.
- If all COC concentrations are below the greater of the IBDS or FDEP GCTL, no action will be taken and groundwater monitoring will continue on a five-year basis.

<u>Site 45 - Steam Generating Plant</u>

Problem Definition
- Long-term monitoring will consist of the periodic collection and analysis groundwater samples in downgradient wells to verify that no contaminant migration is occurring either from soil to groundwater or within the surficial aquifer. Long-term monitoring will be used to assess natural attenuation of groundwater contamination.
- Soil needs to be identified.

Decision Statements
- Determine whether vanadium concentrations in source area groundwater exceed action levels. If > AL, then resample in 5 years. If ≤ AL, then follow up with confirmatory sample one year later. If confirmatory sample is ≤ AL, then pursue

NFA. If confirmatory sample is > AL, then continue monitoring on the 5-year schedule.

- Determine whether vanadium concentrations in downgradient groundwater exceed action levels. If > AL, confirm exceedance. If confirmatory sample is > AL, delineate. If ≤ AL, continue with annual monitoring.

Groundwater Inputs

- Collect groundwater samples every 5 years from onsite monitoring wells CEF-007-01SA, CEF-F11-01SA, CEF-P45-02S, CEF-P45-03S, and CEF-P45-04S.
- Collect groundwater samples annually from five down gradient monitoring wells CEF-P45-06S, CEF-P45-12S, CEF-F11-02SB, CEF-P45-08S, and CEF-P45-13S.
- Analyze for vanadium by SW-846 Method 6010B.
- Compare groundwater vanadium results to FDEP GCTL of 49 µg/L.

Decision Rules [rework these to reflect decision statement]

- If any groundwater vanadium concentration from a source area well is > the FDEP GTCL action level of 49 micrograms per liter (µg/L), groundwater monitoring will continue on a five-year basis. If all source area groundwater vanadium concentrations are ≤ the AL then follow up with confirmatory sample one year later. If confirmatory sample is ≤ AL, then pursue NFA. If confirmatory sample is > AL, then continue monitoring on the 5-year schedule.

- If any groundwater vanadium concentration from a down gradient well is > the FDEP GTCL action level of 49 micrograms per liter (µg/L), confirm exceedance. If confirmatory sample is > AL, delineate. If all down gradient groundwater vanadium concentrations are ≤ the AL, continue with annual monitoring.

<u>Site 36/37 – Control Tower TCE Plume and Hangars 13 and 14 DCE Plume</u>

Problem Definition

- Investigations indicated the presence of groundwater contamination from past operating practices. This contamination could pose an unacceptable human health risk if the groundwater was used as a potable water source. Potential migration of contaminated groundwater to surface drainage ditches and, eventually to Sal Taylor Creek could also cause adverse effects on aquatic organisms.

- Based on data from the first 8 years of groundwater monitoring, the following is recommended:
    - Hot Spot 1 –Semi-annual monitoring program, including the monitoring to determine if concentrations remain less than system action levels.
    - Hot Spot 2 – Continuation of the offline status of the AS system to evaluate rebound. Continuation of monitoring with an emphasis on the deep downgradient wells due to increasing trends in benzene and TCE concentrations.
    - Hot Spot 3 - The modified AS system will be returned to operation and will include a deeper sparging component. When the new AS system is operational source area wells and new wells will be sampled quarterly.

Decision Statement

- Determine whether Hot Spot 1 groundwater COC concentrations exceed remedial action levels (RALs). If concentrations are greater than RALs, then install/operate an AS system. If they are less than or equal to the RAL, continue monitoring. The RALs for benzene and TCE needs to be included.
- Determine whether Hot Spots 2 and 3 groundwater COC concentrations exceed RALs. If concentrations are greater than RALs, then continue operating the AS system. If they are less than or equal to the RALs, turn off the system and continue PARM for one year. If PARM concentrations are greater than RALS, the turn AS back on. If PARM concentrations are less than or equal to RALs, monitor for natural attenuation.
- Determine whether COC concentrations in groundwater exceed GCTLs. If concentrations in gw monitoring wells in the LTM program at Site 36/37 are less than or equal to GCTLs for 2 consecutive monitoring events, then pursue NFA. If they are greater than GCTLs, continue monitoring.
- Determine whether the contaminant plumes are migrating. If concentrations in sentinel wells less than or equal to GCTLs, then continue monitoring. If concentrations in sentinel well are greater than GCTLs, further delineate the plume.

Inputs to the Decision

- Collect groundwater samples from shallow, intermediate, and deep zones (see map).
- Analyze for COCs (see list) by SW-846 Methods.
- Analyze for TRPH by FL-PRO.
- Analyze for NA parameters by various methods.
- Compare results to RALs for benzene (1,000 µg/L) and TCE (100 µg/L).
- Compare results to FDEP GCTLs for all other organics.
- Compare results to IBDS values for Fe and Mn.

Contaminants of Concern

VOCs by SW-846 8260B

- BTEX
- PCE
- 1,1,2- TCA
- TCE
- 1,2- DCA
- 1,1-DCA
- 1,1-DCE
- cis-1,2-DCE
- VC

SVOCs by SW-846 8270C

- Naphthalene
- 1-Methylnaphthalene
- 2-Methylnaphthalene
- 2-Methylphenol
- 3-Methylphenol

- 4-Methylphenol

Metals by SW-846 6010B
- Fe
- Mn

Additional Parameters
- TRPH
- NA Parameters including:
  alkalinity
  chloride
  dissolved iron
  methane/ethane/ethene
  nitrate
  nitrite
  orthophosphate
  sulfate
  dissolved sulfide
  TOC
- Field tests including:
  pH
  specific conductance
  temperature
  turbidity
  DO
  hydrogen sulfide
  sulfide
  carbon dioxide
  ferrous iron
  ORP
  alkalinity

Decision Rules

- If Hot Spot 1 groundwater COC concentrations > RALs, then install/operate an AS system. If they are ≤ RAL, continue monitoring.

- If Hot Spots 2 and 3 groundwater COC concentrations > RALs, then continue operating the AS system. If they are ≤ RALs, turn off the system and continue PARM for one year. If PARM concentrations are > RALS, the turn AS back on. If PARM concentrations are ≤ RALs, monitor for natural attenuation.

- If concentrations in groundwater monitoring wells in the LTM program at Site 36/37 are ≤ GCTLs for 2 consecutive monitoring events, then pursue NFA. If they are > GCTLs, continue monitoring.

- If concentrations in sentinel wells ≤ GCTLs, then continue monitoring. If concentrations in sentinel well are > GCTLs, further delineate the plume.

Site 59 – Building 324/Hangar 1845

Problem Definition

- Investigations indicated groundwater contains TCE at concentrations greater than the FDEP GCTL and EPA MCL from past operating practices. This contamination could pose an unacceptable human health risk if the groundwater was used as a potable water source. Potential migration of contaminated groundwater could occur.
- Monitoring will consist of regularly collecting and analyzing groundwater samples from within and downgradient of the TCE Plumes and TCE Hot Spots to assess the performance of in-situ biological treatment and natural attenuation and to evaluate potential TCE migration.
- Active remediation is being conducted at locations which exceed the NADC for TCE (300 ug/L) This value is established as the RAL.

Decision Statement

- Determine whether COC concentrations in groundwater exceed GCTLs. If concentrations in gw monitoring wells in the LTM program at Site 59 are less than or equal to GCTLs for 2 consecutive monitoring events, then pursue NFA. If they are greater than GCTLs, continue monitoring.
- Determine whether the contaminant plumes are migrating. If concentrations in sentinel wells less than or equal to GCTLs, then continue monitoring. If concentrations in sentinel well are greater than GCTLs, further delineate the plume.

Inputs to the Decision

- Collect groundwater samples from site monitoring wells.
- Analyze all samples for COCs by SW-846 8260B.
- Analyze select wells for NA parameters by various methods.
- Compare TCE results to FDEP GCTL of 3 µg/L and degradation products to FDEP GCTLs.

Contaminants of Concern

VOCs by SW-846 8260B

- TCE
- cis-1,2-DCE
- trans-1,2-DCE
- VC

NA Parameters including:

alkalinity
chloride
dissolved iron and sodium
methane/ethane/ethene
sulfate
dissolved sulfide
TOC

Metabolic Acids

Decision Rules

- If concentrations in groundwater monitoring wells in the LTM program at Site 59 are ≤ GCTLs for 2 consecutive monitoring events, then pursue NFA. If they are > GCTLs, continue monitoring.

- If concentrations in sentinel wells ≤ GCTLs, then continue monitoring. If concentrations in sentinel well are > GCTLs, further delineate the plume.

APPENDIX C

LABORATORY STANDARD OPERATING PROCEDURES

GC/MS VOLATILES
BY EPA METHOD 624 AND
SW-846 METHOD 8260B
INCLUDING APPENDIX IX COMPOUNDS

SOP NUMBER: **SOP-202**

REVISION NUMBER: **21**

APPROVED BY:

SECTION MANAGER

QUALITY ASSURANCE OFFICER

EFFECTIVE DATE: **09/11/08**

DATE OF LAST REVIEW **09/11/08**

GC/MS VOLATILES
BY EPA METHOD 624 AND SW-846 METHOD 8260B

1.0 SCOPE AND APPLICATION

Please see Appendix for definitions.
This SOP (based primarily on SW-846 Method 8260B) is used for the analysis of volatile organic compounds in a variety of matrices (soils, sediments, waters, etc.). Methods SW-846 Method 8000B; *Federal Register* Method 624; and CLP Method for Volatiles have also been used in the development of this SOP. The analyses by these various methods are clearly defined in the respective regulatory manuals. A good understanding of these different methods is essential to the performance of each method. The normal laboratory list of analytes with their typical LCS limits is found attached in the appendix. Other compounds may be analyzed by this SOP as detailed in section 1.0 of SW-846 Method 8260B. Any questions left by this SOP should be answered by reading the methods, paying close attention to SW-846 8000B/8260B, EPA 624 and CLP. If questions still remain unanswered, check with the Organic Lab Manager, QA/QC Officer and/or the Technical Director.

2.0 METHOD SUMMARY

After sample preparation, the sample is introduced into the GC/MS generally using purge and trap but sometimes using direct injection (see SW-846 Methods 5030B, 5035 and 3585 for preparation). In purge and trap, the analytes are stripped from the sample using helium and trapped on an adsorbent tube. The tube is heated while being backflushed with helium to carry the analytes to the GC/MS system. The analytes are separated in the gas chromatograph by a combination of the temperature program and the capillary column. The analytes are then detected by the mass spectrometer. Analytes are identified by comparing the mass spectra of known standards with the mass spectra of the sample. Analytes are quantitated relative to known standards using the internal standard method.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Section 3.0 and tables 3-1 and 3-2 of the Empirical Laboratories, LLC Quality Assurance Manual include details concerning sample preservation, containers and handling of volatile samples. All water and non-quarantined soil volatile samples are stored in the Hobart in the sample storage room at a temperature of 4°C. Quarantined soil volatile samples are stored in the dorm-size refrigerator in the sample receiving/log-in room at a temperature of 4°C. Non-preserved water volatile samples have a holding time of 7 days from date of sampling. Preserved water samples and soil volatile samples have a holding time of 14 days from date of sampling (unless otherwise specified for the project).

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Section 3.0 of SW-846 Method 8260B details interferences and potential problems which may be encountered when dealing with volatile analyses.

5.0. EQUIPMENT AND APPARATUS

5.1 GC : HP 5890 or 6890, temperature programmable, suitable for split or splitless injection.

5.2 Column: DB-VRX 60 meter x 0.25 mm I.D. 1.4 µm film thickness or 20 meter x 0.18 mm ID 1.0 µm film thickness silicon coated fused silica capillary column or equivalent.

5.3 M.S. : HP 5971, 5972 or 5973 capable of scanning 35 to 500 amu every one second or less, using 70 volts electron energy in electron impact ionization mode. The MS is capable of producing a mass spectrum for p-Bromofluorobenzene, BFB, which meets all tuning criteria for EPA methods [when 1 µL (50 ng) of the GC/MS tuning standard are injected through the GC.]

5.4 Purge and Trap Unit

5.4.1 Concentrators: Tekmar LSC 2000 or Tekmar/Dohrmann 3000/3100 Sample Concentrator equipped with Supelco trap number 2-1066-U or 2-4920-U VOCARB 3000 providing good delivery for all target compounds.

5.4.2 Autosamplers: Varian Archon 51 position programmable autosampler with 5ml to 25ml water and heated soil capability.

5.5 Acquisition Software: HP chemstation system interfaced to the GC/MS. The system acquires and stores data throughout the chromatographic programs.

5.6 Data Processing Software: TargetDB on Windows NT data system interfaced to the HP Chemstation. The system accepts and stores acquired data. It plots by extracted ion current profile (EICP). The system is also capable of integrating the abundances of any EICP between specified time or scan-number limits. The most recent NBS mass spectral library is installed.

5.7 Microsyringes – 1.0, 5.0,10, 25, 100, 250, 500 and 1000 µL.

5.8 Syringes – 5, 25 and 50 mL, gas-tight with Luer end.

5.9 Balance - analytical, 0.0001 g; top-loading, 0.1 g.

5.10 Disposable pasteur pipets.

5.11 Volumetric flasks, Class A - 2 mL, 5 mL, 10 mL, 50 mL, 100 mL and 250 mL with ground-glass stoppers.

5.12 Spatula - stainless steel.

5.13 Glass scintillation vials - 20mL with screw caps.

5.14 Nitrile Gloves

5.15 pH paper (measures pH from 0-14).

6.0 REAGENTS AND SOLUTIONS

6.1 Organic-free reagent water - obtained from a modulab system.

6.2 Methanol - Purge and trap grade (EM-Omnisolv EM-0482-6 or equivalent)

6.3 Methanol - suitable for use in gas chromatography (B&J Omnisolv MX0484-1, or equivalent)

6.4 Sodium bisulfate, $NaHSO_4$ – ACS reagent grade, or equivalent. Available from Aldrich (Part No. 30,782-3).

6.5 Stock standards are purchased in mixtures from reputable vendors. The date they are received is noted on the label. The date they are opened is noted on the label and recorded in the VOA standards and reagents logbook along with their lot number and vendor. Each standard that is prepared is recorded in the VOA standards and reagents logbook and given a sequential number. Each standard label is completed with the standard number, name, preparation date, expiration date, solvent and analyst initials. Stock standards, when opened, have an expiration date of 6 months, **except for gas standards for South Carolina samples which have a one week expiration date**. All stocks and standards are stored in the freezer at a temperature of -15°C ± 5°C or less from the date they are received/prepared. The freezer temperature is monitored daily with an annually calibrated thermometer and recorded with calibration correction in the VOA refrigerator/freezer logbook. Makeup of common standards is detailed below. See the VOA standards log book for makeup of other standards.

6.5.1 The Bromofluorobenzene (BFB) tuning standard is prepared as follows: Using a 50µL syringe, 40µL of standard (BFB @ 2500ng/µL) is injected into a 2mL volumetric flask containing approximately 1.0mL P&T methanol (Vendor,Lot) and diluted to volume with same making a 50ng/µL standard. After capping and inverting 3 times, the solution is transferred to a labeled 2ml, teflon-lined, screw-capped vial and stored in the freezer at -15°C ± 5°C or less for up to 6 months(1 week for South Carolina samples). A direct injection of 1µL is used to tune the instrument.

6.5.2 The internal and surrogate standard is prepared as follows: Using the indicated syringe, the indicated amount of standard is injected into a 50 mL volumetric flask containing P&T methanol (Vendor,Lot) and diluted to volume with same making a 150ng/µL standard. After capping and inverting 3 times, the solution is transferred to the Archon standard vial and stored under helium for 1 month or less. Each 8260/624 sample is automatically injected with 1µL of this standard. The internal standard/surrogate solution will be replaced if the –50%-200% criteria fails in the CCV.

Standard	Conc. (ng/µL)	Syringe (µL)	Amount (µL)
8260 ISTD/Surr. Mix (Vendor,Lot)	2500	1000	3000

6.5.3 Calibration standards are prepared from the vendor stock standards at appropriate concentrations as follows. Occasionally unusual compounds are added to the mix so it is best to check the VOA standards log book for exact standard makeup. Note: for laboratory control spikes (LCS), alternate sources or lot numbers from the main calibration standard are used to make the LCS standard. See the appendix for analytes in the main mixes.

6.5.3.1 Primary Standard: Using the indicated syringe, the indicated amount of standard is injected into a 2mL volumetric flask containing approximately 1.0mL P&T methanol (Vendor,Lot) and diluted to volume with same to make a 100-500ng/µL standard. After capping and inverting 3 times, the solution is transferred into 2ml amber vial w/mini-inert valve and stored in the freezer at -15°C ± 5°C for 1 week. A 50µg/L (5mL purge) standard is made using 25µL of this standard to 50mLof reagent water.

Stock Standard(CCV)	Conc (ng/µL)	Syringe(µL)	Amount(µL)	Final Conc (ng/µL)
2-CEVE **(Cat#30265)** (Vendor, Lot)	20000	25	20	200
Vinyl Acetate **(#3766)** (Vendor, Lot)	5000	100	80	200
Ketones **(cat#30006)** (Vendor, Lot)	5000	100	80	200
Liquid mix **(C-349H-07)** (Vendor, Lot)	2000	100	100	100
Custom mix **(CCS-1037)** (Vendor, Lot)	5000	50	40	100
Gases **(cat#30042)** (Vendor, Lot)	2000	100	100	100
Acrolein/Acrylonitrile **(CC2098.10)** (Vendor, Lot)	20,000	50	50	500

Additional compounds may be added such as Appendix IX. Refer to standards log.

6.5.4 ICV/LCS/MATRIX SPIKE MIX: A second source standard is to check the validity of the gas and primary calibration standards used in analyzing the calibration curve. Using the indicated syringe, the indicated amount of standard is injected into a 2mL volumetric flask containing approximately 1.0mL P&T methanol (Vendor,Lot) and diluted to volume with same to make a 100-500ng/µL standard. After capping and inverting 3 times, the solution is transferred into 2ml amber vial w/mini-inert valve and stored in the freezer at -15°C ± 5°C for 1 week. A 50µg/L (5mL purge) ICV/LCS/Matrix Spike is made using 25µL of this standard to 50mLof reagent water/Sample Matrix.

Stock Standard(ICV/LCS)	Conc (ng/µL)	Syringe(µL)	Amount(µL)	Final Conc (ng/µL)
2-CEVE(Vendor,Lot#)	20,000	25	20	200
Vinyl Acetate(Vendor,Lot#)	5000	100	80	200
Ketones(Vendor,Lot#)	5000	100	80	200
Liquid mix (Vendor,Lot#)	2000	100	100	100
Custom Mix(Vendor,Lot#)	5000	50	40	100
Gases (Vendor,Lot#)	2000	100	100	100
Acrolein/Acrylonitrile (Vendor,Lot#)	50,000	50	50	500

7.0 PROCEDURE

7.1 Chromatographic conditions – Refer to corresponding instrument maintenance log for current gas chromatograph, mass spectrometer, and concentrator conditions.

7.2 System Bakeout - Prior to analysis, the autosampler purge and trap unit is stepped to bake and an instrument blank is analyzed.

NOTE: Further cleaning may be accomplished by backflushing the lines with methanol and then analyzing blanks overnight.

7.3 Tuning - Prior to any calibration or analysis, BFB tuning criteria must be met for a 1.0µL injection of the tuning standard [see below]. Tune must be met every 12 hours sample analysis is to be performed (every 24 hours for *Federal Register* Method 624 except for South Carolina which only allows 12 hours). The mass spectrum of BFB is acquired as follows: by using one scan at the apex peak, or by using the mean of the apex and the preceding and following scans or mean of a symmetric pattern of scans about the apex, or using the average across the entire peak. Background subtraction is accomplished using a single scan no more than 20 scans prior to the elution of BFB.

m/z	Required Intensity (relative abundance)
50	15 to 40% of m/z 95
75	30 to 60% of m/z 95
95	Base peak, 100% relative abundance
96	5 to 9% of m/z 95
173	Less than 2% of m/z 174
174	Greater than 50% of m/z 95
175	5 to 9% of m/z 174
176	Greater than 95% but less than 101% of m/z 174
177	5 to 9% of m/z 176

7.4 Calibration: Calibration standards are made up in water using the appropriate amount of the methanol standard. Calibration for soils for South Carolina requires that 5mL of sodium bisulfate solution is added to each calibration standard made if the samples will be preserved with sodium bisulfate. All calibration standard integrations must be checked for acceptability.

7.4.1 Initial Calibration - An initial calibration curve at no less than five concentration levels must be analyzed and shown to meet the initial calibration criteria before any sample analysis may be performed. For Arizona samples the surrogates must also be calibrated at a minimum of five concentrations. Method 624 requires that the %RSD be less than 35% to use the average response factor for quantitation, the curve is to be used otherwise and should have a correlation coefficient (***r***) of $\geq$0.995. Method 8260B requires that the %RSD be less than 15% to use the average response factor for quantitation, the curve is to be used otherwise as long as ***r*** is $\geq$0.995 linear or $\geq$ 0.99 quadratic. In addition, there are calibration check compounds (CCCs) listed below which must have a %RSD less than 30% and five system performance check compounds (SPCCs) which must meet the average response factor criteria listed below. The lowest standard must be less than or equal to the reported quantitation limit and the highest standard must not exceed the linear range of the detector. Any manual integrations are documented by inclusion of the integrated signals (**before and after manual integration**) initialed, dated, and reason with the quantitation report and chromatograms. Any response factors less than 0.050 must be supported by the mass spectrum of the lowest standard. **No quadratic curves for South Carolina.**

CCCs:	1,1-Dichloroethene	Toluene
	Chloroform	Ethylbenzene
	1,2-Dichloropropane	Vinyl chloride

SPCCs:	Chloromethane	0.10
	1,1-Dichloroethane	0.10
	Bromoform	0.10
	Chlorobenzene	0.30
	1,1,2,2-Tetrachloroethane	0.30

7.4.2 Initial Calibration Verification - A second source standard at the 50 µg/L (5mL purge) level is used to check the validity of the curve. The standard recovery for all analytes must be between 75 and 125%. If the second source recovery is above 125%, the main standard has probably deteriorated for that compound. That standard must be replaced and a new curve generated. If the second source recovery is below 75%, the second source standard has probably deteriorated for that compound and must be replaced. Any manual integrations are documented by inclusion of the integrated signals with the quantitation report and chromatogram.

7.4.3 Continuing Calibration Verification (every 12 hours) - A midpoint calibration standard (generally 50 µg/L - 5mL purge) must be analyzed and calculated against the initial calibration curve, then shown to meet the

calibration check criteria before any sample analysis may be performed. Acceptance criteria for method 8260B consists of the same SPCC criteria as above and ≤20% drift or difference (calculations given in section 7.10) for the CCCs as listed above. The internal standards must also be evaluated as listed below. Any manual integrations are documented by inclusion of the integrated signals with the quantitation report and chromatogram. Samples are then quantitated against the initial calibration curve. Note: If any compound in the continuing calibration not subject to the criteria above exceeds 30% D, it must be evaluated and initialed by the organic section manager. If deemed acceptable, the analyst may continue analysis.
NOTE: Acceptance criteria for method 624 consists of meeting recovery limits found in table 5 of the method for a QC check sample. This QC check sample is made from a separate source or lot number than the calibration standard at a concentration of 20 µg/L.

Internal standard checks

7.4.3.1.1 Retention time - The retention times of the internal standards in the calibration verification standard must be evaluated immediately after or during data acquisition. If the retention time for any internal standard changes by more than 30 seconds from that in the mid-point standard level of the most recent initial calibration sequence, then the chromatographic system must be inspected for malfunctions and corrections must be made, as required. When corrections are made, reanalysis of samples analyzed while the system was malfunctioning is required.

7.4.3.1.2 Response - If the EICP area for any of the internal standards in the calibration verification standard changes by a factor of two (-50% to + 100%) from that in the mid-point standard level of the most recent initial calibration sequence, the mass spectrometer must be inspected for malfunctions and corrections must be made, as appropriate. When corrections are made, reanalysis of samples analyzed while the system was malfunctioning is required.

7.5 LCS - An LCS is analyzed every 12 hour tune.Using standards prepared from an alternate vendor or lot number, blank water is spiked at the 50 µg/L (5mL/soil) or 10 µg/L (25mL) level. See section 8.3 below for criteria and corrective action. Note: the concentration of the LCS will be 20 µg/L when analyzing 624 samples (QC Check Sample). **When analyzing samples for DOD QSM Version 3, DOD limits will be used.**

7.6 Method Blank - Prior to sample analysis, the system must be shown to be free of contamination through analysis of a method blank. See section 8.4 below for criteria and corrective action.

7.7 Sample Analysis - Prior to analysis, the samples are prepared for chromatography using the appropriate sample preparation method (5mL water, 25mL water, low soil,

high soil, etc.) See SOP-225 for preparation of a 5035 soil sample. For a 5mL/25mL water sample, use the following procedure:

7.7.1. Load the vial into the Archon autosampler in the expected position.

7.7.2. Program the Archon for the loaded vial range and necessary dilutions, making sure the programmed method is set for the same volume as the purge vessel on the front of the LSC 2000 or 3000/3100 and that the Chemstation sequence matches the Archon sequence. Note: TCLP samples are analyzed at a 10x dilution. One TCLP sample is spiked per matrix.

7.7.3. After analysis of the sample has been completed, check the pH of the sample using pH paper and verify it to be less than a pH of 2. If it is not, record the pH and generate a corrective action report. The sample report will have to be flagged for preservation if the analysis is being performed more than 7 days after sampling. [Note: TCLP samples do not require a pH check.]

7.8 Instrument sequence

An example of a typical instrument sequence log follows:
1-BFB Tune (12:00 am)
2-CCV
3-LCS
4-Method Blank
5-Sample
6-Sample
7-Sample
8-Sample
9-Sample
10-Sample
11-Sample
12-Sample
13-Sample
14-Sample
15-Sample
16-Sample
17-Sample MS
18-Sample MSD
19-BFB (12:00pm - 12 hours since last BFB/CCV)
20-CCV
21-LCS
22-Method Blank
23-Sample
24-Sample

7.9 Data Reduction/Evaluation - Each sample analysis sequence is documented using the computer run log generated on the chemstation. This run log is signed, dated and paginated then placed in a 3 ring binder for that instrument. After the sample has been analyzed, the data is processed through the TargetDB on Windows NT data system. Quantitative measurements are performed using the calculations found in section 7.10 below. The following must be checked to determine if the sample will

need any reanalysis or dilution. Formal data evaluation is detailed in SOP-200 (documented using the USACE Analyst Data Review Checklist for USACE projects). **See SOP-224 for guidance on manual integrations.**

7.9.1 Internal Standards - Areas should be within 50 to 200 percent of the area of the continuing calibration. Retention time should be within 30 seconds of the retention time of the continuing calibration. Note: criteria applies to the continuing calibration, not samples, but is used as an indication of the sample analysis validity. If not, the sample and historical data should be evaluated to determine the cause of the problem. Reanalysis is expected if it appears to be from a leak. If matrix effect is confirmed by reanalysis or historical data, complete a corrective action report and flag the affected compounds on the final report for matrix effect.

7.9.2 Surrogates – Control limits are determined by charting LCSs and method blanks. All of the surrogates must be within these limits in order for the analysis to be in control. If not, the reason for the malfunction must be determined and reanalysis may be necessary. If historical data indicates matrix, the sample would be flagged appropriately. When the surrogates exceed either the control limits, a corrective action report must be completed. *Federal Register* Method 624 contains no criteria for surrogate recovery. **When analyzing samples for DOD QSM Version 3, DOD limits will be used.**

Surrogate	WATER	SOIL/SEDIMENT
Dibromofluoromethane	85-120	80-120
1,2-Dichloroethane-d4	85-130	75-140
Toluene-d8	85-115	80-120
Bromofluorobenzene	80-120	80-125

7.9.3 Analyte concentration must be within the range of the calibration curve after rounding to 2 significant figures. If an analyte exceeds the curve, a dilution must be performed, the next sample must be checked for carryover and the sparge position must be checked for contamination through the analysis of a system blank. Any dilution should keep the concentration of the analyte in question within the mid-range of the curve.

7.9.4 Qualitative identification is made as indicated below.

7.9.4.1 The mass spectra are compared to reference spectra in a user-created data base especially compiled to contain relatively uncontaminated mass spectra of each target compound. Note: Such a file cannot be obtained from the daily calibrations during each 12 hour analytical period due to overlapping peaks in the mixes.

7.9.4.2 The GC/MS analyst uses intelligence guided by experience to make the identifications.In uncontaminated spectra where ions are missing due to low concentration, if the major ions are present in the correct ratios at the correct retention time, the identification will be

considered positive. In contaminated spectra, special emphasis will be placed upon higher mass ions, and the major ions will usually need to be present as major components of the spectrum (either unsubtracted or subtracted) for the identification to be positive. All assessments of relative intensities of ions will be made by visual estimates from the spectra.

7.10 Calculations:

7.10.1 The RF is calculated as follows:

$$RF = \frac{A_s \times C_{is}}{A_{is} \times C_s}$$

where:

A_s = Peak area (or height) of the analyte or surrogate.

A_{is} = Peak area (or height) of the internal standard.

C_s = Concentration of the analyte or surrogate.

C_{is} = Concentration of the internal standard.

7.10.2 Calibration verification involves the calculation of the percent drift (linear) or the percent difference (average) of the instrument response between the initial calibration and each subsequent analysis of the verification standard. Use the equations below to calculate % Drift or % Difference, depending on the calibration procedure used.

$$\% \text{ Drift} = \frac{(\text{Calculated concentration} - \text{Theoretical concentration}) * 100}{\text{Theoretical Concentration}}$$

where the calculated concentration is determined from the initial calibration and the theoretical concentration is the concentration at which the standard was prepared.

$$\% \text{ Difference} = \frac{(\text{CCV RF} - \text{Average RF}) * 100}{\text{Average RF}}$$

where CCV RF is the response factor from the analysis of the verification standard and Average RF is the average response factor from the initial calibration. The % difference or % drift calculated for the calibration verification standard must be within ±20% for each CCC analyte, or for all target analytes if the CCCs are not target analytes, before any sample analyses may take place.

7.10.3 Concentration in water samples is calculated as follows: [Note: Using the units specified here for these terms will result in a concentration in units of ng/mL, which is equivalent to ug/L.]

$$\text{Concentration } (\mu g/L) = \frac{(A_s)(C_{is})(D)(V_i)}{(A_{is})(\overline{RF})(V_s)(1000)}$$

where:

A_s = Area (or height) of the peak for the analyte in the sample.

A_{is} = Area (or height) of the peak for the internal standard.

C_{is} = Concentration of the internal standard in the volume purged in ug/L.

D = Dilution factor, if the sample was diluted prior to analysis. If no dilution was made, D = 1. The dilution factor is always dimensionless.

V_i = For purge-and-trap analysis, V_i is not applicable and is set at 1.

$\overline{RF}$ = Mean response factor from the initial calibration.

V_s = Volume of the aqueous sample purged (mL). If units of liters are used for this term, multiply the results by 1000.

7.10.4 Concentration in non-aqueous samples is calculated as follows: [Note: Using the units specified here for these terms will result in a concentration in units of ng/g, which is equivalent to ug/kg.]

$$\text{Concentration } (\mu\text{g/kg}) = \frac{(A_s)(C_{is})(D)(V_i)}{(A_{is})(\overline{RF})(W_s)(1000)}$$

where: A_s,

A_{is}, C_{is}, D, and $\overline{RF}$ are the same as for aqueous samples, and

W_s = Weight of sample extracted (g). Either a dry weight or wet weight may be used, depending upon the specific application of the data. If units of kilograms are used for this term, multiply the results by 1000.

8.0 QUALITY ASSURANCE/QUALITY CONTROL/CORRECTIVE ACTIONS

8.1 Internal Standards - All samples and QC are spiked with internals. See section 7.9.1 above for criteria and corrective action.

8.2 Surrogates - All samples and QC are spiked with surrogates. The surrogate recoveries from method blanks and LCS are used to generate control limits. See section 7.9.2 above for criteria and corrective action.

8.3 LCS Sample - An LCS is analyzed every 12 hour tune. To prepare the LCS, a blank is spiked with standards prepared from an alternate vendor or lot number from the calibration standards. Note: the concentration of the LCS will be 20 µg/L when analyzing 624 samples (QC Check Sample). The recoveries are used to generate control limits. See the LCS report forms in the appendix for the laboratory generated limits. The limits are in-house generated matrix spike limits or client specified limits for matrix spike analytes and 70-130% (or client specified limits) recovery for waters or soils for all other analytes if limits have not been generated. Limits for 624 LCSs are taken from table 5 of method 624. If the LCS compound has a recovery above the upper limit, but the same compound is not detected in any of the batch samples, no corrective action is required. For all other

situations, the LCS should be reanalyzed for the failed analytes only. If the second analysis fails, all associated samples should be reanalyzed for the failed analytes only. **When analyzing samples for DOD QSM Version 3, DOD limits will be used. South Carolina limits are 70-130% except for poor purgers which are 60-140%.**

8.4 Method Blanks - The concentration for most method target analytes must be < ½ the reporting limit. Common laboratory contaminants, such as acetone and methylene chloride, must be < the reporting limit. The first step of corrective action is to assess the affect on the samples. If an analyte is found only in the method blank, but not in any batch samples, no further corrective action may be necessary. Steps should be taken to find/reduce/eliminate the source of this contamination in the method blank. If an analyte is found in the method blank and some, or all, of the other batch samples, then corrective action is required. The source of contamination must be investigated and appropriate action taken and documented to find/reduce/eliminate the source of this contamination. The method blank, and any samples containing the same contaminant, would likely be reanalyzed. For the common laboratory contaminants, meeting the above requirements is not practical. Random cases of contamination are difficult to control, however, daily contamination is not acceptable and corrective action is essential. If a contaminant is found in the method blank and the samples, the compound concentration must be flagged with a 'B' on the final report unless the concentration is greater than 10x that found in the method blank. A method blank is analyzed every 12 hour tune.

8.5 Matrix Spike/Matrix Spike Duplicate (MS/MSD) Sample - 1 in 20 samples are spiked for an MS/MSD with the LCS standard. Criteria for the MS/MSD recoveries are the same as the LCS limits. Limits for the RPDs are 30% RPD for water and soil.. Samples that do not meet these criteria due to matrix must be flagged on the final report for QC problems. Generally, batch control is not based on MS/MSD results unless general method failure is determined to be the problem. In that case, the samples and associated QC would be reanalyzed for the failed analytes only. MS data evaluation must include the consideration of the following factors. **When analyzing samples for DOD QSM Version 3, DOD limits will be used.**

8.5.1 Sample matrix - If the sample is a soil, grab sample or sequentially collected water sample it may affect the %R and RPD of the MS/MSD. A water sample which was taken from the same VOA vial for the original sample and the MS/MSD should have very good RPDs unless there has been a method problem. Corrective action must be taken in the form of reanalysis if a method problem is indicated.

8.5.2 Original sample concentration - If a spiked compound has a problem and the concentration of that compound in the original sample was two or more times the concentration of the spike, no further corrective action may be necessary other than the generation of a corrective action report to document the problem.

8.5.3 MS vs. MSD - If a spiked compound has a problem in both the MS and MSD, review the LCS and if acceptable no further action may be necessary since it is attributable to matrix effect.

8.5.4 Non-target Interference - The presence of significant non-target interference should be brought to the immediate attention of your supervisor who should discuss the problem with the client/project manager to determine the action to be taken.

8.6 Demonstration of Capability (DOC) – Each new analyst must complete a demonstration of capability by analyzing four LCSs with acceptable precision and accuracy. This also must be done when a new instrument is installed or a significant change to the method has been made.

CHROMATOGRAPHIC COND.	**VOA1**	**VOA3**	**VOA4**	**VOA5**
GC	**5890 SERIES II**	**6890**	**5890 SERIES II**	**5890 SERIES II**
MS	**5971**	**5973**	**5972**	**5972**
GC COLUMN	RTX-VRX-60mX0.25mmX1.4um	RTX-VRX-60mX0.25mmX1.4um	DBVRX-60mX0.25mmX1.4um	RTX-VRX-60mX0.25mmX1.4um
INJECTOR LINER	1.0MM	1.0MM	2.0MM	2.0MM
INJECTOR TEMPERATURE	150deg C	150deg C	150deg C	150deg C
TRANSFER LINE TEMP.	250deg C	**150deg C**	250deg C	250deg C
COLUMN PRESSURE	9.0PSI	X	X	X
COLUMN FLOW	X	1.1 ml/min	1.1 ml/min	1.2 ml/min
SPLIT FLOW/RATIO	19ml/min@50deg C	43.3ml/min (40:1)	20ml/min@50deg C	20ml/min@50deg C
INITIAL TEMPERATURE	**45deg C**	**50deg C**	**50deg C**	**50deg C**
INITIAL HOLD TIME	**5.0 min**	**10 min**	**10 min**	**10 min**
RAMP1	**9deg C / min**	**25deg C / min**	**25deg C / min**	**25deg C / min**
TEMPERATURE 1 / TIME 1	**240deg C/ 6.1 min**	**220deg C/ 6.0 min**	**220deg C/ 7.2 min**	**220deg C/ 6.0 min**
RAMP2	X	X	X	X
TEMPERATURE 2 / TIME 2	X	X	X	X
TOTAL RUN TIME	32.7 min	23.0 min	24.2 min	23.0 min
CONCENTRATOR	**(Tekmar 2000)**	**(Tekmar 3100)**	**(Tekmar 3000)**	**(Tekmar 3100)**
ARCHON PURGE COND.				
VALVE/LINE TEMP.	125deg / 125deg C	110deg / 110deg C	130deg / 130deg C	130deg / 130deg C
PURGE TIME	11.0 min	11.0 min	11.0 min	11.0 min
PURGE FLOW	45ml/min	40ml/min	40ml/min	40ml/min
DRY PURGE TIME	2.0 min	2.0 min	2.0 min	2.0 min
DESORB PREHEAT	245deg C	255deg C	255deg C	255deg C
DESORB TEMPERATURE	250deg C	260deg C	260deg C	260deg C
DESORB TIME	**2.0 min**	**1.0 min**	**1.0 min**	**1.0 min**
BAKE TEMPERATURE	270deg C	270deg C	270deg C	270deg C
BAKE TIME	9.0 min	10.0 min	10.0 min	10.0 min

RTX columns are from RESTEK & DBVRX columns are from J&W.

9.0 HEALTH AND SAFETY

9.1 Care should be used in handling all samples. Safety glasses must be worn in the lab at all times. The use of blue nitrile gloves and lab coats is highly recommended.

9.2 Research into expected sample content and concentration should be done in order to be prepared for additional safety considerations. Generally, any samples that need special consideration have applicable notes on the sample logs.

9.3 MSDS sheets are available for all reagents and standards that have been purchased. These are located in the office next to the technical director.

10. WASTE MANAGEMENT AND POLLUTION PREVENTION

10.1 Please see Waste Disposal, SOP-210 and SOP-405 for proper disposal of waste coming from this area within our laboratory.

10.2 Quantity of chemicals purchased should be based on expected usage during its shelf-life and the disposal cost of unused material. Actual reagent preparation volumes should reflect anticipated usage and reagent stability.

11.0 EXAMPLE FORMS

Definitions and examples of the instrument run log, LCS report sheets (624, water and soil) and the USACE analyst data review checklist are located in the following Appendix.
When analyzing samples for DOD QSM Version 3, DOD limits will be used for surrogates, LCS, and MS/MSD.

APPENDIX

TABLE OF DEFINITIONS

1. amu- atomic mass unit
2. BFB- Bromofluorobenzene
3. °C- degrees Centigrade
4. CCC- Calibration Check Compound
5. CCV- Continuing Calibration Verification
6. CLP- Contract Laboratory Program
7. %D- percent difference
8. EICP- extracted ion current profile
9. EPA- Environmental Protection Agency
10. g- gram or grams
11. GC- Gas Chromatograph
12. GC/MS- Gas Chromatograph/Mass Spectrometer
13. ICV- Initial Calibration Verification
14. I.D.- inner diameter
15. ISTD- internal standard
16. LSC- Laboratory Sample Concentrator
17. MDL- method detection limit
18. MS- Matrix Spike
19. MSD- Matrix Spike Duplicate
20. M.S.- Mass Spectrometer
21. µm- micometer
22. µL- microliter
23. mL- milliliter
24. mm- millimeter
25. ng- nanogram
26. P&T- purge and trap
27. QC- quality control
28. %R- percent recovery
29. RPD- relative percent difference
30. %RSD- percent relative standard deviation
31. SOP- Standard Operating Procedure
32. Surr.- surrogate
33. SPCC- System Performance Check Compound
34. TCLP- Toxicity Characteristic Leaching Procedure
35. USACE- United States Army Corps Of Engineers
36. VOA- volatile organic analysis
37. LCS- Lab Control Sample

REFERENCES

1. *40 CFR, Part 136*; Appendix A
2. *Test Methods for Evaluating Solid Waste*, SW-846, Third Edition
3. *National Environmental Laboratory Accreditation Conference*; CH. 5, 2001
4. USACE, *EM 200-1-3; Appendix 1; Shell*, 2/2001
5. *DOD Quality Systems Manual for Environmental Laboratories*, 6/2002

FORM 3

WATER VOLATILE LAB CONTROL SAMPLE (624)

Lab Name: Empirical Laboratories, LLC Contract: ELAB

Lab Code: NA Batch No.: NA SAS No.: NA SDG No.:

Matrix Spike - Client Sample No.:

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	LCS CONCENTRATION (ug/L)	LCS % REC #	QC. LIMITS REC.
Acrolein	100.00	0.0000	100.000	100	NML
Acrylonitrile	100.00	0.0000	100.000	100	NML
Benzene	20.00	0.0000	20.000	100	64-136
Bromodichloromethane	20.00	0.0000	20.000	100	66-134
Bromoform	20.00	0.0000	20.000	100	71-129
Bromomethane	20.00	0.0000	20.000	100	14-186
Carbon tetrachloride	20.00	0.0000	20.000	100	73-127
Chlorobenzene	20.00	0.0000	20.000	100	66-134
Chloroethane	20.00	0.0000	20.000	100	38-162
2-Chloroethyl vinyl eth	40.00	0.0000	40.000	100	D-224
Chloroform	20.00	0.0000	20.000	100	68-132
Chloromethane	20.00	0.0000	20.000	100	D-204
Dibromochloromethane	20.00	0.0000	20.000	100	68-132
1,2-Dichlorobenzene	20.00	0.0000	20.000	100	63-137
1,3-Dichlorobenzene	20.00	0.0000	20.000	100	73-127
1,4-Dichlorobenzene	20.00	0.0000	20.000	100	63-137
1,1-Dichloroethane	20.00	0.0000	20.000	100	73-127
1,2-Dichloroethane	20.00	0.0000	20.000	100	68-132
1,1-Dichloroethene	20.00	0.0000	20.000	100	51-149
trans-1,2-Dichloroethen	20.00	0.0000	20.000	100	70-130
1,2-Dichloropropane	20.00	0.0000	20.000	100	34-166
cis-1,3-Dichloropropene	20.00	0.0000	20.000	100	24-176
trans-1,3-Dichloroprope	20.00	0.0000	20.000	100	50-150
Ethylbenzene	20.00	0.0000	20.000	100	59-141
Methylene chloride	20.00	0.0000	20.000	100	61-139
1,1,2,2-Tetrachloroetha	20.00	0.0000	20.000	100	61-139
Tetrachloroethene	20.00	0.0000	20.000	100	74-126
Toluene	20.00	0.0000	20.000	100	75-125
1,1,1-Trichloroethane	20.00	0.0000	20.000	100	75-125
1,1,2-Trichloroethane	20.00	0.0000	20.000	100	71-129
Trichloroethene	20.00	0.0000	20.000	100	67-133
Trichlorofluoromethane	20.00	0.0000	20.000	100	48-152
Vinyl chloride	20.00	0.0000	20.000	100	4-196

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

NML = No Method Limits

COMMENTS: _____

VOA Water Limits

	In-House	DOD Limits		South Carolina
1,1,1 Trichloroethane	80-125	65-130		70-130
1,1,1,2-Tetrachlorethane	70-140	80-130		70-130
1,1,2,2-Tetrachloroethane	70-130	65-130		70-130
1,1,2-Trichloroethane	80-130	75-125		70-130
1,1-Dichloroethane	75-130	70-135		70-130
1,1-Dichloroethene	70-125	70-130		70-130
1,2,4 Trichlorobenzene	45-135	65-135		70-130
1,2-Dibromo-3-chloropropane	70-130	50-130		70-130
1,2-Dibromoethane	75-130	80-120		70-130
1,2-Dichlorobenzene	70-130	70-120		70-130
1,2-Dichloroethane	70-135	70-130		70-130
1,2-Dichloropropane	75-130	75-125		70-130
1,3-Dichlorobenzene	65-125	75-125		70-130
1,4-Dichlorobenzene	70-125	75-125		70-130
2-Butanone	65-145	30-150		60-140*
2-Hexanone	70-140	55-130		60-140*
4-Methyl-2-pentanone	75-135	60-135		60-140*
Acetone	35-175	40-140		60-140*
Benzene	75-125	80-120		70-130
Bromochloromethane	80-125	65-130		70-130
Bromodichloromethane	85-135	75-130		70-130
Bromoform	70-140	70-130		70-130
Bromomethane	45-150	30-145		70-130
Carbon disulfide	65-130	35-160		70-130
Carbon tetrachloride	75-135	65-140		70-130
Chlorobenzene	75-120	80-120		70-130
Chloroethane	65-145	60-135		70-130
Chloroform	75-125	65-135		70-130
Chloromethane	45-145	40-125		70-130
Cis-1,2-Dichloroethene	80-120	70-125		70-130
Cis-1,3-Dichloropropene	75-130	70-130		70-130
Dibromochloromethane	80-140	60-135		70-130
Dibromomethane	65-140	75-125		70-130
Dichlorodifluoromethane	40-160	30-155		70-130
Ethylbenzene	75-130	75-125		70-130
Methylene chloride	70-130	55-140		70-130
M,p-Xylene	75-125	75-130		70-130
o-Xylene	75-130	80-120		70-130
Styrene	75-125	65-135		70-130
Tetrachloroethene	70-125	45-150		70-130
Toluene	75-125	75-120		70-130
Trans-1-2 Dichlorethene	70-125	60-140		70-130
Trans-1-3-Dichloropropene	70-130	55-140		70-130
Trichloroethene	80-125	70-125		70-130
Trichloroflurormethane	70-140	60-145		70-130
Vinyl chloride	65-140	50-145		70-130
MTBE	75-125	65-125		70-130

Naphthalene	45-135	55-140		70-130

*** - Poor Purger**

VOA Soil Limits

	Soil	DOD Limits		
1-1-1-2 Tetrachloroethane	75-125	75-125		
1-1-1-Trichloroethane	65-140	70-135		
1-1-2-2-Tetrachloroethane	65-130	55-130		
1-1-2-Trichloroethane	70-130	60-125		
1-1-Dichloroethane	70-135	75-125		
1-1-Dichloroethene	65-135	65-135		
1-2-4-Trichlorobenzene	55-135	65-130		
1-2-Dibromo-3-chloropropane	55-145	40-135		
1-2-Dibromoethane	70-135	70-125		
1-2-Dichlorobenzene	75-125	75-120		
1-2-Dichloroethane	65-140	70-135		
1-2-Dichloropropane	70-135	70-120		
1-3-Dichlorobenzene	70-125	70-125		
1-4-Dichlorobenzene	70-125	70-125		
2-Butanone	50-145	30-160		
2-Hexanone	50-140	45-145		
4-Methyl-2-pentanone	55-145	45-145		
Acetone	30-155	20-160		
Benzene	70-130	75-125		
Bromochloromethane	75-130	70-125		
Bromodichloromethane	70-145	70-130		
Bromoform	60-130	55-135		
Bromomethane	50-160	30-160		
Carbon disulfide	65-145	45-160		
Carbon tetrachloride	65-140	65-135		
Chlorobenzene	70-120	75-125		
Chloroethane	60-145	40-155		
Chloroform	65-135	70-125		
Chloromethane	50-150	50-130		
Dibromochloromethane	70-140	65-130		
Dibromomethane	75-125	75-130		
Dichlorodifluoromethane	35-155	35-135		
Ethylbenzene	75-125	75-125		
Methylene chloride	55-155	55-140		
Styrene	70-125	75-125		
Tetrachloroethene	65-130	65-140		
Toluene	55-140	70-125		
Trichloroethene	60-145	75-125		
Trichlorofluoromethane	60-140	25-185		
Vinyl Acetate	50-135			
Vinyl chloride	60-145	60-125		
cis-1-2-Dichlorethene	70-135	65-125		
cis-1-3-Dichloropropene	75-135	70-125		
m-p-Xylene	70-125	80-125		

o-Xylene	70-125	75-125		
trans-1-2-Dichloroethene	65-140	65-135		
trans-1-3--Dichloropropene	65-125	65-125		
MTBE	55-150			
Naphthalene	55-145	40-125		

VOA MIXES

LIQUID MIX (2000PPM)
C-610H (PRIMARY STANDARD)
M-502A-R-10X (ICV/LCS/MATRIX SPIKE)
Benzene
Bromobenzene
Bromochloromethane
Bromodichloromethane
Bromoform
n-Butylbenzene
sec-Butylbenzene
tert-butylbenzene
Carbon tetrachloride
Chlorobenzene
Chloroform
2- & 4-Chlorotoluene
Trichloroethene
Dibromochloromethane
1,2-Dibromo-3-chloropropane
1,2-Dibromoethane
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
1,1- & 1,2-Dichloroethane
1,1,2-Trichloroethene
1,1-Dichloroethene
cis-1,2-Dichloroethene
trans-1,2-Dichloroethene
1,2- & 1,3-Dichloropropane
1,2,3-Trichloropropane
2,2-Dichloropropane
1,1-Dichloropropene
cis-1,3-Dichloropropene
trans-1,3-Dichloropropene
Ethylbenzene
Hexachlorobutadiene
Isopropylbenzene
Isopropyltoluene
Methylene Chloride
Naphthalene
n-Propylbenzene
Styrene
1,1,1,2-Tetrachloroethane
1,1,2,2-Tetrachloroethane
Tetrachloroethene
Toluene
1,2,3-Trichlorobenzene

GASES MIX (2000PPM)
#30042 (PRIMARY STANDARD)
M-502B-R-10X (ICV/LCS/MATRIX SPIKE)
Bromomethane
Chloroethane
Vinyl chloride
Chloromethane
Dichlorodifluoromethane
Trichlorofluoromethane

C610H-PRIMARY STANDARD
M60310X (ICV/LCS/MATRIX SPIKE)
Acrolein (10,000PPM)
Acrylonitrile (10,000PPM)

CCS1037-PRIMARY CUSTOM MIX (5000PPM)
#557102- ICV/LCS CUSTOM MIX (5000PPM)
Tetrahydrofuran
MTBE
Methyl metacrylate
Ethyl methacrylate
1,1,2-Trichlorotrifluoroethane
Cyclohexane
Methylcyclohexane
Methyl acetate
Carbon disulfide
Iodomethane

PRIMARY and ICV/LCS STANDARD-neat
Vinyl acetate (5000PPM)

PRIMARYand ICV/LCS STANDARD-neat
2-Chloroethyl vinyl ether (20000PPM)

KETONES MIX (5000PPM)
#30006 (PRIMARY STANDARD and ICV/LCS) different lots
Acetone
2-butanone
2-hexanone
4-methyl-2-pentanone

1,2,3-Trimethylbenzene
1,2,4-Trimethylbenzene
1,3,5-Trimethylbenzene
m-,p- & o-Xylene
1,1,1-Trichloroethene

VOA CALIBRATIONS RANGE FOR EPA8260B/624(AQUEOUS)

Liquid mix, Gases mix & primary custom mix is calibrated at these levels - 0.5ppb, 1.0ppb, 2.0ppb, 10ppb, 20ppb, 50ppb, 100ppb & 200ppb. The ketones mix, 2-chloroethyl vinyl ether & vinyl acetate are calibrated at these levels - 1.0ppb, 2.0ppb, 4.0ppb, 20ppb, 40ppb, 100ppb, 200ppb & 400ppb. Acrolein & Acrylonitrile are calibrated at these levels – 2.5ppb, 5.0ppb, 10ppb, 50ppb, 100ppb, 250ppb, 500ppb, 1000ppb.

VOA CALIBRATIONS RANGE FOR EPA8260B(SOLIDS)

Liquid mix, Gases mix & primary custom mix is calibrated at these levels – 2.0ppb, 5.0ppb, 10ppb, 20ppb, 50ppb, 100ppb & 200ppb. The ketones mix, 2-chloroethyl vinyl ether & vinyl acetate are calibrated at these levels - 2.0ppb, 10ppb, 20ppb, 40ppb, 100ppb, 200ppb & 400ppb. Acrolein & Acrylonitrile are calibrated at these levels – 5.0ppb, 10ppb, 50ppb, 100ppb, 250ppb, 500ppb, 1000ppb.

VOA LCS/ICV/MATRIX SPIKE LEVEL FOR EPA8260B

Liquid mix, Gases mix, Ethyl methacrlate, Metyl methacrylate, Tetrahydrofuran, MTBE, Trichlorotrifluoroethane, Cyclohexane, Methylcyclohexane & Methyl acetate are spiked at 50ppb level. Acrolein & Acrylonitrile spiked at 250ppb level. Acetone, 2-Butanone, 2-Hexanone, Carbon disulfide, 2-Chloroethyl vinyl ether, 4-Methyl-2-pentanone, Vinyl acetate & Iodomethane are spiked at 100ppb level.

INTERNAL STANDARD ASSOCIATION / QUANT ION TABLE

COMPOUND	QUANT MASS	* I.S.	COMPOUND	QUANT MASS	* I.S.
			Dibromomethane	93	1
*Fluorobenzene **(1)**	96		1,1,2-Trichloroethane	83	2
*Chlorobenzene-d5 **(2)**	117		1,2,3-Trichloropropane	110	2
*1,4-Dichlorobenzene-d4 **(3)**	152		Hexachlorobutadiene	225	3
			Isopropylbenzene	105	2
Bromomethane	94	1	Isopropyltoluene	119	3
Chloroethane	64	1	Methylene Chloride	84	1
Vinyl chloride	62	1	Naphthalene	128	3
Chloromethane	50	1	Propionitrile	54	1
Dichlorodifluoromethane	85	1	n-Propylbenzene	91	3
Acetonitrile	41	1	Styrene	104	2
Allyl chloride	41	1	1,1,1,2-Tetrachloroethane	131	2
Trichlorofluoromethane	101	1	1,1,2,2-Tetrachloroethane	83	3
Benzene	78	1	Tetrachloroethene	166	2
Bromobenzene	156	3	Toluene	92	2
Bromochloromethane	128	1	1,2,3-Trichlorobenzene	180	3
Bromodichloromethane	83	2	1,2,4-Trichlorobenzene	180	3
Bromoform	173	2	1,2,4-Trimethylbenzene	105	3
n-Butylbenzene	91	3	1,3,5-Trimethylbenzene	105	3
sec-Butylbenzene	105	3	m-Xylene	91	2
tert-butylbenzene	119	3	p-Xylene	91	2
Carbon tetrachloride	117	1	o-Xylene	91	2
Chlorobenzene	112	2	Acrolein	56	1
Chloroform	83	1	Acrylonitrile	53	1
Chloroprene	53	1	Tetrahydrofuran	42	1
2-Chlorotoluene	91	3	MTBE	73	1
4-Chlorotoluene	91	3	Methacrylonitrile	41	1
Dibromochloromethane	129	2	Methyl methacrylate	41	1
1,2-Dibromo-3-chloropropane	157	3	Ethyl methacrylate	69	2
1,2-Dibromoethane	107	2	1,1,2-Trichlorotrifluoroethane	101	1
1,2-Dichlorobenzene	146	3	Cyclohexane	56	1
1,3-Dichlorobenzene	146	3	Methylcyclohexane	83	1
1,4-Dichlorobenzene	146	3	Methyl acetate	43	1
1,1-Dichloroethane	63	1	Carbon disulfide	76	1
1,2-Dichloroethane	62	1	Iodomethane	142	1
1,1-Dichloroethene	96	1	Vinyl acetate	43	1
cis-1,2-Dichloroethene	96	1	2-Chloroethyl vinyl ether	63	1
trans-1,2-Dichloroethene	96	1	Acetone	43	1
trans-1,4-Dichloro-2-butene	53	3	2-butanone	43	1
1,2-Dichloropropane	63	1	2-hexanone	43	2
1,3-Dichloropropane	76	2	Isobutyl alcohol	43	1
2,2-Dichloropropane	77	1	1,4-Dioxane	88	1
1,1-Dichloropropene	75	1	4-methyl-2-pentanone	43	1
cis-1,3-Dichloropropene	75	1	Dibromofluoromethane (S)	111	1
trans-1,3-Dichloropropene	75	2	1,2-Dichloroethane-d4 (S)	102	1
Ethylbenzene	91	2	Toluene-d8 (S)	98	2
1,1,1-Trichloroethane	97	1	Bromofluorobenzene (S)	95	2
Trichloroethene	95	1			

***I.S=internal Standard.**
S=surrogate.

ANALYST DATA REVIEW CHECKLIST

Sample Number(s):	
Batch Number(s):	
Method:	**8260B/8270C (Circle One)**

QA/QC Item	Yes	No	NA	Second Level Review
1. Is the BFB/DFTPP tune performed every 12 hours and is the tuning criteria met?				
2. Are the RRFs and % RSDs within QC limits for appropriate analytes for the initial calibration? Check the retention times for compounds with the same spectra. Check compounds with different conc.(eg. m/p-xylene, ketones,etc.).				
3. Was the initial calibration curve verified by a second source calibration standard (ICV) and have criteria been met?				
4. Does the Continuing Calibration Standard (CCV) meet the criteria for the CCCs and SPCCs.				
5. Is the Method Blank run at the desired frequency and is its concentration for target analytes less than the MDLs?				
6. Are the LCS, MS, MSD within control limits and run at the desired frequency?				
7. Are all sample holding times met, analytes within calibration range, IS areas and surrogate recoveries within QC limits?				
8. Was the Method Blank, LCS, MS, MSD and samples loaded to the GCMS_LFSYS Tablespace within the Target DB Database?				

Comments on any "No" response:

Primary-Level Review: _____ Date: _____

Second-Level Review: _____ Date: _____

GC/MS LOW LEVEL PAH'S

BY SW846 METHOD 8270C SIM

SOP NUMBER: **SOP-231**

REVISION NUMBER: **3**

APPROVED BY:

SECTION MANAGER

QUALITY ASSURANCE OFFICER

EFFECTIVE DATE: **01/16/09**

DATE OF LAST REVIEW: **01/16/09**

GC/MS LOW LEVEL PAH'S BY SW846 METHOD 8270C

1.0 SCOPE AND APPLICATION

This SOP (based primarily on SW-846 Method 8000B/8270C using SIM) is used for the analysis of semi-volatile organic compounds in a variety of matrices (soils, sediments, waters, etc.). The normal laboratory list of PAH analytes with their water and soil LCS limits are found attached in the appendix. Any questions left by this SOP should be answered by reading the method SW-846 8000B/8270C. If questions still remain unanswered, check with the Organic Lab Manager, QA/QC Officer and/or Technical Director. A documentation of capability (DOC) should be performed by each analyst using this method.

2.0 METHOD SUMMARY

After sample preparation using the appropriate extraction technique, the sample is introduced into the GC/MS using direct injection. The analytes are separated in the gas chromatograph by a combination of the temperature program, the pressure program and the capillary column. The analytes are then detected by the mass spectrometer. Analytes are identified by comparing the mass spectra of known standards with the mass spectra from the sample. Analytes are quantitated relative to known standards using the internal standard method.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Section 3.0 and tables 3-1 and 3-2 of the Empirical Laboratories, LLC Quality Assurance Manual include details concerning sample preservation, containers and handling of semi-volatile samples and extracts. All water and soil samples are stored in their respective walk-in coolers at a temperature of 4°C. All extracts are stored in the Hobart in the Extraction lab at a temperature of 4°C. Water samples have a holding time of 7 days from date of sampling. Soil samples have a holding time of 14 days from date of sampling with 40 days from extraction to analysis for waters and soils. (unless otherwise specified for the project).

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

4.1 All raw data (samples & QC) must be evaluated for interferences. If contamination occurs, determine whether the source of interference is in the preparation or clean-up of the samples and take corrective action to eliminate the problem.

4.2 Contamination by carryover can occur when samples of high-concentration and low-concentration are analyzed sequentially. To reduce carryover, the sample syringe must be rinsed with solvent between injections. If an unusually high sample is detected, a solvent blank should be analyzed for cross contamination.

5.0. EQUIPMENT AND APPARATUS

5.1 HP 7890 GC complete with electronic pressure control and temperature programmable gas chromatograph suitable for splitless injection.

5.2 Column: RTX-5MS (or equivalent) 30 m x 0.25 mm I.D. x 0.25 µm film thickness fused silica capillary column or RTX-5 SIL-MS 30 m x 0.28 mm I.D. x 0.5µm film thickness.

5.3 HP 5975 mass spectrometer capable of scanning from 35 to 500 amu every second or less and capable of using Selected Ion Monitoring (SIM), using 70 volts electron energy in electron impact ionization mode. The mass spectrometer is capable of producing a mass spectrum for decafluorotriphenylphosphine, DFTPP, which meets all the tuning criteria of the EPA methods.

5.4 HP 7683B autosampler capable of reproducibility from one injection to another proven by meeting QC and calibration criteria.

5.5 HP GC/MS interface that gives acceptable calibration points at 10 ng per injection for each compound of interest and achieves acceptable tuning performance criteria.

5.6 Acquisition Software: HP Chemstation system is interfaced to the GC/MS. The system acquires and stores data throughout the chromatographic programs.

5.7 Data Processing Software: Target DB on Windows NT server data system is interfaced to the HP Chemstation. The system accepts and stores acquired data. It plots by extracted ion current profile (EICP). The system is also capable of integrating the abundances in any EICP between specified time or scan-number limits. The most recent NBS mass spectral library is installed.

6.0 REAGENTS

6.1 Methylene chloride **(Please read SOP-336 before handling this solvent in our laboratory.)** – Trace analysis grade.

6.2 Stock standards are purchased in mixtures from reputable vendors. The date they are received is noted on the label and recorded in the BNA standards log book. The date they are opened is noted on the label and recorded in the BNA standards log book along with their lot number and vendor. Each standard that is prepared is recorded in the BNA standards log book and given a sequential number. Each standards label is completed with the standard number, name, preparation date, expiration date, solvent and analyst initials. All stocks and standards are stored in the freezer at a temperature of -15°C ± 5°C from the date they are received/prepared. Standards are brought to room temperature before being used to make standards. Sonication is used if precipitation is observed after bringing to room temperature. The refrigerator and freezer temperature is monitored daily with an annually calibrated thermometer and recorded with calibration correction in the Extraction temperature/calibration logbook. Makeup of common standards is detailed below. See the BNA standards log book for makeup of other standards.

6.2.1 The Decafluorotriphenylphosphine (DFTPP) tuning standard is prepared as follows (includes benzidine, pentachlorophenol and 4,4'-DDT): Using a 10µL syringe, 10µL (GCM-150, Ultra Scientific @ 1000µg/mL, or equivalent) is injected into a 1.0mL volumetric flask containing approximately 0.900mL methylene chloride (Trace Grade) and diluted to volume with same making a

10µg/mL standard. It is stored in the freezer at -15°C ± 5°C for up to 6 months. A direct injection of 1.0µL is used to tune the instrument.

6.2.2 Calibration standards are prepared from a 50µg/mL intermediate standard at a minimum of five concentrations. Calibration standards are prepared semi-annually unless the initial calibration verification standard indicates a problem. To makeup the 50µg/mL intermediate standard inject the indicated amount of the following standards (or equivalent) into a 10mL volumetric containing approximately 1mL methylene chloride (Trace Grade) and dilute to volume with the same. After capping and inverting several times, the solution is transferred into a labeled 10ml, teflon-lined, screw-capped vial and stored in the freezer at -15°C ± 5°C for up to 12 months. See the Appendix for analytes contained in these mixes.

Standard	Conc (µg/mL)	Amount(µL)	Final Conc(µL)
PAH Mix (Vendor,Lot#)	2000	250	50
BN Surrogate (Vendor,Lot#)	5000	100	50

To makeup the calibration standards, inject the indicated amount of a 5.0µg/mL or 0.5 ug/ml intermediate standard, made from a 10x cut of the 50 and 5.0 ug/ml, or the 50 ug/ml into a 2mL vial containing methylene chloride (Trace Grade) and diluted to 1000ul with the same. After capping and inverting several times and adding 5ul internal standard, the standards are transferred into labeled 2ml, teflon-lined, screw-capped vials and stored in the freezer at -15°C ± 5°C for up to 6 months.

Standard	Amount of standard	Amount of 100µg/mL Internal Standard
0.005 µg/mL	10 µL of 0.5 µg/mL	10 µL
0.01 µg/mL	20 µL of 0.5 µg/mL	10 µL
0.05 µg/mL	10 µL of 5 µg/mL	10 µL
0.1 µg/mL	20 µL of 5 µg/mL	10 µL
0.25 µg/mL	50 µL of 5 µg/mL	10 µL
0.5 µg/mL	100 µL of 5 µg/mL	10 µL
1.0 µg/mL	20 µL of 50 µg/mL	10 µL
5.0 µg/mL	100 µL of 50 µg/mL	10 µL
10.0 µg/mL	200 µL of 50 µg/mL	10 µL
20.0 µg/mL	400 µL of 50 µg/mL	10 µL
30.0 µg/mL	600 µL of 50 µg/mL	10 µL
50.0 µg/mL	25 µL of 2000 µg/mL	10 µL

The makeup of the 5.0µg/mL CCV standard is detailed below. Note: MS list spikes and full list spikes for LCS and/or MS/MSD are prepared from an alternate source or lot number than the calibration standards.

5.0µg/mL CCV standard: Using a 100µL syringe, 100µL of a 50µg/mL working standard is injected into a 2 ml vial containing 900µL methylene chloride (Trace Grade) to make a 5.0µg/mL standard. After capping and inverting several times, 10µL of internal standard (100µg/mL) is then added and the standard is stored in the freezer at -15°C ± 5°C for up to 1 week.

6.2.3 The Initial Calibration Verification (ICV) standard is prepared from a vendor stock standard at a concentration of 50µg/mL as detailed below.

5.0 µg/mL ICV standard: Using a 50µL syringe, 50µL (C-507, NSI Solutions @ 100µg/mL, or equivalent) is injected into a 2mL vial containing 950µL methylene chloride (Trace Grade) making a 5.0µg/mL standard. After capping and inverting several times, 10µL of internal standard (100µg/mL) is added and the standard is stored in the freezer at -15°C ± 5°C for up to 6 months.

***For some clients an SPCC curve and CCV are analyzed along with the PAH standards to check for SPCC min. responses. See standard log for preparation of these standards.**

7.0 PROCEDURE

Prior to using SW-846 8270C (semivolatile method) the samples are prepared for chromatography using the appropriate sample preparation and clean up methods (generally SW-846 methods 3510, 3520, 3541, or 3550).

7.1 Chromatographic conditions:

7.1.1 GC

Capillary Column	RTX-5MS 0.25 mm ID
Inlet mode	Pulsed Splitless
Pressure	15.17 psi (on)
Pulse Pressure	20 psi
Pulse time	0.2 minutes
Purge flow	60 mL/min.
Purge time	0.15 minutes
Injector temperature	300°C
Transfer line temperature	280°C
Initial column temperature	50°C for 0.5 minutes
Initial column temperature ramp	20°C/min
Intermed. column temperature	290°C for 0 minutes
Intermed. Temperature ramp	5°C/min
Final column temperature	320°C for 4.9 minutes

7.1.2 MS

Electron energy	70 volts (nominal)
Mass range	35 to 500 amu or SIM
A/D Samples	3
Solvent Delay	4 minutes or as needed

7.2 Tuning - Prior to any calibration or analysis, DFTPP tuning criteria must be met for a 1.0µL injection of the tuning standard [see below]. Tune must be met every 12 hours sample analysis is to be performed.

Mass	Ion Abundance Criteria
51	30-60% of mass 198
68	<2% of mass 69
70	<2% of mass 69
127	40-60% of mass 198
197	<1% of mass 198
198	Base peak, 100% relative abundance
199	5-9% of mass 198
275	10-30% of mass 198
365	>1% of mass 198
441	Present, but less than mass 443
442	>40% of mass 198
443	17-23% of mass 442

7.3 Calibration

7.3.1 Initial Calibration - An initial calibration curve at no less than five concentration levels must be analyzed and shown to meet the initial calibration criteria before any sample analysis may be performed. Method 8270C requires that the %RSD be less than 15% to use the average response factor for quantitation, the curve is to be used otherwise as long as the correlation factor is ≥0.99. The lowest standard must be less than or equal to the reported quantitation limit and the highest standard must not exceed the linear range of the detector. Generally, levels for the curve are 0.005 µg/mL, 0.01 µg/mL, 0.05 µg/mL, 0.1 µg/mL, 0.25 µg/mL, 0.5 µg/mL, 1.0 µg/mL, 5.0 µg/mL, 10µg/mL, 20µg/mL, 30µg/mL, and 50µg/mL. Any manual integrations are documented by inclusion of the integrated signals(**before and after manual integration**)initialed, reason and dated with the quantitation report and chromatogram. All integrations are checked for acceptability. Response factors of less than 0.050 must be supported by the mass spectrum of the lowest standard.

7.3.2 Initial Calibration Verification (ICV) - A second source standard at the 5.0 µg/mL level is used to check the validity of the curve. The standard recovery for all analytes must be between 75 and 125%. If the second source recovery is above 125%, it is possible that the main standard has deteriorated for that compound. That standard should be remade and reevaluated. If that does not correct the problem, the standard should probably be replaced and a new curve generated. If the second source recovery is below 75%, the second source standard may have deteriorated for that compound. The standard should be remade and reanalyzed. If this does not correct the problem, the standard should probably be replaced. If any compound in the ICV exceeds the criteria above, it may be evaluated and initialed by the organic section

manager. If deemed acceptable, the analyst may continue analysis. Any manual integrations are documented by inclusion of the integrated signals with the quantitation report and chromatogram. All integrations are checked for acceptability.

7.3.2 Continuing Calibration Verification (CCV)- Every 12 hours a CCV at 5.0 µg/mL must be analyzed and calculated against the initial calibration curve, then shown to meet the calibration criteria before any sample analysis may be performed. Acceptance criteria for 8270C analytes must be less than or equal to 20% difference or drift (%D, calculations follow in section 7.9). Internal standard areas should be within 50 to 200 percent of the area of the curve midpoint or the previous CCV. Retention times for the internal standards should be within 30 seconds of the retention time of the curve midpoint or the previous CCV. Any manual integrations are documented by inclusion of the integrated signals with the quantitation report and chromatogram. All integrations are checked for acceptability. Samples are then quantitated against the initial calibration curve.

7.4 LCS - The LCS is extracted 1 per extraction batch of up to 20 samples. The LCS is spiked using an alternate source or lot number than the calibration standards. See the LCS report forms in the appendix for the laboratory generated limits. Recoveries for the MS/MSD spike analytes in LCSs are charted annually to generate control limits for samples analyzed by method 8270C. In all cases, the lowest upper limit would be 110% and the lowest lower limit would be 10%. If enough data points are not present to generate limits, the limits default to 10-110% for all other analytes. See Section 8.3 below for corrective action.

7.5 Method Blank - Method blanks are extracted at a minimum of 1 per extraction batch - up to 20 samples. See Section 8.4 below for criteria and corrective action.

7.6 Samples - Prior to analysis, 0.5 mL samples are prepared by verifying volume and spiking with 5uL of the internal standard solution.

7.7 Data Reduction/Evaluation - Each sample analysis sequence is documented using the computer run log generated on the chemstation. This run log is signed, dated and paginated then placed in a 3 ring binder for that instrument. After the sample has been analyzed, the data is processed through Target DB on the Windows NT data system. The following must be checked to determine if the sample will need any reanalysis or dilution. Formal data evaluation is detailed in SOP-200 and documented using the Analyst Data Review Checklist (see Appendix). **See SOP-224 for guidance on manual integrations.**

7.7.1 Internal Standards - Areas should be within 50 to 200 percent of the area of the curve midpoint. Retention time should be within 30 seconds of the retention time of the curve midpoint. If not, the sample and historical data should be evaluated to determine the cause of the problem. If matrix effect is confirmed by reextraction/reanalysis or historical data, complete a corrective action

report and flag the affected compounds on the final report for matrix effect. Note: criteria applies to the continuing calibration, not samples, but is used as an indication of the sample analysis validity.

7.7.2 Surrogates – Control limits are determined annually by charting LCSs and method blanks. In all cases, the lowest upper limit would be 110% and the lowest lower limit would be 10%. All of the three surrogates for each fraction must be within the control limits in order for the extraction batch to be in control. If a surrogate exceeds the limits, the reason for the malfunction must be determined and a corrective action report must be completed. The sample must be reanalyzed, reextracted or flagged for QC problems.

Surrogate	**Water**	**Soil/Sediment**
2-Fluorobiphenyl	34-167	14-129
Terphenyl-d14	34-167	14-129

7.7.3 Analyte concentration must be within the range of the calibration curve after rounding to 2 significant figures. If an analyte exceeds the curve, a dilution must be performed and the next sample must be checked for carryover. Any dilution should keep the concentration of the analyte in question within the top half of the curve.

7.7.4 The qualitative identification of compounds is based on retention time and a comparison of the sample mass spectrum, after background subtraction, with characteristic ions in a reference mass spectrum from the NBS database (NBS75K.I). This database is used as it contains relatively uncontaminated mass spectra of each target compound which cannot be obtained from the daily calibrations during each 12 hour analytical period due to overlapping peaks in the mixes. Characteristic ions from the reference mass spectrum library are defined as the three ions of greatest relative intensity, or any ions over 30% relative intensity, if less than three such ions occur in the reference spectrum. In addition, the following criteria must be met. The RRT of the sample analyte must be within 0.06 RRT units of the RRT of the standard analyte. The relative intensities of the characteristic ions must agree within 30% of the relative intensities of the same ions in the reference spectrum. Structural isomers that produce very similar mass spectra should be identified as individual isomers so long as their GC retention times differ substantially. A library search may be made for analytes not associated with the calibration for the purpose of tentative identification. NOTE: The GC/MS analyst uses intelligence guided by experience to make the identifications. In uncontaminated spectra where ions are missing due to low concentration, if the major ions are present in the correct ratios at the correct retention time, the identification will be considered positive. In contaminated spectra, special emphasis will be placed upon higher mass ions, and the major ions will usually need to be present as major components of the spectrum (either unsubtracted or subtracted) for the identification to be positive. All assessments of relative intensities of ions will be made by visual estimates from the spectra.

7.8 Quantitation - Once a compound has been identified qualitatively, the concentration must then be quantitated. If the RSD of the compound's response

factor is 15% or less, then the concentration may be determined using the average response factor ($\overline{RF}$) from the initial calibration data. Otherwise, the concentration must be determined from equations based on internal standard calibration using either linear or non-linear calibration. Calculations follow in Section 7.9.

7.9 Calculations:

7.9.1 The RF is calculated as follows:

$$RF = \frac{A_s \times C_{is}}{A_{is} \times C_s}$$

where:

A_s = Peak area (or height) of the analyte or surrogate.

A_{is} = Peak area (or height) of the internal standard.

C_s = Concentration of the analyte or surrogate.

C_{is} = Concentration of the internal standard.

7.9.2 Calibration verification involves the calculation of the percent drift (linear or quadratic) or the percent difference (average) of the instrument response between the initial calibration and each subsequent analysis of the verification standard. Use the equations below to calculate % Drift or % Difference, depending on the calibration procedure used.

$$\% \text{ Drift} = \frac{(\text{Calculated concentration} - \text{Theoretical concentration}) * 100}{\text{Theoretical Concentration}}$$

where the calculated concentration is determined from the initial calibration and the theoretical concentration is the concentration at which the standard was prepared.

$$\% \text{ Difference} = \frac{(\text{CCV RF} - \text{Average RF}) * 100}{\text{Average RF}}$$

where CCV RF is the response factor from the analysis of the verification standard and Average RF is the average response factor from the initial calibration. The % difference or % drift calculated for the calibration verification standard must be within ±20% for each analyte before any sample analyses may take place.

7.9.3 Concentration in water samples is calculated as follows: [Note: Using the units specified here for these terms will result in a concentration in units of ng/mL, which is equivalent to µg/L.]

$$\text{Concentration } (\mu g/L) = \frac{(A_s)(C_{is})(D)(V_i)}{(A_{is})(\overline{RF})(V_s)(1000)}$$

where:

A_s = Area (or height) of the peak for the analyte in the sample.

A_{is} = Area (or height) of the peak for the internal standard.

C_{is} = Concentration of the internal standard in the volume extracted in ug/L.

D = Dilution factor, if the sample was diluted prior to analysis. If no dilution was made, D = 1. The dilution factor is always dimensionless.

V_i = Volume of the extract injected (µL). The nominal injection volume for samples and calibration standards must be the same.

$\overline{RF}$ = Mean response factor from the initial calibration.

V_s = Volume of the aqueous sample extracted (mL). If units of liters are used for this term, multiply the results by 1000.

The 1000 in the denominator represents the number of µL in 1 mL. If the injection (V_i) is expressed in mL, then the 1000 may be omitted.

7.9.4 Concentration in non-aqueous samples is calculated as follows: [Note: Using the units specified here for these terms will result in a concentration in units of ng/g, which is equivalent to µg/kg.]

7.9.5

$$\text{Concentration } (\mu\text{g/kg}) = \frac{(A_s)(C_{is})(D)(V_i)}{(A_{is})(\overline{RF})(W_s)(1000)}$$

where: A_s, A_{is}, C_{is}, D, and $\overline{RF}$ are the same as for aqueous samples, and

W_s = Weight of sample extracted (g). Either a dry weight or wet weight may be used, depending upon the specific application of the data. If units of kilograms are used for this term, multiply the results by 1000.

The 1000 in the denominator represents the number of µL in 1 mL. If the injection (V_i) is expressed in mL, then the 1000 may be omitted.

8.0 QUALITY ASSURANCE/QUALITY CONTROL/CORRECTIVE ACTIONS

8.1 Internals - All samples and QC are spiked with internal standards. See section 7.7.1 above for criteria and corrective action.

8.2 Surrogates - All samples and QC are spiked with surrogates. The surrogate recoveries from method blanks and LCS are used to generate control control limits for the surrogates. See section 7.7.2 above for criteria and corrective action. If any surrogate recoveries are below 10%, samples must be re-extracted if sample is available.

8.3 LCS Sample - The LCS is extracted 1 per extraction batch of up to 20 samples. The LCS is spiked using an alternate source or lot number than the calibration standards. If the LCS compound has a recovery above the upper limit, but the same compound is not detected in any of the batch samples, no corrective action is required. For all

other situations, the LCS should be reanalyzed for the failed analytes only. If the second analysis fails, all associated samples should be reextracted/reanalyzed for the failed analytes only or the data must be evaluated for flagging due to QC problems.

8.4 Method Blanks - The concentration of all method target analytes should be below the MDL for each method target analyte(**< ½ RL for DOD QSM**). The first step of corrective action is to assess the effect on the samples. If an analyte is found only in the method blank, but not in any batch samples, no further corrective action may be necessary. Steps should be taken to find/reduce/eliminate the source of this contamination in the method blank. If an analyte is found in the method blank and some, or all, of the other batch samples, then corrective action is required. The source of contamination must be investigated and appropriate action taken and documented to find/reduce/eliminate the source of this contamination. The method blank, and any samples containing the same contaminant, may need to be reextracted/reanalyzed. For the common laboratory contaminants, meeting the above requirements is not practical. Random cases of contamination are difficult to control, however, daily contamination is not acceptable and corrective action is essential. If a contaminant is found in the method blank and the samples, the compound concentration must be flagged with a 'B' on the final report unless the concentration is greater than 10x that found in the method blank.

8.5 Matrix Spike/Matrix Spike Duplicate (MS/MSD) Sample - 1 in 20 samples are spiked for a MS/MSD (for full list spikes, the full list spiking solution is used). Control limits for the MS/MSD recoveries are the same as those for the LCS found in the appendix. RPD limits are found on the LCS report forms in the appendix. Samples which do not meet these criteria due to matrix must be evaluated for flagging on the final report due to QC problems. Generally, batch control is not based on MS/MSD results unless general method failure is determined to be the problem. In that case, the samples and associated QC would be reanalyzed for the failed analytes only. MS data evaluation must include the consideration of the following factors.

8.5.1 Sample matrix - If the sample is a soil, grab sample or sequentially collected water sample it may affect the %R and RPD of the MS/MSD. Corrective action must be taken in the form of reanalysis if a method problem is indicated.

8.5.2 Original sample concentration - If a spiked compound has a problem and the concentration of that compound in the original sample was two or more times the concentration of the spike, no further corrective action may be necessary other than the generation of a corrective action report to document the problem.

8.5.3 MS vs. MSD - If a spiked compound has a similar problem in both the MS and MSD and is not traced to a method problem, no further action may be necessary other than the generation of a corrective action report to document the problem.

8.5.4 Non-target Interference - The presence of significant non-target interference should be brought to the immediate attention of your supervisor who should discuss the problem with the client/project manager to determine the action to be taken.

8.5.5 Demonstration of Capability (DOC) – Each new analyst must complete a demonstration of capability by analyzing four LCSs with acceptable precision and accuracy. This also must be done when a new instrument is installed or a significant change to the method has been made.

9.0 HEALTH AND SAFETY

9.1 Care should be used in handling all samples. Safety glasses must be worn in the lab at all times. The use of gloves and lab coats is highly recommended.

9.2 Research into expected sample content and concentration should be done in order to be prepared for additional safety considerations. Generally, any samples which need special consideration have applicable notes on the sample logs.

9.3 MSDS sheets are available for all reagents and standards which have been purchased. These are located on the bookshelf outside the office supply storage room.

REFERENCES

1. *Test Methods for Evaluating Solid Waste*, SW-846,Method 8270C, Third Edition.
2. *DOD Quality Systems Manual for Environmental Laboratories*, 6/2002.
3. *AFCEE QAPP, Version 4.0, July 2004.*

10.0 EXAMPLE FORMS

Definitions and examples of the LCS report sheets (625 water limits, in-house water limits and in-house soil limits), the analyst data review checklist and figure 13 from *Federal Register* method 625 for the tailing factor calculation are located in the appendix.

APPENDIX

TABLE OF DEFINITIONS

1. amu- atomic mass unit
2. PAH-Polyaromatic hydrocarbons
3. BNA-base neutral acid
4. °C- degrees Centigrade
5. CCC- Calibration Check Compound
6. CCV- Continuing Calibration Verification
7. CLP- Contract Laboratory Program
8. %D- percent difference
9. DFTPP- Difluorotriphenyphosphine
10. EICP- extracted ion current profile
11. EPA- Environmental Protection Agency
12. g- gram or grams
13. GC- Gas Chromatograph
14. GC/MS- Gas Chromatograph/Mass Spectrometer
15. ICV- Initial Calibration Verification
16. I.D.- inner diameter
17. ISTD- internal standard
18. LSC- Laboratory Sample Concentrator
19. MDL- method detection limit
20. MS- Matrix Spike
21. MSD- Matrix Spike Duplicate
22. M.S.- Mass Spectrometer
23. µm- micometer
24. µL- microliter
25. mL- milliliter
26. mm- millimeter
27. ng- nanogram
28. NPDES- National Pollutant Discharge Elimination System
29. P&T- purge and trap
30. QC- quality control
31. %R- percent recovery
32. RPD- relative percent difference
33. RRT- relative retention time
34. %RSD- percent relative standard deviation
35. SOP- Standard Operating Procedure
36. Surr.- surrogate
37. SPCC- System Performance Check Compound
38. TCLP- Toxicity Characteristic Leaching Procedure
39. USACE- United States Army Corps Of Engineers

Refer to SOP-431 for additional definitions

FORM 3

WATER PAH LAB CONTROL SAMPLE (8270C)

Lab Name: ELAB Contract:

Lab Code: NA Batch No.: NA SAS No.: NA SDG No.:

Matrix Spike - Client Sample No.:

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	LCS CONCENTRATION (ug/L)	LCS % REC #	QC. LIMITS REC.
Acenaphthene	1.00	0.0000	1.00	100	41-132
Acenaphthylene	1.00	0.0000	1.00	100	43-140
Anthracene	1.00	0.0000	1.00	100	50-139
Benzo(a)anthracene	1.00	0.0000	1.00	100	58-141
Benzo(b)fluoranthene	1.00	0.0000	1.00	100	42-156
Benzo(k)fluoranthene	1.00	0.0000	1.00	100	49-165
Benzo(g,h,i)perylene	1.00	0.0000	1.00	100	12-171
Benzo(a)pyrene	1.00	0.0000	1.00	100	31-142
Chrysene	1.00	0.0000	1.00	100	51-155
Dibenz(a,h)anthracene	1.00	0.0000	1.00	100	28-153
Fluoranthene	1.00	0.0000	1.00	100	47-158
Fluorene	1.00	0.0000	1.00	100	40-140
Indeno(1,2,3-cd)pyrene	1.00	0.0000	1.00	100	20-167
Naphthalene	1.00	0.0000	1.00	100	39-125
Phenanthrene	1.00	0.0000	1.00	100	46-144
Pyrene	1.00	0.0000	1.00	100	39-158
2-Methylnaphthalene	1.00	0.0000	1.00	100	36-121
1-Methylnaphthalene	1.00	0.0000	1.00	100	35-131

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

COMMENTS: _____

page 1 of 1

FORM III SV
FORM 3

SOIL PAH LAB CONTROL SAMPLE (8270C)

Lab Name: ELAB Contract:

Lab Code: NA Batch No.: NA SAS No.: NA SDG No.:

Matrix Spike - Client Sample No.:

COMPOUND	SPIKE ADDED (ug/Kg)	SAMPLE CONCENTRATION (ug/Kg)	LCS CONCENTRATION (ug/Kg)	LCS % REC #	QC. LIMITS REC.
Acenaphthene	67.00	0.0000	67.00	100	28-110
Acenaphthylene	67.00	0.0000	67.00	100	23-126
Anthracene	67.00	0.0000	67.00	100	28-136
Benzo(a)anthracene	67.00	0.0000	67.00	100	31-146
Benzo(b)fluoranthene	67.00	0.0000	67.00	100	30-139
Benzo(k)fluoranthene	67.00	0.0000	67.00	100	42-129
Benzo(g,h,i)perylene	67.00	0.0000	67.00	100	21-149
Benzo(a)pyrene	67.00	0.0000	67.00	100	28-128
Chrysene	67.00	0.0000	67.00	100	39-134
Dibenz(a,h)anthracene	67.00	0.0000	67.00	100	30-138
Fluoranthene	67.00	0.0000	67.00	100	30-142
Fluorene	67.00	0.0000	67.00	100	27-116
Indeno(1,2,3-cd)pyrene	67.00	0.0000	67.00	100	17-164
Naphthalene	67.00	0.0000	67.00	100	29-106
Phenanthrene	67.00	0.0000	67.00	100	32-127
Pyrene	67.00	0.0000	67.00	100	28-130
2-Methylnaphthalene	67.00	0.0000	67.00	100	30-111
1-Methylnaphthalene	67.00	0.0000	67.00	100	30-111

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

For 8270-SIM projects, the AFCEE QAPP Ver. 4.0 limits for PAHs in soil and water will be used.

PAH Mix

Acenaphthene
Acenapthylene
Anthracene
Benzo(a)anthracene
Benzo(b)fluoranthene
Benzo(k)fluoranthene
Benzo(g,h,i)perylene
Benzo(a)pyrene
Chrysene
Dibenz(a,h)anthracene
Fluoranthene
Fluorene
Indeno(1,2,3-cd)pyrene
2-Methylnaphthalene
1-Methylnaphthalene
Naphthalene
Phenanthrene
Pyrene

BN Surrogates

2-Fluorobiphenyl
Terphenyl-d14

Internal Standards

Perylene-d12
Phenanthrene-d10

ANALYST DATA REVIEW CHECKLIST

Sample Number(s):	
Batch Number(s):	
Method:	**8260/8270 (Circle One)**

QA/QC Item	Yes	No	NA	Second Level Review
1. Is the BFB/DFTPP tune performed every 12 hours and is the tuning criteria met?				
2. Are the RRFs and % RSDs within QC limits for appropriate analytes for the initial calibration? Check the retention times for compounds with the same spectra. Check compounds with different conc.(eg. m/p-xylene, ketones,etc.).				
3. Was the initial calibration curve verified by a second source calibration standard (ICV) and have criteria been met?				
4. Does the Continuing Calibration Standard (CCV) meet the criteria for the CCCs and SPCCs.				
5. Is the Method Blank run at the desired frequency and is its concentration for target analytes less than the MDLs?				
6. Are the LCS, MS, MSD within control limits and run at the desired frequency?				
7. Are all sample holding times met, analytes within calibration range, IS areas and surrogate recoveries within QC limits?				
8. Was the Method Blank, LCS, MS, MSD and samples loaded to the GCMS_LFSYS Tablespace within the Target DB Database?				

Comments on any "No" response:

_____

_____

_____

_____

Primary-Level Review: _____ Date: _____

Second-Level Review: _____ Date: _____

APPENDIX D

LABORATORY DoD ELAP CERTIFICATION

LABORATORY ACCREDITATION BUREAU

Certificate # L2226

Scope of Accreditation For Empirical Laboratories, LLC

621 Mainstream Drive, Suite 270
Nashville, TN 37228
Marcia K. McGinnity
1-877-345-1113

In recognition of a successful assessment to ISO/IEC 17025:2005 and the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in the DoD Quality Systems Manual for Environmental Laboratories (DoD QSM v4.1) based on the National Environmental Laboratory Accreditation Conference Chapter 5 Quality Systems Standard (NELAC Voted Revision June 5, 2003), accreditation is granted to Empirical Laboratories, LLC to perform the following tests:

Accreditation granted through: **November 30, 2012**

Testing - Environmental

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	8260B	1,1,1-Trichloroethane (1,1,1-TCA)
GC/MS	8260B	1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113; Freon 113)
GC/MS	8260B	1,1,2-Trichloroethane
GC/MS	8260B	1,1,2,2-Tetrachloroethane
GC/MS	8260B	1,1,1,2-Tetrachloroethane
GC/MS	8260B	1,1-Dichloroethane (1,1-DCA)
GC/MS	8260B	1,1-Dichloroethene (1,1-DCE)
GC/MS	8260B	1,2,3-Trichlorobenzene
GC/MS	8260B	1,2,4-Trichlorobenzene
GC/MS	8260B	1,2,3-Trichloropropane
GC/MS	8260B	1,2,4-Trimethylbenzene
GC/MS	8260B	1,3,5-Trimethylbenzene
GC/MS	8260B	1,2-Dibromoethane (EDB)
GC/MS	8260B	1,2-Dibromo-3-chloropropane (DBCP)
GC/MS	8260B	1,2-Dichlorobenzene
GC/MS	8260B	1,2-Dichloroethane (EDC)
GC/MS	8260B	1,2-Dichloropropane
GC/MS	8260B	1,3-Dichlorobenzene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	8260B	1,4-Dichlorobenzene
GC/MS	8260B	1,1-Dichloropropene
GC/MS	8260B	1,3-Dichloropropane
GC/MS	8260B	2,2-Dichloropropane
GC/MS	8260B	2-Butanone (Methyl ethyl ketone; MEK)
GC/MS	8260B	2-Hexanone (Methyl butyl ketone; MBK)
GC/MS	8260B	4-Methyl-2-pentanone (Methyl isobutyl ketone; MIBK)
GC/MS	8260B	Acetone
GC/MS	8260B	Benzene
GC/MS	8260B	Bromochloromethane
GC/MS	8260B	Bromodichloromethane
GC/MS	8260B	Bromobenzene
GC/MS	8260B	Bromoform
GC/MS	8260B	Bromomethane
GC/MS	8260B	n-Butylbenzene
GC/MS	8260B	sec-Butylbenzene
GC/MS	8260B	tert-Butylbenzene
GC/MS	8260B	Carbon Disulfide
GC/MS	8260B	Carbon Tetrachloride
GC/MS	8260B	Chlorobenzene
GC/MS	8260B	Chloroethane
GC/MS	8260B	Chloroform
GC/MS	8260B	Chloromethane
GC/MS	8260B	2-Chlorotoluene
GC/MS	8260B	4-Chlorotoluene
GC/MS	8260B	cis-1,2-Dichloroethene (cis-1,2-DCE)
GC/MS	8260B	cis-1,3-Dichloropropene
GC/MS	8260B	Cyclohexane
GC/MS	8260B	Dibromochloromethane
GC/MS	8260B	Dibromomethane
GC/MS	8260B	Dichlorodifluoromethane (CFC-12)
GC/MS	8260B	Ethylbenzene
GC/MS	8260B	Hexachlorobutadiene
GC/MS	8260B	Isopropylbenzene (Cumene)
GC/MS	8260B	p-Isopropyltoluene
GC/MS	8260B	Methyl Acetate
GC/MS	8260B	Methyl Tertiary Butyl Ether (MTBE)
GC/MS	8260B	Methylcyclohexane
GC/MS	8260B	Methylene Chloride, or Dichloromethane

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	8260B	Naphthalene
GC/MS	8260B	n-Propylbenzene
GC/MS	8260B	Styrene
GC/MS	8260B	Tetrachloroethene (PCE; PERC)
GC/MS	8260B	Toluene
GC/MS	8260B	trans-1,2-Dichloroethene (trans-1,2-DCE)
GC/MS	8260B	trans-1,3-Dichloropropene
GC/MS	8260B	Trichloroethene (TCE)
GC/MS	8260B	Trichlorofluoromethane (CFC-11)
GC/MS	8260B	Vinyl Chloride (VC)
GC/MS	8260B	Xylenes (Total)
GC/MS	8260B	Acrolein
GC/MS	8260B	Acrylonitrile
GC/MS	8260B	Di-isopropyl ether
GC/MS	8260B	ETBE
GC/MS	8260B	Ethyl methacrylate
GC/MS	8260B	Iodomethane
GC/MS	8260B	Methyl methacrylate
GC/MS	8260B	t-Butyl alcohol
GC/MS	8260B	tert-Amyl methyl ether
GC/MS	8260B	Vinyl acetate
GC/MS	8270C/D	Bis(2-chloroisopropyl)ether, or 2,2'-oxybis (1-Chloropropane)
GC/MS	8270C/D	1,2-Dichlorobenzene
GC/MS	8270C/D	1,3-Dichlorobenzene
GC/MS	8270C/D	1,4-Dichlorobenzene
GC/MS	8270C/D	2,4,5-Trichlorophenol
GC/MS	8270C/D	2,4,6-Trichlorophenol (TCP)
GC/MS	8270C/D	2,4-Dichlorophenol (DCP)
GC/MS	8270C/D	2,4-Dimethylphenol
GC/MS	8270C/D	2,4-Dinitrophenol
GC/MS	8270C/D	2,4-Dinitrotoluene (DNT)
GC/MS	8270C/D	2,6-Dichlorophenol
GC/MS	8270C/D	2,6-Dinitrotoluene
GC/MS	8270C/D	1,2-Diphenylhydrazine
GC/MS	8270C/D	2-Chloronaphthalene
GC/MS	8270C/D	2-Chlorophenol
GC/MS	8270C/D	2-Methylnaphthalene
GC/MS	8270C/D	2-Methylphenol (o-Cresol)
GC/MS	8270C/D	2-Nitroaniline

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	8270C/D	2-Nitrophenol (ONP)
GC/MS	8270C/D	3,3'-Dichlorobenzidine (DCB)
GC/MS	8270C/D	3-Methylphenol
GC/MS	8270C/D	3-Nitroaniline
GC/MS	8270C/D	4,6-Dinitro-2-methylphenol (DNOC)
GC/MS	8270C/D	4-Bromophenyl phenyl ether
GC/MS	8270C/D	4-Chloro-3-methylphenol
GC/MS	8270C/D	4-Chloroaniline
GC/MS	8270C/D	4-Chlorophenyl phenyl ether
GC/MS	8270C/D	4-Methylphenol (p-Cresol)
GC/MS	8270C/D	4-Nitroaniline (PNA)
GC/MS	8270C/D	4-Nitrophenol (PNP)
GC/MS	8270C/D	Acenaphthene
GC/MS	8270C/D	Acenaphthylene
GC/MS	8270C/D	Acetaphenone
GC/MS	8270C/D	Anthracene
GC/MS	8270C/D	Benzo(a)anthracene
GC/MS	8270C/D	Benzo(a)pyrene
GC/MS	8270C/D	Benzo(b)fluoranthene
GC/MS	8270C/D	Benzo(g,h,i)perylene
GC/MS	8270C/D	Benzo(k)fluoranthene
GC/MS	8270C/D	Benzyl alcohol
GC/MS	8270C/D	Benzoic Acid
GC/MS	8270C/D	bis(2-Chloroethoxy)methane
GC/MS	8270C/D	bis(2-Chloroethyl)ether (BCEE)
GC/MS	8270C/D	bis(2-Ethylhexyl)phthalate (BEHP)
GC/MS	8270C/D	Butyl benzyl phthalate (BBP)
GC/MS	8270C/D	Carbazole
GC/MS	8270C/D	Chrysene
GC/MS	8270C/D	Di-n-butyl phthalate (DBP)
GC/MS	8270C/D	Di-n-octyl phthalate (DNOP)
GC/MS	8270C/D	Dibenz(a,h)anthracene
GC/MS	8270C/D	Dibenzofuran (DBF)
GC/MS	8270C/D	Diethyl phthalate (DEP)
GC/MS	8270C/D	Dimethyl phthalate (DMP)
GC/MS	8270C/D	Fluoranthene
GC/MS	8270C/D	Fluorene
GC/MS	8270C/D	Hexachlorobenzene (HCB)
GC/MS	8270C/D	Hexachlorobutadiene (HCBD)

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	8270C/D	Hexachlorocyclopentadiene (HCCPD)
GC/MS	8270C/D	Hexachloroethane (HCE)
GC/MS	8270C/D	Indeno(1,2,3-cd)pyrene
GC/MS	8270C/D	Isophorone
GC/MS	8270C/D	N-Nitrosodimethylamine
GC/MS	8270C/D	N-Nitroso-di-n-propylamine (NDPA)
GC/MS	8270C/D	N-nitrosodiphenylamine (NDPHA)
GC/MS	8270C/D	Naphthalene
GC/MS	8270C/D	Nitrobenzene
GC/MS	8270C/D	Pentachlorophenol
GC/MS	8270C/D	Phenanthrene
GC/MS	8270C/D	Phenol
GC/MS	8270C/D	Pyrene
GC/MS	8270C/D	Pyridine
GC/MS	8270C/D	1,2,4-Trichlorobenzene
GC/MS	8270C/D	1,1'-Biphenyl
GC/MS	8270C/D	1,2,4,5-Tetrachlorobenzene
GC/MS	8270C/D	1,4-Dioxane
GC/MS	8270C/D	1-Methylnaphthalene
GC/MS	8270C/D	2,3,4,6-Tetrachlorophenol
GC/MS	8270C/D	Aniline
GC/MS	8270C/D	Atrazine
GC/MS	8270C/D	Benzaldehyde
GC/MS	8270C/D	Benzidine
GC/MS	8270C/D	Caprolactam
GC/ECD	8081A/B	4,4'-DDD
GC/ECD	8081A/B	4,4'-DDE
GC/ECD	8081A/B	4,4'-DDT
GC/ECD	8081A/B	Aldrin
GC/ECD	8081A/B	alpha-BHC (alpha-HCH)
GC/ECD	8081A/B	alpha-Chlordane
GC/ECD	8081A/B	beta-BHC (beta-HCH)
GC/ECD	8081A/B	delta-BHC (delta-HCH)
GC/ECD	8081A/B	Dieldrin
GC/ECD	8081A/B	Endosulfan I
GC/ECD	8081A/B	Endosulfan II
GC/ECD	8081A/B	Endosulfan sulfate
GC/ECD	8081A/B	Endrin

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/ECD	8081A/B	Endrin aldehyde
GC/ECD	8081A/B	Endrin ketone
GC/ECD	8081A/B	gamma-BHC (Lindane; gamma-HCH)
GC/ECD	8081A/B	gamma-Chlordane
GC/ECD	8081A/B	Heptachlor
GC/ECD	8081A/B	Heptachlor epoxide
GC/ECD	8081A/B	Methoxychlor
GC/ECD	8081A/B	Chlordane
GC/ECD	8081A/B	Toxaphene
GC/ECD	8082 /A	Aroclor-1016
GC/ECD	8082 /A	Aroclor-1221
GC/ECD	8082 /A	Aroclor-1232
GC/ECD	8082 /A	Aroclor-1242
GC/ECD	8082 /A	Aroclor-1248
GC/ECD	8082 /A	Aroclor-1254
GC/ECD	8082 /A	Aroclor-1260
GC/ECD	8151A	2,4,5-T
GC/ECD	8151A	2,4,5-TP (Silvex)
GC/ECD	8151A	2,4-D
GC/ECD	8151A	2,4-DB
GC/ECD	8151A	Dalapon
GC/ECD	8151A	Dicamba
GC/ECD	8151A	Dichlorprop
GC/ECD	8151A	Dinoseb
GC/ECD	8151A	MCPA
GC/ECD	8151A	MCPP (Mecoprop)
HPLC/UV	8330A	1,3,5-Trinitrobenzene
HPLC/UV	8330A	1,3-Dinitrobenzene
HPLC/UV	8330A	2,4,6-Trinitrophenylmethylnitramine (Tetryl)
HPLC/UV	8330A	2,4,6-Trinitrotoluene (TNT)
HPLC/UV	8330A	2,4-Dinitrotoluene (DNT)
HPLC/UV	8330A	2,6-Dinitrotoluene
HPLC/UV	8330A	2-Amino-4,6-dinitrotoluene
HPLC/UV	8330A	2-Nitrotoluene (ONT)
HPLC/UV	8330A	3-Nitrotoluene
HPLC/UV	8330A	4-Amino-2,6-dinitrotoluene
HPLC/UV	8330A	4-Nitrotoluene (PNT)
HPLC/UV	8330A	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
HPLC/UV	8330A	Nitroglycerin

Non-Potable Water		
Technology	**Method**	**Analyte**
HPLC/UV	8330A	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
HPLC/UV	8330A	3,5-Dinitroaniline
HPLC/UV	8330A	PETN
GC/FID	8015B	TPH DRO
GC/FID	8015B	TPH GRO
GC/FID	RSK-175	Methane
GC/FID	RSK-175	Ethane
GC/FID	RSK-175	Ethene
GC/ECD	8011	1,2-Dibromoethane (EDB)
GC/ECD	8011	1,2-Dibromo-3-chloropropane (DBCP)
HPLC/MS	6850	Perchlorate
ICP	6010B/C	Aluminum
ICP	6010B/C	Antimony
ICP	6010B/C	Arsenic
ICP	6010B/C	Barium
ICP	6010B/C	Beryllium
ICP	6010B/C	Cadmium
ICP	6010B/C	Calcium
ICP	6010B/C	Chromium, total
ICP	6010B/C	Cobalt
ICP	6010B/C	Copper
ICP	6010B/C	Iron
ICP	6010B/C	Lead
ICP	6010B/C	Magnesium
ICP	6010B/C	Manganese
CVAA	7470A	Mercury
ICP	6010B/C	Nickel
ICP	6010B/C	Potassium
ICP	6010B/C	Selenium
ICP	6010B/C	Silver
ICP	6010B/C	Sodium
ICP	6010B/C	Thallium
ICP	6010B/C	Vanadium
ICP	6010B/C	Zinc
ICP	6010B/C	Molybdenum
ICP	6010B/C	Tin
ICP	6010B/C	Titanium
IC	300.0	Chloride
IC	300.0	Fluoride

Non-Potable Water		
Technology	**Method**	**Analyte**
IC	300.0	Nitrate
IC	300.0	Nitrite
IC	300.0	Sulfate
IC	9056A	Chloride
IC	9056A	Fluoride
IC	9056A	Nitrate
IC	9056A	Nitrite
IC	9056A	Sulfate
Titration	SM 2320B 20th ed.	Alkalinity
ISE	SM 4500 B, D, 20th ed.	Ammonia
UV/Vis	7196A	Hexavalent Chromium
Colorimetric	353.2	Nitrate/Nitrite
Titration	Chap.7, Sect. 7.3.4 Mod.	Reactive Sulfide
Titration	SM 4500 S-2CF, 20th edition	Sulfide
UV/Vis	SM 4500 P B5, E, 20th edition	Total Phosphorus
UV/Vis	SM 4500 PE, 20th edition	Ortho-Phosphorus
TOC	9060A/SM5310C, 20th edition	Total Organic Carbon
Gravimetric	SM 2540C, 20th edition	TDS
Colorimetric	9012A/B	Cyanide
Physical	1010A	Ignitability
Physical	9095B	Paint Filter
Probe	9040B/C	pH
Preparation	**Method**	**Type**
Preparation	1311	TCLP
Preparation	3005A	Metals digestion
Preparation	3010A	Metals digestion
Preparation	3510C	Organics Liquid Extraction
Preparation	5030A/B	Purge and Trap Water

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	8260B	1,1,1-Trichloroethane (1,1,1-TCA)
GC/MS	8260B	1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113; Freon 113)
GC/MS	8260B	1,1,2-Trichloroethane
GC/MS	8260B	1,1,2,2-Tetrachloroethane
GC/MS	8260B	1,1,1,2-Tetrachloroethane
GC/MS	8260B	1,1-Dichloroethane (1,1-DCA)
GC/MS	8260B	1,1-Dichloroethene (1,1-DCE)
GC/MS	8260B	1,2,3-Trichlorobenzene
GC/MS	8260B	1,2,4-Trichlorobenzene
GC/MS	8260B	1,2,3-Trichloropropane
GC/MS	8260B	1,2,4-Trimethylbenzene
GC/MS	8260B	1,3,5-Trimethylbenzene
GC/MS	8260B	1,2-Dibromoethane (EDB)
GC/MS	8260B	1,2-Dibromo-3-chloropropane (DBCP)
GC/MS	8260B	1,2-Dichlorobenzene
GC/MS	8260B	1,2-Dichloroethane (EDC)
GC/MS	8260B	1,2-Dichloropropane
GC/MS	8260B	1,3-Dichlorobenzene
GC/MS	8260B	1,4-Dichlorobenzene
GC/MS	8260B	1,1-Dichloropropene
GC/MS	8260B	1,3-Dichloropropane
GC/MS	8260B	2,2-Dichloropropane
GC/MS	8260B	2-Butanone (Methyl ethyl ketone; MEK)
GC/MS	8260B	2-Hexanone (Methyl butyl ketone; MBK)
GC/MS	8260B	4-Methyl-2-pentanone (Methyl isobutyl ketone; MIBK)
GC/MS	8260B	Acetone
GC/MS	8260B	Benzene
GC/MS	8260B	Bromochloromethane
GC/MS	8260B	Bromodichloromethane
GC/MS	8260B	Bromobenzene
GC/MS	8260B	Bromoform
GC/MS	8260B	Bromomethane
GC/MS	8260B	n-Butylbenzene
GC/MS	8260B	sec-Butylbenzene
GC/MS	8260B	tert-Butylbenzene
GC/MS	8260B	Carbon Disulfide
GC/MS	8260B	Carbon Tetrachloride
GC/MS	8260B	Chlorobenzene
GC/MS	8260B	Chloroethane

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	8260B	Chloroform
GC/MS	8260B	Chloromethane
GC/MS	8260B	2-Chlorotoluene
GC/MS	8260B	4-Chlorotoluene
GC/MS	8260B	cis-1,2-Dichloroethene (cis-1,2-DCE)
GC/MS	8260B	cis-1,3-Dichloropropene
GC/MS	8260B	Cyclohexane
GC/MS	8260B	Dibromochloromethane
GC/MS	8260B	Dibromomethane
GC/MS	8260B	Dichlorodifluoromethane (CFC-12)
GC/MS	8260B	Ethylbenzene
GC/MS	8260B	Hexachlorobutadiene
GC/MS	8260B	Isopropylbenzene (Cumene)
GC/MS	8260B	p-Isopropyltoluene
GC/MS	8260B	Methyl Acetate
GC/MS	8260B	Methyl Tertiary Butyl Ether (MTBE)
GC/MS	8260B	Methylcyclohexane
GC/MS	8260B	Methylene Chloride, or Dichloromethane
GC/MS	8260B	Naphthalene
GC/MS	8260B	n-Propylbenzene
GC/MS	8260B	Styrene
GC/MS	8260B	Tetrachloroethene (PCE; PERC)
GC/MS	8260B	Toluene
GC/MS	8260B	trans-1,2-Dichloroethene (trans-1,2-DCE)
GC/MS	8260B	trans-1,3-Dichloropropene
GC/MS	8260B	Trichloroethene (TCE)
GC/MS	8260B	Trichlorofluoromethane (CFC-11)
GC/MS	8260B	Vinyl Chloride (VC)
GC/MS	8260B	Xylenes (Total)
GC/MS	8260B	Acrolein
GC/MS	8260B	Acrylonitrile
GC/MS	8260B	Ethyl methacrylate
GC/MS	8260B	Iodomethane
GC/MS	8260B	Methyl methacrylate
GC/MS	8260B	Vinyl acetate
GC/MS	8270C/D	Bis(2-chloroisopropyl)ether, or 2,2'-oxybis (1-Chloropropane)
GC/MS	8270C/D	1,2-Dichlorobenzene
GC/MS	8270C/D	1,3-Dichlorobenzene
GC/MS	8270C/D	1,4-Dichlorobenzene

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	8270C/D	2,4,5-Trichlorophenol
GC/MS	8270C/D	2,4,6-Trichlorophenol (TCP)
GC/MS	8270C/D	2,4-Dichlorophenol (DCP)
GC/MS	8270C/D	2,4-Dimethylphenol
GC/MS	8270C/D	2,4-Dinitrophenol
GC/MS	8270C/D	2,4-Dinitrotoluene (DNT)
GC/MS	8270C/D	2,6-Dichlorophenol
GC/MS	8270C/D	2,6-Dinitrotoluene
GC/MS	8270C/D	1,2-Diphenylhydrazine
GC/MS	8270C/D	2-Chloronaphthalene
GC/MS	8270C/D	2-Chlorophenol
GC/MS	8270C/D	2-Methylnaphthalene
GC/MS	8270C/D	2-Methylphenol (o-Cresol)
GC/MS	8270C/D	2-Nitroaniline
GC/MS	8270C/D	2-Nitrophenol (ONP)
GC/MS	8270C/D	3,3'-Dichlorobenzidine (DCB)
GC/MS	8270C/D	3-Methylphenol
GC/MS	8270C/D	3-Nitroaniline
GC/MS	8270C/D	4,6-Dinitro-2-methylphenol (DNOC)
GC/MS	8270C/D	4-Bromophenyl phenyl ether
GC/MS	8270C/D	4-Chloro-3-methylphenol
GC/MS	8270C/D	4-Chloroaniline
GC/MS	8270C/D	4-Chlorophenyl phenyl ether
GC/MS	8270C/D	4-Methylphenol (p-Cresol)
GC/MS	8270C/D	4-Nitroaniline (PNA)
GC/MS	8270C/D	4-Nitrophenol (PNP)
GC/MS	8270C/D	Acenaphthene
GC/MS	8270C/D	Acenaphthylene
GC/MS	8270C/D	Acetaphenone
GC/MS	8270C/D	Anthracene
GC/MS	8270C/D	Benzo(a)anthracene
GC/MS	8270C/D	Benzo(a)pyrene
GC/MS	8270C/D	Benzo(b)fluoranthene
GC/MS	8270C/D	Benzo(g,h,i)perylene
GC/MS	8270C/D	Benzo(k)fluoranthene
GC/MS	8270C/D	Benzyl alcohol
GC/MS	8270C/D	Benzoic Acid
GC/MS	8270C/D	bis(2-Chloroethoxy)methane
GC/MS	8270C/D	bis(2-Chloroethyl)ether (BCEE)

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	8270C/D	bis(2-Ethylhexyl)phthalate (BEHP)
GC/MS	8270C/D	Butyl benzyl phthalate (BBP)
GC/MS	8270C/D	Carbazole
GC/MS	8270C/D	Chrysene
GC/MS	8270C/D	Di-n-butyl phthalate (DBP)
GC/MS	8270C/D	Di-n-octyl phthalate (DNOP)
GC/MS	8270C/D	Dibenz(a,h)anthracene
GC/MS	8270C/D	Dibenzofuran (DBF)
GC/MS	8270C/D	Diethyl phthalate (DEP)
GC/MS	8270C/D	Dimethyl phthalate (DMP)
GC/MS	8270C/D	Fluoranthene
GC/MS	8270C/D	Fluorene
GC/MS	8270C/D	Hexachlorobenzene (HCB)
GC/MS	8270C/D	Hexachlorobutadiene (HCBD)
GC/MS	8270C/D	Hexachlorocyclopentadiene (HCCPD)
GC/MS	8270C/D	Hexachloroethane (HCE)
GC/MS	8270C/D	Indeno(1,2,3-cd)pyrene
GC/MS	8270C/D	Isophorone
GC/MS	8270C/D	N-Nitrosodimethylamine
GC/MS	8270C/D	N-Nitroso-di-n-propylamine (NDPA)
GC/MS	8270C/D	N-nitrosodiphenylamine (NDPHA)
GC/MS	8270C/D	Naphthalene
GC/MS	8270C/D	Nitrobenzene
GC/MS	8270C/D	Pentachlorophenol
GC/MS	8270C/D	Phenanthrene
GC/MS	8270C/D	Phenol
GC/MS	8270C/D	Pyrene
GC/MS	8270C/D	Pyridine
GC/MS	8270C/D	1,2,4-Trichlorobenzene
GC/MS	8270C/D	1,1'-Biphenyl
GC/MS	8270C/D	1,2,4,5-Tetrachlorobenzene
GC/MS	8270C/D	1,4-Dioxane
GC/MS	8270C/D	1-Methylnaphthalene
GC/MS	8270C/D	2,3,4,6-Tetrachlorophenol
GC/MS	8270C/D	Aniline
GC/MS	8270C/D	Atrazine
GC/MS	8270C/D	Benzaldehyde
GC/MS	8270C/D	Benzidine
GC/MS	8270C/D	Caprolactam

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/ECD	8081A/B	4,4'-DDD
GC/ECD	8081A/B	4,4'-DDE
GC/ECD	8081A/B	4,4'-DDT
GC/ECD	8081A/B	Aldrin
GC/ECD	8081A/B	alpha-BHC (alpha-HCH)
GC/ECD	8081A/B	alpha-Chlordane
GC/ECD	8081A/B	beta-BHC (beta-HCH)
GC/ECD	8081A/B	delta-BHC (delta-HCH)
GC/ECD	8081A/B	Dieldrin
GC/ECD	8081A/B	Endosulfan I
GC/ECD	8081A/B	Endosulfan II
GC/ECD	8081A/B	Endosulfan sulfate
GC/ECD	8081A/B	Endrin
GC/ECD	8081A/B	Endrin aldehyde
GC/ECD	8081A/B	Endrin ketone
GC/ECD	8081A/B	gamma-BHC (Lindane; gamma-HCH)
GC/ECD	8081A/B	gamma-Chlordane
GC/ECD	8081A/B	Heptachlor
GC/ECD	8081A/B	Heptachlor epoxide
GC/ECD	8081A/B	Methoxychlor
GC/ECD	8081A/B	Chlordane
GC/ECD	8081A/B	Toxaphene
GC/ECD	8082 /A	Aroclor-1016
GC/ECD	8082 /A	Aroclor-1221
GC/ECD	8082 /A	Aroclor-1232
GC/ECD	8082 /A	Aroclor-1242
GC/ECD	8082 /A	Aroclor-1248
GC/ECD	8082 /A	Aroclor-1254
GC/ECD	8082 /A	Aroclor-1260
GC/ECD	8151A	2,4,5-T
GC/ECD	8151A	2,4,5-TP (Silvex)
GC/ECD	8151A	2,4-D
GC/ECD	8151A	2,4-DB
GC/ECD	8151A	Dalapon
GC/ECD	8151A	Dicamba
GC/ECD	8151A	Dichlorprop
GC/ECD	8151A	Dinoseb
GC/ECD	8151A	MCPA
GC/ECD	8151A	MCPP (Mecoprop)

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
HPLC/UV	8330A	1,3,5-Trinitrobenzene
HPLC/UV	8330A	1,3-Dinitrobenzene
HPLC/UV	8330A	2,4,6-Trinitrophenylmethylnitramine (Tetryl)
HPLC/UV	8330A	2,4,6-Trinitrotoluene (TNT)
HPLC/UV	8330A	2,4-Dinitrotoluene (DNT)
HPLC/UV	8330A	2,6-Dinitrotoluene
HPLC/UV	8330A	2-Amino-4,6-dinitrotoluene
HPLC/UV	8330A	2-Nitrotoluene (ONT)
HPLC/UV	8330A	3-Nitrotoluene
HPLC/UV	8330A	4-Amino-2,6-dinitrotoluene
HPLC/UV	8330A	4-Nitrotoluene (PNT)
HPLC/UV	8330A	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
HPLC/UV	8330A	Nitroglycerin
HPLC/UV	8330A	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
HPLC/UV	8330A	PETN
GC/FID	8015B	TPH DRO
GC/FID	8015B	TPH GRO
HPLC/MS	6850	Perchlorate
ICP	6010B/C	Aluminum
ICP	6010B/C	Antimony
ICP	6010B/C	Arsenic
ICP	6010B/C	Barium
ICP	6010B/C	Beryllium
ICP	6010B/C	Cadmium
ICP	6010B/C	Calcium
ICP	6010B/C	Chromium, total
ICP	6010B/C	Cobalt
ICP	6010B/C	Copper
ICP	6010B/C	Iron
ICP	6010B/C	Lead
ICP	6010B/C	Magnesium
ICP	6010B/C	Manganese
CVAA	7471A/B	Mercury
ICP	6010B/C	Nickel
ICP	6010B/C	Potassium
ICP	6010B/C	Selenium
ICP	6010B/C	Silver
ICP	6010B/C	Sodium
ICP	6010B/C	Thallium

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Solid and Chemical Materials		
Technology	**Method**	**Analyte**
ICP	6010B/C	Vanadium
ICP	6010B/C	Zinc
ICP	6010B/C	Molybdenum
ICP	6010B/C	Tin
ICP	6010B/C	Titanium
UV/Vis	7196A	Hexavalent Chromium
TOC	Lloyd Kahn	Total Organic Carbon
Colorimetric	9012A/B	Cyanide
Titration	Chap.7, Sect. 7.3.4 Mod.	Reactive Sulfide
Titration	9034	Sulfide
Probe	9045D	pH
Preparation	**Method**	**Type**
Preparation	1311	TCLP
Preparation	1312	SPLP
Preparation	NJ Modified 3060A	Hexavalent Chromium
Preparation	3050B	Metals Digestion
Preparation	3546	Organics Microwave Extraction
Preparation	3541	Organics Soxhlet Extraction
Preparation	3550B	Organics Sonication
Preparation	SM 2540B 20th edition	Percent Solids (Percent Moisture)
Preparation	5035 /A	Purge and Trap Solid

Notes:

1) This laboratory offers commercial testing service.

Approved By: _____ Date: November 30, 2009

R. Douglas Leonard
Chief Technical Officer

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