

**A1. TITLE AND APPROVAL**

**Generic Quality Assurance Project Plan  
For Brownfields Phase II Environmental Site Assessments  
And Other Assessments Related to the  
City of Orlando, Florida  
USEPA Brownfields Assessment Grant  
Cooperative Agreement BF-95498212**

*Prepared for:*



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*ECT Project No. 130591.0001 & 130592.0001*

*September 2013*

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## A2. TABLE OF CONTENTS

<b>A1.</b>	<b>TITLE AND APPROVAL</b> .....	1
<b>A2.</b>	<b>TABLE OF CONTENTS</b> .....	2
<b>A3.</b>	<b>DISTRIBUTION LIST</b> .....	3
<b>A4.</b>	<b>PROJECT/TASK ORGANIZATION</b> .....	4
<b>A5.</b>	<b>PROBLEM DEFINITION/BACKGROUND</b> .....	6
<b>A6.</b>	<b>PROJECT/TASK DESCRIPTION AND SCHEDULE</b> .....	6
<b>A7.</b>	<b>SPECIAL TRAINING REQUIREMENTS/CERTIFICATION</b> .....	6
<b>A8.</b>	<b>DOCUMENTS AND RECORDS</b> .....	7
<b>B1.</b>	<b>PROJECT/TASK ORGANIZATION</b> .....	10
<b>B2.</b>	<b>SAMPLING DESIGN PROCESS</b> .....	10
<b>B3.</b>	<b>SAMPLE HANDLING AND CUSTODY REQUIREMENTS</b> .....	14
<b>B4.</b>	<b>ANALYTICAL METHODS AND REQUIREMENTS</b> .....	14
<b>B5.</b>	<b>FIELD QUALITY CONTROL REQUIREMENTS</b> .....	15
<b>B6.</b>	<b>LABORATORY QUALITY CONTROL REQUIREMENTS</b> .....	15
<b>B7.</b>	<b>FIELD EQUIPMENT AND CORRECTIVE ACTION</b> .....	16
<b>B8.</b>	<b>LAB EQUIPMENT AND CORRECTIVE ACTION</b> .....	16
<b>B9.</b>	<b>ANALYTICAL SENSITIVITY AND PROJECT CRITERIA</b> .....	16
<b>B10.</b>	<b>DATA MANAGEMENT AND DOCUMENTS</b> .....	17
<b>C1.</b>	<b>ASSESSMENT AND RESPONSE ACTIONS</b> .....	18
<b>C2.</b>	<b>PROJECT REPORTS</b> .....	18
<b>D1.</b>	<b>FIELD DATA EVALUATION</b> .....	19
<b>D2.</b>	<b>LABORATORY DATA EVALUATION</b> .....	19
<b>D3.</b>	<b>DATA USABILITY AND PROJECT VERIFICATION</b> .....	20
	<b>REFERENCES</b> .....	22
	<b>LIST OF ABBREVIATIONS</b> .....	23

### List of Attachments

- A—Quality Assurance Project Organization – Figure 1
- B— Project Corrective Action Process – Figure 2
- C—Chapter 62-777, F.A.C, Tables I, II and V
- D—Accutest Laboratories Southeast, Inc. Quality Systems Manual
- E—FDEP SOPs
- F—Field Data Sheets

### A3. DISTRIBUTION LIST

The following individuals will receive copies of the approved Generic Quality Assurance Project Plan (Generic QAPP) and subsequent revisions:

- Brian Gross, Brownfields Project Officer/Manager, United States Environmental Protection Agency (EPA) Region 4, Atlanta Federal Building, 61 Forsyth Street S.W., Atlanta, Georgia 30303; Phone (404) 562-8604, email: [Gross.Brian@epamail.epa.gov](mailto:Gross.Brian@epamail.epa.gov)
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- Rick Watkins, Laboratory Manager/Technical Director, Accutest Laboratories Southeast, Inc., 4405 Vineland Road, Suite C-15, Orlando, Florida 32811; Phone (407) 425-6700; fax (407) 425-0707; email: [rwatkins@accutest.com](mailto:rwatkins@accutest.com)
- Svetlana Izosimova, Ph.D., Quality Assurance Officer, Accutest Laboratories Southeast, Inc., 4405 Vineland Road, Suite C-15, Orlando, Florida 32811; Phone (407) 425-6700; fax (407) 425-0707; email: [svetlanai@accutest.com](mailto:svetlanai@accutest.com)

#### **ECT (Contractor) Distribution List**

- Jeffrey Peters, P.G., Contract/Project Manager, ECT, 3660 Maguire Boulevard, Suite 107, Orlando, Florida 32803; Phone (407) 903-0005, email: [jpeters@ectinc.com](mailto:jpeters@ectinc.com)
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- Joseph Schmidt, P.E., Field Team Leader, ECT, 3660 Maguire Boulevard, Suite 107, Orlando, Florida 32803; Phone (407) 903-0005, email: [jschmidt@ectinc.com](mailto:jschmidt@ectinc.com)
- Chad Downing, Field Team Technician, ECT, 3660 Maguire Boulevard, Suite 107, Orlando, Florida 32803; Phone (407) 903-0005. [cdowning@ectinc.com](mailto:cdowning@ectinc.com)

#### A4. PROJECT/TASK ORGANIZATION

A Quality Assurance Project Organization chart is provided as Figure 1 in Attachment A. The individuals participating in the project and their specific roles and responsibilities are provided below:

**Brian Gross, EPA Region 4 Brownfields Project Officer/Manager and Designated Approving Official (DAO)** - This individual will be responsible for approval of the Generic QAPP, Site-Specific QAPP (SSQAPP) Addendum, and subsequent revisions for compliance with the current version of EPA QA/R-5, "EPA Requirements for Quality Assurance Plans for Environmental Data Operations", current EPA Region 4 Guidance, and will retain revised documents on file. This individual will also be responsible for final review and approval of the QAPP and subsequent revisions for compliance with the current version of EPA QA/R-5, "EPA Requirements for Quality Assurance Plans for Environmental Data Operations".

**George Houston II, P.G., Brownfields Project Coordinator; Central District FDEP** - As applicable, this individual will be involved in review and approval of the final site assessment report(s). This individual will also ensure plans are in compliance with current FDEP rules and regulations.

**Dan Dashtaki, Brownfields Coordinator; City of Orlando, Florida** - This individual will be responsible for coordinating with the ECT Team and the FDEP Central District. This individual will also ensure plans are implemented according to schedule and are compliant with current FDEP Standard Operating Procedures (SOPs).

**Note:** The following roles are dependent upon the Contractor conducting work under the referenced Cooperative Agreements. The roles and responsibilities are identified below; however, individuals filling these roles will be identified in SSQAPPs.

**Jeffrey Peters, P.G., Contract/Project Manager** - Mr. Peters will be responsible for the coordination of reports with the ECT Team, the City of Orlando and the regulatory agencies. Mr. Peters will be the primary decision maker for the project and primary user of the data to determine whether or not further action is required at the site. Mr. Peters will also coordinate the project activities; specific responsibilities are:

1. Approving the Generic QAPP and subsequent revisions in terms of Brownfields specific requirements; distribution of the Generic QAPP document to the Field Team Leader and members of the project team.
2. Overall responsibility of the investigation.
3. Coordinating field and laboratory activities.
4. Conducting project activities in accordance with the SSQAPP.
5. Validating field data.
6. Reporting to the FDEP Brownfields Coordinator and the City of Orlando Brownfields Coordinator regarding the project status per the work order and preparing interim and final reports for submittal to FDEP and the City.

7. Making final project decisions with the authority to commit the necessary resources to execute the project.
8. Responsible for instituting corrective actions for problems encountered during field sampling activities.
9. Communicate corrective actions to the Field Team Leader to remedy problems encountered in the field and coordinate with the Lab Manager to correct any corresponding problems encountered in the chemical analyses.
10. Compile documentation detailing any corrective actions and provide them to the QA/QC officer and FDEP Brownfields Project Coordinator.

**David L. Kraus, P.G., QA/QC Officer** - Mr. Kraus, as QA/QC Officer, will remain independent of the groups responsible for data generation and will provide QA/QC technical assistance to the Project Manager. Mr. Kraus will also be responsible for final internal review and approval of the Generic QAPP, internal QA audits, and QC implementation of the project. The QA/QC officer will report audit results to the Project Manager and review implemented corrective actions.

**Joe Schmidt, P.E., Field Team Leader** - Mr. Schmidt will perform the following duties:

1. Select the field sampling team.
2. Conduct the field activities per the approved SSQAPP and supervise the field sampling team.
3. Upon receipt from the Project Manager, Mr. Schmidt will distribute the approved QAPPs and subsequent revisions to the members of the field sampling team.
4. Report problems in the field to the Project Manager.
5. Implement corrective actions in the field as directed by the Project Manager. Corrective actions will be documented in the field logs and provided to the Project Manager.

**Field Team Technicians** - These individuals will perform the actual field work per the SSQAPP and at the direction of the field team leader. The field team typically consists of two to four people and will be named at a later date by the field team leader.

**Laboratory Manager Rick Watkins and Quality Assurance Officer Svetlana Izosimova (Accutest Laboratories Southeast, Inc.)** - Mr. Watkins will be responsible for coordinating the analysis of the samples and laboratory validation of the data. He will coordinate the receipt of the samples at the laboratory, select the analytical team, ensure internal laboratory audits are conducted per the Laboratory's Quality Systems Manual (QSM) and distribute the applicable sections of the QAPPs and subsequent revisions to members of the analytical team. Ms. Izosimova is responsible for instituting corrective actions for problems encountered in the chemical analyses and will also report laboratory problems affecting the project data to the Laboratory Manager and ECT Project Manager. Corrective actions for chemical analyses will be detailed in a QA report that will be provided to the Project Manager via electronic and conventional mail.

## **A5. PROBLEM DEFINITION/BACKGROUND**

The problem definition/background information will be detailed in the SSQAPPs.

## **A6. PROJECT/TASK DESCRIPTION AND SCHEDULE**

The project/task description and schedule will be detailed in the SSQAPP addendums.

While the specific contaminants of concern (COCs) will be identified in the SSQAPPs, the objectives of the Brownfields Phase II Environmental Site Assessments (ESAs) will be to evaluate whether COCs are present in environmental media, whether they are present at concentrations above applicable regulatory criteria, and whether further assessment is warranted based on exceedences of these criteria. For this project, FDEP Chapter 62-777, F.A.C. Table I Groundwater Cleanup Target Levels (GCTLS) and FDEP Chapter 62-77, F.A.C. Table II Soil Cleanup Target Levels (SCTLs) are the applicable regulatory criteria, unless modified by the development of site specific CTLs as provided in Chapter 62-780, F.A.C. The scope of work will be designed to assess the presence or absence of environmental impacts and the general magnitude of impacts: not to delineate impacts or to design a remediation strategy. Table V, Natural Attenuation Default Concentrations is provided as a reference for situations where contaminants are found above cleanup target levels; however, the GCTs and the SCTL regulatory limits are used to determine if contaminants are present. Referenced above, Tables I, II, and V are provided in Attachment C located on the CD provided in the front cover of this manual.

## **A7. SPECIAL TRAINING REQUIREMENTS/CERTIFICATION**

The Field Team Leader will ensure that project personnel have current certificates of training for the 40-hour OSHA Hazardous Waste Operations and Emergency Response (HAZWOPER)/Safety Training Class with annual 8-hour refresher courses. Personnel mobilizing to the site shall carry a Certificate of Training identification card on their person. Current Certificates of Training are also kept in personnel files located at their respective headquarters. Field team members will have received extensive in-house and outside training to complete their assigned tasks and this is ensured with annual personnel evaluations. Staff receives continual training on an as-needed basis by attending courses at the local universities as well as attending state and federal training when offered. Deficiencies and the need for new training are identified during personnel evaluations by Management. A Florida-licensed driller will perform the drilling tasks that may be required for this project; however, the project manager will provide technical oversight via communication with field personnel and the drilling subcontractor. Licensure of the subcontracted drilling operator will be confirmed during solicitation for drilling services. Subcontractors are required to provide proof of their 40-hour and 8-hour HAZWOPER certifications. The final assessment reports will be signed and sealed by either a professional geologist or a professional engineer certified in the State of Florida.

The City of Orlando Brownfield Team will be responsible for ensuring that their Brownfields program personnel have valid and current specialized training required by the OSHA regulations as a prerequisite for site visit(s). Specific certifications have not been identified as necessary during the planning of this project.

The laboratory performing the analysis will analyze environmental samples for this project in compliance with applicable regulations and standards. The analytical laboratory, methods of analysis, and applicable accreditation will be defined in the SSQAPPs. It is anticipated that Accutest Laboratories Southeast, Inc. (Accutest) will be utilized for assessments under this program. The laboratory's Quality Assurance Manual (QAM) is included in Attachment D of this Generic QAPP.

## **A8. DOCUMENTS AND RECORDS**

Contractors tasked with completing assessment or cleanup work will follow DEP-SOP-001/01 for sample custody and documentation. The complete DEP-SOP-001/01 has been attached to this Generic QAPP document as Attachment E. Field personnel will maintain appropriate documents and records for sampling events. Specific forms (chain of custody, field sampling and calibration logs, etc.) are provided in Attachment F. Document and records requirements are also maintained per U.S. EPA Region 4, Science and Ecosystem Support Division (SESD) Operating Procedure, Document Control, dated April 13, 2011. Some of the required documentation includes:

- Field crew signs or initials records/notes with a waterproof pen.
- Use of field sampling and documentation supplies, and equipment are tracked with an in-house system.
- Sampling containers are prepared by the laboratory and shipped with a packing list documenting contents.
- Preservative used by the laboratory are traceable by preparation date, vendor, and lot number.
- Sampling containers are pre-cleaned at the laboratory.
- Water level indicator and field parameter meters are cleaned according to specifications and the documentation is contained in the field notes.
- Equipment is maintained and calibrated in accordance with manufacturers' specifications.

Chain-of-Custody forms accompany all samples from origin through disposal. Sample containers are labeled with sample location ID, preservative, sampler name, analyses required, and date/time of collection. The sample location ID is linked to the labels, Chain-of-Custody, and field notes. The Chain-of-Custody form includes the following information:

- Project name and address.
- Date and times of sample collection.
- Name of sampler.
- Sample location ID.
- Number of samples.

- Analyses required.
- Preservation method.
- Sample turnaround time in days.
- Comments.

Field notes are recorded during site visits and include:

- Names of personnel, subcontractors, and others onsite.
- Date and chronological summary of field activities.
- Ambient conditions.
- Sample location descriptions, sample ID.
- Lithology.
- Field measurement data.
- Sample order.
- Purging and sampling equipment.
- Field decontamination procedures.
- Field calibration records.
- Types and number of quality control samples collected.
- Sampler and QA/QC officer signatures.
- Results of QC checks.
- Documentation of problems encountered in the field including corrective action resolution.

Field logs will be recorded and bound in three-ring binders or in a bound field book. Field logs/field books will include weather observations at the site when field activities are conducted. Relevant observations or digressions from the procedures in this Generic QAPP, deemed notable by any field team member, will also be recorded in the field logbook. The approved SSQAPP will be located onsite during field activities. Field data worksheets will be used to record field measurements. Examples and are provided in Attachment F. Each page of the field logs and field data worksheets will be dated and signed by the person making the entries. The originals will be placed in bound three-ring binders and retained in the physical project file. Monitoring well installation and sampling sheets are recorded and include:

- Well casing material, diameter, screened interval, and total depth.
- Drilling method(s) and lithology.
- Water table depth.
- Calculation of purge volume and sampling procedures.
- Field parameter measurements and equipment used.
- Sampling date.

- Observations.

Samples collected are immediately placed in laboratory-provided coolers and chilled to 4 degrees Celsius using wet ice. Chain-of-Custody information accompanies the samples, which are collected at the site by a laboratory representative. Upon receipt of the samples and Chain-of-Custody information, the laboratory:

- Checks sample container integrity, temperature, and documentation.
- Verifies the sample preservatives.
- Logs receipt of the samples.
- E-mails a PDF file copy of the Chain-of-Custody and login information.

Upon receipt of the e-mail confirmation, the Project Manager and QA/QC Officer will review the PDF versions of the Chain-of-Custody and laboratory login information for consistency with the internal work order that documented the sampling work and analyses to be conducted during that field event.

The laboratory provides both electronic and paper copies of the analytical results generally within 10 days of sample receipt. Laboratory data are reviewed by the Project Manager and QA/QC Officer. The electronic copy is placed in the project file maintained on the server, which is routinely “backed-up” to ensure data integrity. The paper version of the results is maintained in the physical project file, which is eventually archived for a period of at least 7 years.

Types of information requested from the laboratory include:

- Analytical result sheets.
- Method blank results.
- Surrogate recoveries and acceptance limits.
- Matrix spike/matrix spike duplicate results, and acceptance limits.
- Spike/Duplicate results and acceptance limits.
- Laboratory control sample results and acceptance limits.
- Inductively Coupled Plasma (ICP) serial dilution results.
- ICP interference check samples.
- Project narrative containing observations and explanation of any data qualifiers.
- Signature by laboratory quality assurance officer.

The laboratory analytical report will be submitted to the Project Manager. When necessary, a narrative will be provided with the laboratory report that describes:

- The dates of sample receipt, preparation, and analysis.
- The condition of the samples upon receipt.
- Sample preparation and analysis.

- Any problems encountered during sampling handling storage, preparation, or analysis, and their resolution.
- Any variance from the standard operating procedures.
- A discussion of the quality of the reported analytical data.

Project records will include correspondence, field logs, and data sheets, laboratory analytical reports, and a final report. The final report will be submitted to the City of Orlando Brownfields Coordinator who will forward to the EPA Region 4 Brownfields Project Officer/Manager.

The Project Manager will submit a field activity report to the City of Orlando Brownfields Coordinator within 15 days of completion of the field activities as described in the SSQAPP. This report will include the analytical data report, a signed narrative about field activities, a summary of collected field data, a written report of the audit of field activities (see Section C1), and copies of the original field log books and field data worksheets for this project. The narrative report will include at least discussions of field activities, any divergences from QAPP procedures, and a discussion of field data quality.

The Project Manager will distribute copies of the SSQAPP to the people filling the roles identified in the distribution list (see Section A3), once it is approved. Any revisions to this Generic QAPP, or to any SSQAPPs, will be documented as *revised* with corresponding revision number (*revision #1*). It will be the responsibility of the Project Manager to see to it that each person on the distribution list receives copies of any revisions.

Project records and documents will be handled in general accordance with EPA SOP #EPA-09251.3b "Handling and Disposition of Project Records and Documents." The laboratory will manage the original raw data from this project in both hard copy and electronic format. The Laboratory Manager will retain information on where the records are stored, who will be responsible for records management, and how long specific types of records or documents will be maintained.

Records and reports can be found in the physical project file located at the Project Manager's local ECT office. The project file will eventually be archived for a period of at least 7 years at the office of the Contractor responsible for conducting the assessment. The Project Manager will submit copies of records and reports to the City of Orlando Brownfields Coordinator, who will approve deviations from these procedures before implementation, if applicable.

## **B1. PROJECT/TASK ORGANIZATION**

The site specific sampling design process and site figures will be provided in the SSQAPP addendum.

## **B2. SAMPLING DESIGN PROCESS**

The DEP-SOP-001/01 provides procedures for routine field sampling and measurement; the procedures presented in DEP-SOP-001/01 will be followed during field sampling events.

Groundwater and surface water samples will be collected to assess the presence of COCs. Water quality characteristics will be collected to support the critical measurements of COCs in surface water and groundwater. Soil samples will be collected in order to assess the presence of COCs in soils. Sample collection locations will be selected using predetermined and/or field-based data for delineation purposes, and identified using Global Positioning Satellite (GPS) technology and site observations.

### **Water Sampling**

The following sampling methods are contained in DEP-SOP-001/01 and will be used, or associated guidance adhered to, in completing sampling activities associated with this project (sampling methods referenced below are provided in Attachment E).

1. SOP FS 1000, "General Sampling Procedures," describes preliminary activities; contamination prevention; protective gloves; container and equipment rinsing; fuel-powered equipment and related activities; preservation, holding times and container types; preventive and routine maintenance; sample documentation and evidentiary custody; health and safety; hazardous wastes.
2. SOP FC 1000, "Cleaning/Decontamination Procedures," describes the process for preparation and decontamination of sampling equipment.
3. SOP FS 2000, "General Aqueous Sampling," describes the aqueous, sample collection of grab and composite samples for laboratory analyses.
4. SOP FS 2100, "Surface Water Sampling," presents procedure to be used to consistently collect representative surface water samples.
5. SOP FS 2200, "Groundwater Sampling," ensures collected samples will be representative of water in the aquifer or target formation and have not been altered or contaminated by the sampling or handling procedures. Samples will be collected from onsite monitor wells by variable-speed peristaltic pump.
6. Pre-cleaned, single-use sample containers provided by the selected project laboratory will be used for sample collection. The following tables, also provided in Attachment E, list the sample container requirements, preparation requirements for these containers, sample preservation requirements, and holding time criteria:
  - SOP Table FS 1000-4 "40 CFR Part 136 Table II, Required Containers, Preservation Techniques and Holding Times" (Water/Wastewater Samples)
  - SOP Table FS 1000-7 "Sample Handling, Preservation and Holding Time Table for SW 846 Method 5035"
  - SOP Table FS1000-8 "Preservation Methods and Holding Times for Drinking Water Samples that Differ from 40 CFR Part 136, Table II"

In general, precautions will be taken to prevent contamination. If the field team encounters any problems or unexpected situations while in the field (e.g., access problems, safety issues, inadequate supplies, equipment failure, etc.), the Project

Corrective Action Process Flowchart will be followed, included as Figure 2, Attachment B.

The following SOPs will be followed for field measurement:

1. SOP FT 1000, "General Field Testing and Measurement"
2. SOP FT 1100, "Field Measurement of Hydrogen Ion Activity (pH)"
3. SOP FT 1200, "Field Measurement of Specific Conductance"
4. SOP FT 1400, "Field Measurement of Temperature"
5. SOP FT 1500, "Field Measurement of Dissolved Oxygen (DO)"
6. SOP FT 1600, "Field Turbidity"
7. SOP FT 1900, "Continuous Monitoring with Multi-parameter Meters"

### **Soil Sampling**

The following guidance documents will be followed for the sample collection of soil samples for the designated COCs; sampling methods referenced below are provided in CD format in Attachment E:

1. SOP FS 1000, "General Sampling," describing preliminary activities; contamination prevention and sample collection order; protective gloves; container and equipment rinsing; fuel-powered equipment and related activities; preservation, holding and container types, preventive and routine maintenance; documentation and references; sample custody; health and safety; and hazardous wastes.
2. SOP FC 1000, "Field Decontamination," describes the process for preparation and decontamination of sampling equipment.
3. SOP FS 3000, "Soil," describing general soil sampling, procedures for compositing, specific procedures for volatile organic compounds, surface and subsurface soil sampling.
4. Pre-cleaned, single-use sampling containers provided by the selected project laboratory will be used for sample collection. The following tables, also provided in Attachment E, list the sample container requirements, preparation requirements for these containers, sample preservation requirements, and holding time criteria:
  - SOP Table FS 1000-6 "Recommended Sample Containers, Sample Volumes, Preservation Techniques and Holding Times for Residuals, Soil and Sediment Samples."
  - SOP Table FS 1000-7 "Sample Handling, Preservation and Holding Time Table for SW 846 Method 5035"
  - SOP Table FS 1000-8 "Preservation Methods and Holding Times for Drinking Water Samples that Differ from 40 CFR Part 136, Table II."

The laboratory provides preserved or non-preserved containers for the samples where applicable. The Field Team Leader is responsible for ensuring the laboratory provides the appropriate sampling containers, including preservative. A Terra Core sampler is used during the collection of VOC samples.

The lithology descriptions and soil samples will be made using the Unified Soil Classification System (USCS), as discussed in American Society for Testing and

Materials (ASTM) specification D2487. In addition, depending on the project objectives, the organic vapor concentrations may be measured using an organic vapor analyzer; SOP FS 3000 describes the collection of soil from a direct-push rig. Generally, soil samples have an analysis holding time of 14 days before extraction and 40 days after extraction.

In general, precautions will be taken to prevent contamination. If the field team encounters any problems or unexpected situations while in the field (e.g., access problems, safety issues, inadequate supplies, equipment failure, etc.), the Project Corrective Action Process Flowchart will be followed, included as Figure 2 in Attachment B.

A table for sampling containers, methods of analysis, number of samples for each analytical analysis and quality assurance sampling requirements will be included in the SSQAPPs. An example format of this Table is as follows:

Matrix	Parameter	Number of Samples	Method	Container	Preservative	Hold Time	Min. Volume
Water	Volatiles	No.	8260B	Glass	0.3mL 1:1 HCL	14 days	40 mL

### Equipment Needs

Following is a list of equipment anticipated for use during the implementation of this project.

Coring Drill	Tygon Tubing
OVA Diluter Kits	Stainless Steel Auger
Organic Vapor Analyzers	Auger Extensions
OVA Calibration Kit	Stainless Steel Sample Spoon
pH Meter/Specific Ion Meters	Stainless Steel Sample Tray
pH/Conductivity Calibration Standards	Stainless Steel Spray Canisters
Conductivity Meters	Plastic Spray Canister
Free Product Probe	Decontamination Buckets
Ground Penetrating Radar with Printer	H <sub>2</sub> O Level Indicators
Bailers	Temporary Monitor Wells
Laboratory Expendables –Assorted	Locking Well Caps
pH Paper	YSI, Probe Kit w/Accessories
Dissolved Oxygen Meter	Field Sampling Pump (Peristaltic)
Turbidity Meter and Calibration Standards	Field Sampling Pump (Bladder)
Pressure Transducer	Hach Turbidimeter w/Accessories
Omni Data Logger	Petite Ponar (Wildco)
Omni Polycorder	Stainless Steel Spoons and Buckets
Teflon Sampling Tips	Mason Jars
Field Sheets	

### Consumable Equipment:

Nitrile Gloves	Packing Material
----------------	------------------

Paper Towels  
Ice  
Teflon Tubing  
Custody Seals

Trash Bags  
Tape for Coolers  
Polyethylene Tubing  
Decontamination Supplies

A vehicle equipped for sampling will store the above equipment and will serve as the on-site support facilities for this project. Field Technicians also maintain accounts with environmental equipment and supply vendors throughout the southeastern United States to provide additional support. Field personnel are equipped with cellular telephones and have direct access to alternative sampling and monitoring equipment when necessary. A breaker bit will be used on the Geoprobe to remove asphalt and contract surfaces.

### **B3. SAMPLE HANDLING AND CUSTODY REQUIREMENTS**

The following sample custody procedures will be followed during the implementation of this project:

DEP SOPs and the Laboratory Quality Manuals, which describe the sample handling and custody requirement for this activity, will be followed. Examples of DEP sample logs sheets are available in Attachment F. Chain-of-Custody procedures will begin with the laboratory preparation of a field kit that includes appropriate sample containers for the requested matrices and methods, and ends with the transfer of the collected samples back to the laboratory analyst.

Each sample will have its own identification number. The numbering scheme will provide tracking for the retrieval and usage of analytical field data for each sample. Sample containers will be clearly labeled in ink and will correspond to field data sheets and/or logbooks, Chain-of-Custody records, and other documentation used during the project.

### **B4. ANALYTICAL METHODS AND REQUIREMENTS**

The quality characteristics and non-critical determinations for water and soil will be performed in the field. The laboratory will perform the measurement of COCs in water and soil. Once the samples are received and logged in at the laboratory, the samples will be analyzed using EPA or other appropriate methods that will be specified in the SSQAPP. A listing of analytical methodologies to be followed for the project's analytes of concern and the required instrumentation will be provided in the SSQAPP Addendum. Extraction and digestion criteria are included in Laboratory QSM, included in Attachment D.

Validation criteria for any non-standard or unpublished methodologies will be provided in the SSQAPP when applicable.

In general the turnaround time for hardcopy and electronic laboratory data deliverables is anticipated to be about 10 days. A project specific schedule, indicating turnaround times will be provided in the SSQAPP document.

## **B5. FIELD QUALITY CONTROL REQUIREMENTS**

Constituents of concern, analytical/extraction methods, sample container, preservation, holding time requirements, are summarized in SOP FS 1000-4 through FS 1000-8; pp. 22-36 (see Attachment E). These items will be further defined in the SSQAPP. In addition, QA/QC acceptance criteria for matrix spikes, equipment blanks, trip blanks, laboratory control samples, etc. will be included in the SSQAPP. The target detection limit requirements for each analyte are typically below applicable regulatory criteria for the parameters of interest. The Project Manager will review the laboratory QC samples and control limits identified in the laboratory QSM. The quality of the data generated using the laboratory QSM will provide analytical data of a sufficient quality for this project. Quality assurance samples are required pursuant to Chapter 62-160 FAC. As required, appropriate duplicate and blanks will be collected and analyzed. The number of duplicates and blanks will be identified in the SSQAPPs.

Purge water and soil generated during well installation and sampling activities will be drummed and sampled according to requirements evaluate the need for specialized disposal. Matrix spike samples and matrix spike duplicate samples are collected in the field for each matrix sampled, when appropriate.

Pre-cleaned equipment blanks and duplicate samples will be collected as specified in DEP-SOP-001/01 and the SSQAPP. Trip blanks will be prepared by the laboratory and included in each sample cooler containing samples for which volatile organics will be analyzed. Field equipment will be visually inspected and calibrated at the beginning of each sampling day, every four hours of use, and at the end of the workday. A calibration log will be maintained for each instrument.

## **B6. LABORATORY QUALITY CONTROL REQUIREMENTS**

Stated previously, the Project Manager monitors the project to ensure quality assurance policies are met. If quality issues are identified, mechanisms are in place to handle situations that may arise. Potential problems will be resolved by following the DEP SOP procedures.

Laboratory control checks include:

- Laboratory Control Standard.
- Laboratory Control Standard Duplicates.
- Matrix Spikes.
- Matrix Spike Duplicates.
- Method Reagent Blanks.

The laboratory analyzes matrix spikes and matrix spike duplicates to assess precision and accuracy. Quality Control parameters will be provided in the SSQAPP.

## **B7. FIELD EQUIPMENT AND CORRECTIVE ACTION**

The multi-parameter meter, the dissolved oxygen meter, and the turbidimeter will require calibration, calibration verification checks, routine inspection, and maintenance per the manufacturer's recommendations. The multi-parameter meter will be used to measure pH, temperature, conductivity for water samples while in the field. Equipment manufacturer's literature (e.g. operator instruction/user manuals for testing and inspecting the meters, etc.) will be maintained and made available by the Field Team Leader.

An inspection checklist and initial calibration check will be completed by a field team member prior to mobilizing to the site for the site investigation. A maintenance kit, which will include extra batteries, calibration standards, and commonly needed spare parts, will be made available at the site for the meters. Any preventive or corrective maintenance completed will be documented in the field notes. If any meter fails the initial testing and inspection, spare meters can be obtained from inventory or rented from an environmental equipment vendor.

Field calibration logs are maintained for equipment that requires onsite calibration. Field equipment calibration log books are maintained for each piece of equipment and project field logs are maintained for each sampling event and given to the Project Manager upon completion of the sampling event to maintain in the project file for reference. The Project Manager or QA/QC officer may request spot checks of equipment calibration at any time. Calibration records can be traced to equipment logs by referencing project specific field notes.

pH Buffers 4.01, 7.0, and 10.0, turbidity standards 1, 2, 10, and 100, Nephelometric Turbidity Unit (NTU), and conductivity standards of 100, 500, and 1,000 micromhos/cm will be used in the field. In addition, a confidence solution from YSI is used for the YSI unit for calibration verification.

## **B8. LAB EQUIPMENT AND CORRECTIVE ACTION**

The laboratory QSM addresses the testing, inspection, and maintenance for the analytical instruments and is included in Attachment D. Procedures include reviewing the instrument log for any notations regarding problems experienced during previous use and verifying that scheduled preventative maintenance has been conducted in accordance with the manufacturer's recommendations. The lab will document any preventive or corrective maintenance conducted on laboratory equipment/instrumentation.

## **B9. ANALYTICAL SENSITIVITY AND PROJECT CRITERIA**

An analytical method sensitivity and project criteria table for the analytical methods will be included in the SSQAPPs.

## **B10. DATA MANAGEMENT AND DOCUMENTS**

Data for each project conducted under this Generic QAPP and SSQAPPs will be produced in two locations: onsite and at the project laboratory. Data collected onsite will be recorded on field data worksheets (included in Attachment F) and into field logbooks, which will become a part of the project file. The Project Manager will submit copies of the field data worksheets and logbooks with the field activity report when field activities are complete. The Laboratory Manager will submit laboratory data to the Project Manager within an agreed upon timeframe. The Project Manager will be responsible for ensuring the analytical report meets requirements and prior to forwarding it to the FDEP Brownfields Coordinator when applicable.

In general, the turnaround time for hardcopy and electronic laboratory data deliverables is anticipated to be approximately 10 working days. A project specific schedule, indicating turnaround time will be provided in the SSQAPP document.

As discussed previously in this document, project records will be managed according to FDEP SOP FA3300, Section 6 "Documentation" and laboratory records will be managed according to Accutest "Data Reduction, Validation, Review and Reporting."

Adherence to these SOPs will assure that applicable information resource management requirements are satisfied.

Project records and documents will be handled in general accordance with EPA SOP #EPA-90251.3b "Handling and Disposition of Project Records and Documents." The laboratory will manage the original raw data from this project (both hard copy and electronic). The Laboratory Manager retains and maintains laboratory records.

ECT will maintain records of the field staff in the project folder, electronic records, including final reports, will be maintained in-house in the project folder on a computer network. ECT's IT-department maintains the security of the network with up to date software and virus protection. The network maintains restricted access to ECT staff. Sample results are provided from the laboratory both in hard-copy and electronic (PDF) form to ensure results remain in its original content. Additionally, files are maintained in a locked storage room.

The listing below summarizes types of reports, records, and other documents that may be generated for this project:

- Field Logs (checklists and standard forms -see Attachment F).
- Quality Assurance Project Plans.
- Historical Phase I Environmental Assessments.
- Phase II Environmental Assessments.
- Limited Site Assessment Report.
- Interim Source Removal Proposal.
- Interim Source Removal Report.
- Site Rehabilitation Plan.
- Site Assessment Report.
- Risk Assessment Report.

- No Further Action Proposal.
- Natural Attenuation with Monitoring Proposal.
- Remedial Action Plan.
- Remedial Action Status Report.
- Post-Active Remedial Monitoring Report.
- Site Rehabilitation Completion Report.
- No Further Action Proposal with Monitoring Proposal.
- No Further Action Proposal with Monitoring Reports.
- Combined Documents.

Records and reports, including any review comments and checklist from the U.S. EPA Region 4 Designated Approving Official can be found in the physical project file located at the Contractor's designated office identified in the SSQAPP. The project file will be eventually archived for a period of at least 7 years. Any deviations from these procedures will be documented in the project file and approved by the Project QA/QC Officer.

## **C1. ASSESSMENT AND RESPONSE ACTIONS**

Due to the limited duration of this project, assessment projects are planned to include one audit of field activities, the verification and validation of reported data, and QA review of reports by senior level technical staff. The Project QA/QC Officer may conduct an on-site field audit at the time(s) when samples are being collected for both field and laboratory analysis. The Project QA/QC officer will have the authority to halt the on-site work if he/she believes the findings from the audit justify such action. In the event discrepancies are identified during an audit, the Project QA/QC Officer will discuss findings with the Project Manager and Field Team Leader. The Field Team Leader, in consultation with the Project Manager, will be responsible for corrective actions related to field activities. Audit findings would be included in the Final Reports along with descriptions as warranted; this information is provided to project staff, state, and EPA project personnel.

The laboratory will provide a narrative report with the analytical results referencing the project, associated Chain-of-Custody, quality control issues, and the validity and integrity of the results. Section D2 of this Generic QAPP discusses the verification and validation process in detail.

The Project Corrective Action Process flow chart, provided as Figure 2, Attachment B, outlines the standard process for communicating and resolving problems that arise in the field, via corrective actions implementation.

## **C2. PROJECT REPORTS**

Laboratory analytical reports will be generated by the Laboratory Manager and submitted to the Project Manager within agreed upon timeframes. In general, the turnaround time for hardcopy and electronic laboratory data deliverables is anticipated to be 10 working days. A project specific schedule, indicating turnaround time will be provided in the SSQAPP document. The Project Manager will prepare the final report, which will be reviewed for technical accuracy and data quality by the Project QA/QC Officer or similar

senior technical staff (as appropriate). The final report will include a summary description of project activities, a summary of data, the field activity report, a discussion on any problems encountered during the project and the corrective actions taken, a discussion of the conclusions drawn from the results and the rationale for those conclusions, and the results of the data quality assessment. The final report will be distributed to the project team. The report will then be reviewed for conformance with internal document standards. After approval by the City's Brownfields Coordinator, final reports will be forwarded to the EPA Project Officer/Manager along with the quarterly report submittal as required.

Execution of proposed field activities will commence following approval of the Generic QAPP and the SSQAPPs.

### **D1. FIELD DATA EVALUATION**

Data will be reviewed by the Project Manager for integrity by checking field entries for errors and consistency. Data validation will be accomplished through a series of checks and reviews intended to assure that the reported results are of a verifiable, reproducible, and acceptable quality. The validation process will include:

- Quality control blanks meet criteria.
- Quality control data (spikes, duplicates) are acceptable.
- Surrogate spike recoveries are acceptable.

A data usability review that includes an assessment of field procedures, completeness, comparability, representativeness, precision, and bias (accuracy) of the data will be performed. The findings of this review will be documented and presented in the final report.

### **D2. LABORATORY DATA EVALUATION**

Quality control checks are performed on field data by reviewing the Chain-of-Custody forms and the results from the lab for each sampling event. Sample results will be reviewed by the Project Manager and correlated to field measurements and observations. The validation process will include:

- Unacceptable data are identified and corrective actions are initiated.
- Data qualifiers are assigned, if necessary.

In addition to evaluating data qualifiers associated with laboratory analyses, a comparison of the sample duplicate(s) and the corresponding sample result(s) will be made to evaluate the reproducibility of the sample results based on the laboratory analysis and sample collection and transportation procedures. For this comparison, if the duplicate or sample result is less than 5 times the reporting limit, then the comparison is made by the absolute difference between the results (S-D). For water samples, if this difference is less than the magnitude of the (higher) reporting limit, precision is considered "acceptable". For soil samples, if the difference is less than twice the magnitude of the (higher)

reporting limit, precision is considered "acceptable". If these differences are within 2X the "acceptable" limits, they are considered "slightly high"; anything beyond that would be considered "high". If both sample and duplicate results are greater than five times (5X) the reporting limit (the higher of the two RLs, if they're not the same), then precision is assessed by the %RPD (difference in results divided by the average of the two results X 100). <35% RPD = "good/acceptable", >35% but < 50% = variability is "slightly high", >50% = "high".

Based on the data qualifiers provided by the laboratory, and on the sample/sample duplicate comparison described above, data will be categorized as either usable or unusable. Unusable data will not be utilized in the project decision process. Raw data will be included in submitted project reports.

An evaluation of laboratory analysis procedures and review of holding times, blanks, control samples, duplicate analysis, detection limits, holding times, laboratory controls, and overall assessment of data will be conducted.

The data usability will compare proposed sample locations to actual sample locations. The review also will verify that the predefined number of samples were analyzed and will confirm that the predefined analytical methods and detection limits were used. The Project Manager will review the quality control samples, hold times, calibration, surrogate recovery, as well as the precision and accuracy data for the sampled analytes of concern to determine whether the data will be accepted or rejected. In the event results are rejected, the Project QA/QC Officer, Project Manager, and the City's Brownfields Coordinator will meet to discuss the reasons for the rejection of data and what steps should be initiated including additional site sampling if deemed necessary.

Problems associated with the laboratory will be documented in the laboratory QA report provided with analytical results, which will be provided to end users in the form of summary reports.

Precision, accuracy and completeness calculations are as follows, respectively:

1.  $RPD = 100 * (BS \%R - BSD \text{ Result}) / [(BS \%R + BSD \text{ Result})/2]$
2.  $BS \text{ Recovery} = 100 * (BS \text{ Result}) / [\text{Spike Added}]$
3.  $BSD \text{ Recovery} = 100 * (BSD \text{ Result}) / [\text{Spike Added}]$

RPD: Relative Percent Difference

%R: Percent Recovery

BS: Blank Spike

BSD: Blank Spike Duplicate

### **D3. DATA USABILITY AND PROJECT VERIFICATION**

The Project Manager will validate the field data and discuss any problems identified during the project with the Field Team Leader. Any problems and associated corrective actions will be documented in the field activity report.

The Laboratory Manager will review and verify the laboratory data generated under their corrective action system for accuracy according to the laboratory's QSM. Any problems

identified during this process will be reported to the Project Manager in the analytical data report. Information on QC criteria will be included in the SSQAPP. The Project QA/QC Officer, along with the Project Manager validates laboratory data upon receipt of the analytical results.

The database manager or Project Manager will evaluate the sample/sample duplicate data and equipment blank data to assess whether the data precision is of an acceptable quality. Pending these three data validation procedures, the data will be determined to be of a specified quality and reported as such. For instance, data will typically be reported with no qualifiers if the data are determined to be fully useable. However, a discussion of data limitations will be added to the data summary tables and data discussion within the reports if data validity is compromised in any way.

When applicable, the City and/or FDEP Brownfields Project Coordinator may also review and verify the field sheets, the final report, and the analytical data report. Any problems or deviations are typically reported to the Project Manager in the form of a comment and a formal action and response is provided back to the FDEP. Issues are resolved through staff total quality management (TQM) meetings or through the FDEP comment and response process.

Valid data of known and documented quality is required for the media sampled. Once reliable and representative data are obtained, the data will be compared to the CTLs to evaluate whether no further action is required or if active remediation is needed. The City and/or FDEP Brownfields Coordinator may also reconcile the data with the project-specific objectives.

The process for reconciling the data includes the evaluation of the following questions: (1) were samples collected using the appropriate collection procedures; (2) were samples handled in accordance with the SOPS; (3) were the samples collected from the pre-determined or specific sampling locations; (4) were the samples properly preserved; (5) were field sampling problems documented in field logs; (6) were the QAPP-specified analytical methods used; (7) were problems identified during laboratory analysis; (8) was the laboratory able to meet the MDLs, PQLs, and QA/QC requirements specified in the QAPP and provided in the analytical methods; (9) what were the results of data validation -do any of the data points require rejection; (10) if data is problematic, is re-sampling or reanalysis required (if data is rejected -how does the result affect the ability to make site decisions).

## REFERENCES

- U.S. Environmental Protection Agency, Region 4, Generic QAPP Appendix A Checklist
- U.S. Environmental Protection Agency, Region 4, SESD, Field Branches Quality System and Technical Procedures, February 2008.
- U.S. Environmental Protection Agency. 1998. Quality Assurance Guidance for Conducting Brownfields Site Assessments. EPA 540-R-98-038. September.
- U.S. Environmental Protection Agency. 2002. EPA Guidance for Quality Assurance Project Plans. EPA QAIG-5. EPA 2401R-02/009. December.
- U.S. Environmental Protection Agency. 2006. Data Quality Assessment: Statistical Tools for Practitioners. EPA QAIG-9S. EPA 240-B-06-003. February.
- U.S. Environmental Protection Agency. 2006. EPA Guidance on Systematic Planning Using the Data Quality Objectives Process. EPA 240/B-06/00 I. February.
- U.S. Environmental Protection Agency. 2006. EPA Requirements for Quality Assurance Project Plans. EPA QAIR-5. EPA 240-B-01-003. Reissued May.

**LIST OF ABBREVIATIONS**

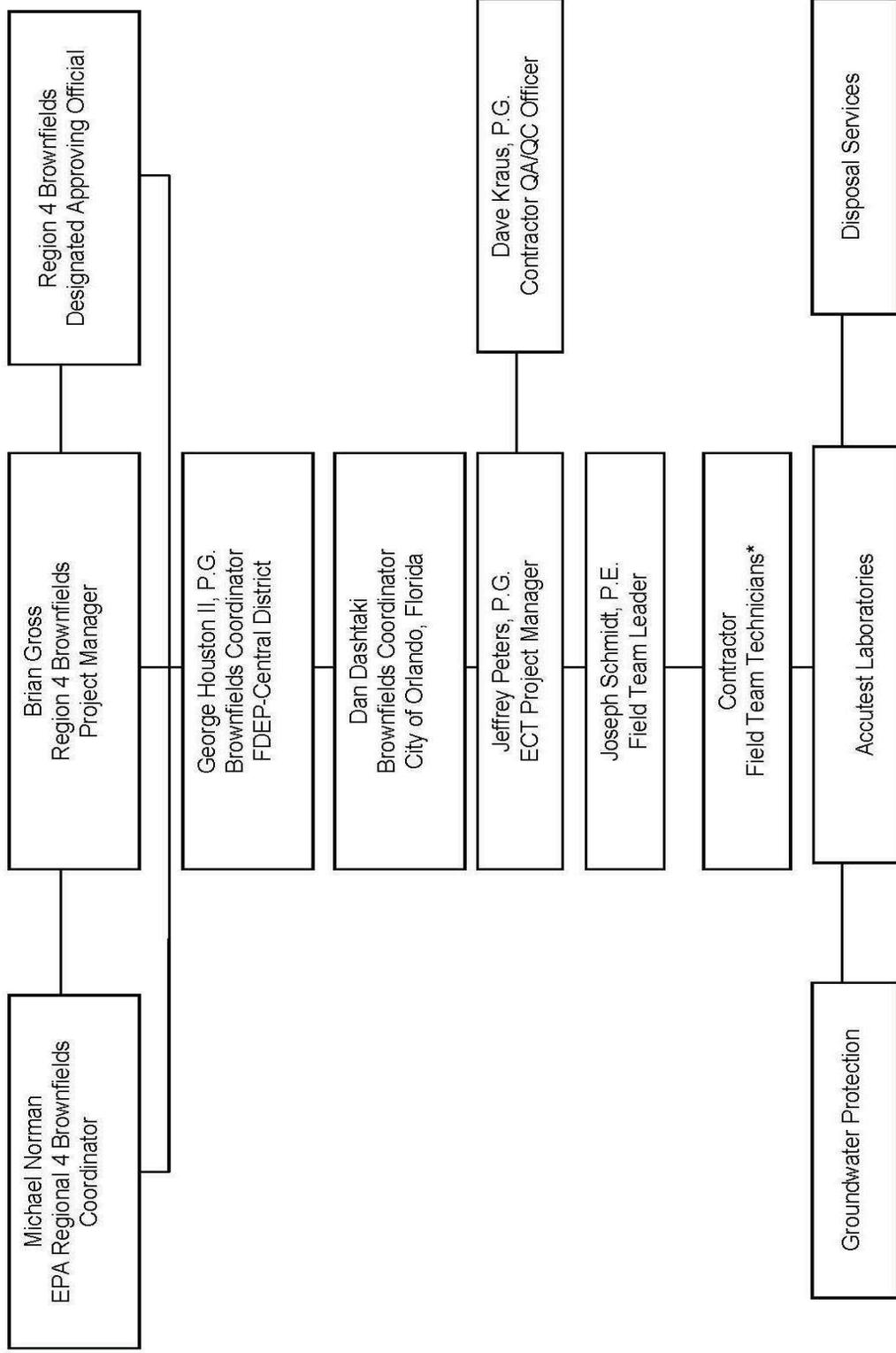
ASTM	American Society for Testing and Materials
BSA	Brownfields Site Assessment
BSRA	Brownfields Site Rehabilitation Agreement
BTEX	Benzene, Toluene, Ethylbenzene, and Total Xylenes
CD	Compact Disc
COC	Contaminants of Concern
CTL	Cleanup Target Levels
DEFT	Decision Error Feasibility Trials
DEP/FDEP	Florida Department of Environmental Protection
DPT	Direct Push Technology
DQO	Data Quality Objective
e.g.	<i>exempli gratia</i> – for example
ECT	Environmental Consulting & Technology, Inc.
ESA	Environmental Site Assessment
ECT	Electron Capture Device
FID	Flame Ionization Detector
FL-PRO	Florida Petroleum Range Organics
GC	Gas Chromatography
GC-MS	Gas Chromatography – Mass Spectrometry
GIS	Geographic Information Systems
GPS	Global Positioning Satellite
HAZWOPER	Hazardous Waste Operations
HPLC	High Performance Liquid Chromatography
ICP	Inductively Coupled Plasma
ID	Identification
i.e.	<i>id est</i> – that is
IUPAC	International Union of Pure and Applied Chemistry
L	Liter
LQM	Laboratory Quality Manual
MDLs	Method Detection Limits
MIP	Membrane Interface Probe
mL	Milliliter
MTBE	Methyl tert-butyl ether
MW	Monitoring Well
N/A	Not Applicable
NELAC	National Environmental Laboratory Accreditation Conference
OSHA	Occupational Safety and Health Administration

**LIST OF ABBREVIATIONS**

OVA	Organic Vapor Analyzer
PAHs	Polynuclear Aromatic Hydrocarbons
PE	Performance Evaluation
P.E.	Professional Engineer
P.G.	Professional Geologist
PQLs	Practical Quantitation Limits
QA	Quality Assurance
QAM	Quality Assurance Manual
QAPP	Quality Assurance Project Plan
QC	Quality Control
RCRA	Resource and Conservation Recovery Act
RPD	Relative Percent Difference
RQAO	Regional Quality Assurance Designated Approving Official
SPLP	Synthetic Precipitate Leaching Procedures
SS	Soil Sample
SSQAPP	Site Specific Quality Assurance Project Plan
SVOC	Semi-volatile Organic Compounds
SOP	Standard Operating Procedures
TCLP	Toxicity Characteristics Leaching Procedure
TQM	Total Quality Management
USC	United Soil Classification
U.S. EPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VOC	Volatile Organic Compounds

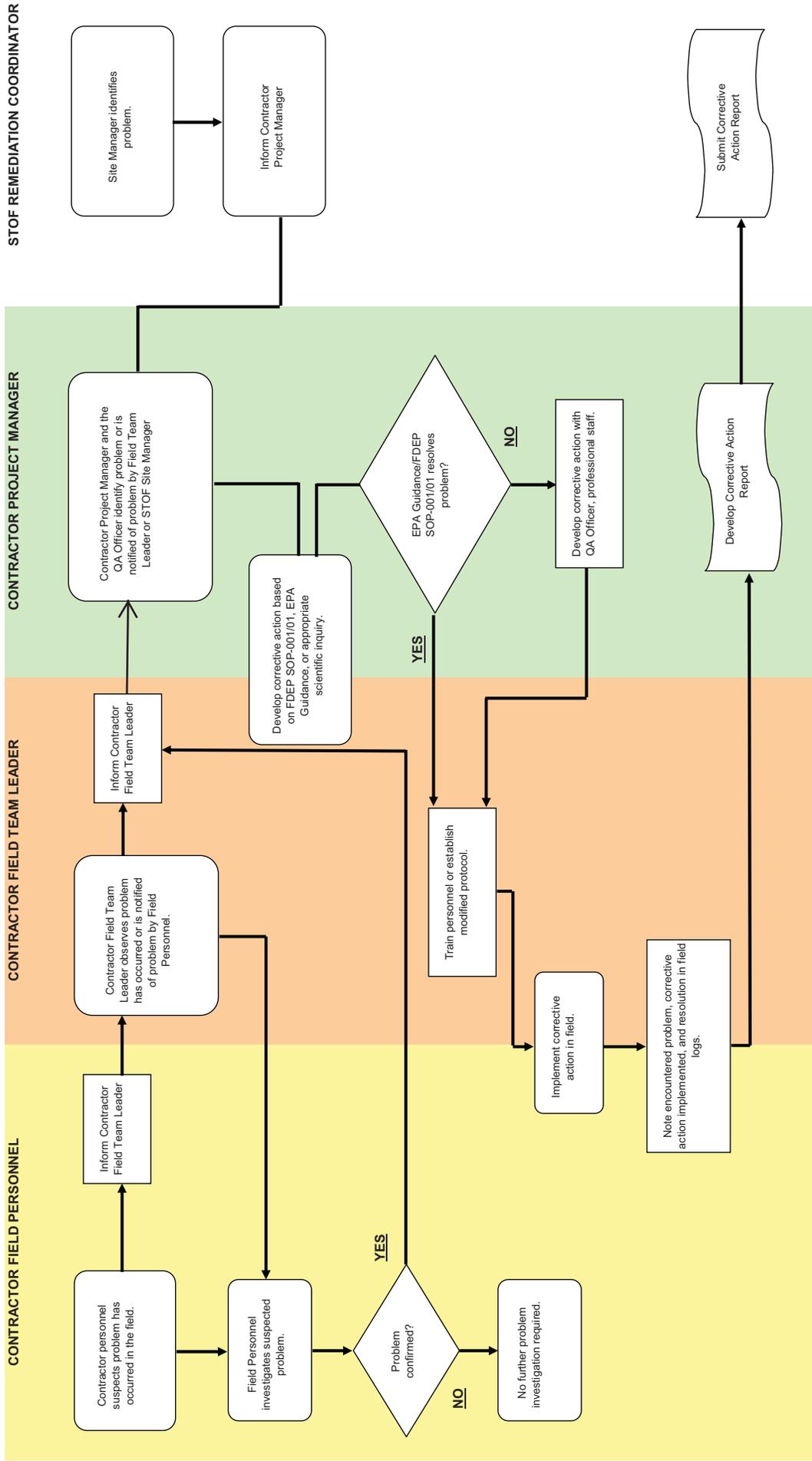
**Attachment A**  
**Figure 1 – Project Organization Chart**

**Figure 1 – Attachment A  
City of Orlando, Florida  
Quality Assurance Project Plan**



**Attachment B**  
**Figure 2 – Project Corrective Action Process**

**Figure 2 – Attachment B  
City of Orlando, Florida  
Project Corrective Action Process**



**Attachment C**  
**Chapter 62-777, F.A.C.**  
**Tables I, II, and V**

**Table I  
Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Acenaphthene	83-32-9	20 Minimum Criteria Organoleptic	3 Toxicity Criteria	3 Toxicity Criteria	200	-Liver
Acenaphthylene	208-96-8	210 Minimum Criteria Systemic Toxicant	**	**	2100	-Liver
Acephate	30560-19-1	4 Minimum Criteria Carcinogen	190 Toxicity Criteria	190 Toxicity Criteria	40	-Carcinogen -Neurological
Acetone	67-64-1	6300 Minimum Criteria Systemic Toxicant	1700 Toxicity Criteria	1700 Toxicity Criteria	63000	-Kidney -Liver -Neurological
Acetonitrile	75-05-8	42 Minimum Criteria Systemic Toxicant	20000 Toxicity Criteria	20000 Toxicity Criteria	420	-Mortality
Acetophenone	98-86-2	700 Minimum Criteria Systemic Toxicant	7800 Toxicity Criteria	7800 Toxicity Criteria	7000	-None Specified
Acifluorfen, sodium [or Blazer]	62476-59-9	1 Minimum Criteria Carcinogen	190 Toxicity Criteria	190 Toxicity Criteria	10	-Kidney
Acrolein	107-02-8	3.5 Minimum Criteria Systemic Toxicant	0.4 Toxicity Criteria	0.4 Toxicity Criteria	35	-Nasal
Acrylamide	79-06-1	0.008 Minimum Criteria Carcinogen	0.3 Human Health	0.3 Human Health	0.08	-Carcinogen -Neurological
Acrylic acid	79-10-7	3500 Minimum Criteria Systemic Toxicant	NA	NA	35000	-Developmental
Acrylonitrile	107-13-1	0.06 Minimum Criteria Carcinogen	0.2 Human Health	0.2 Human Health	0.6	-Carcinogen -Nasal -Reproductive
Alachlor	15972-60-8	* Primary Standard	0.5 Human Health	0.5 Human Health	***	-Blood -Carcinogen
Aldicarb [or Temik]	116-06-3	7 Minimum Criteria Systemic Toxicant	0.9 Toxicity Criteria	0.9 Toxicity Criteria	70	-Neurological
Aldicarb sulfone	1646-88-4	7 Minimum Criteria Systemic Toxicant	46 Toxicity Criteria	46 Toxicity Criteria	70	-Neurological

**Table I**  
**Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Aldicarb sulfoxide	1646-87-3	7 Minimum Criteria Systemic Toxicant	4.2 Toxicity Criteria	4.2 Toxicity Criteria	70	-Neurological
Aldrin	309-00-2	0.002 Minimum Criteria Carcinogen	**	**	0.02	-Carcinogen -Liver
Ally [or Metsulfuron, methyl]	74223-64-6	1800 Minimum Criteria Systemic Toxicant	NA	NA	18000	-Body Weight
Allyl alcohol	107-18-6	35 Minimum Criteria Systemic Toxicant	5 Toxicity Criteria	5 Toxicity Criteria	350	-Kidney -Liver
Allyl chloride	107-05-1	35# Minimum Criteria Systemic Toxicant	NA	NA	350	-Neurological
Aluminum	7429-90-5	* Secondary Standard	13 Toxicity Criteria	**	***	-Body Weight
Aluminum phosphide	20859-73-8	2.8 Minimum Criteria Systemic Toxicant	6.5 Toxicity Criteria	6.5 Toxicity Criteria	28	-Body Weight
Ametyrn	834-12-8	63 Minimum Criteria Systemic Toxicant	6.2 Toxicity Criteria	6.2 Toxicity Criteria	630	-Liver
Ammonia	7664-41-7	2800 Minimum Criteria Systemic Toxicant	**	NA	28000	-Respiratory
Ammonium sulfamate	7773-06-0	1400 Minimum Criteria Systemic Toxicant	10000 Toxicity Criteria	10000 Toxicity Criteria	14000	-Body Weight
Anilazine [or Dyrene]	101-05-3	2.8 Minimum Criteria Systemic Toxicant	NA	NA	28	-None Specified
Aniline	62-53-3	6.1 Minimum Criteria Carcinogen	4 Toxicity Criteria	4 Toxicity Criteria	61	-Blood -Carcinogen -Spleen
Anthracene	120-12-7	2100 Minimum Criteria Systemic Toxicant	0.3 Toxicity Criteria	0.3 Toxicity Criteria	21000	-None Specified
Antimony	7440-36-0	* Primary Standard	**	**	***	-Blood

**Table I**  
**Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Aramite	140-57-8	1.4 Minimum Criteria Carcinogen	3 Toxicity Criteria	3 Toxicity Criteria	14	-Carcinogen
Aroclor mixture [see PCBs]						
Arsenic	NOCAS	* Primary Standard	**	**	***	-Carcinogen -Cardiovascular -Skin
Atrazine	1912-24-9	* Primary Standard	1.9 Human Health	1.9 Human Health	***	-Carcinogen -Cardiovascular
Azinphos, methyl [see Guthion]						
Azobenzene	103-33-3	0.3 Minimum Criteria Carcinogen	3.6 Human Health	3.6 Human Health	3	-Carcinogen
Barium (soluble salts)	7440-39-3	* Primary Standard	NA	NA	***	-Cardiovascular
Baygon [or Propoxur]	114-26-1	28 Minimum Criteria Systemic Toxicant	0.4 Toxicity Criteria	0.4 Toxicity Criteria	280	-Blood -Neurological
Bayleton	43121-43-3	210 Minimum Criteria Systemic Toxicant	500 Toxicity Criteria	500 Toxicity Criteria	2100	-Blood
Benomyl	17804-35-2	35# Minimum Criteria Systemic Toxicant	0.3 Toxicity Criteria	0.3 Toxicity Criteria	350	-Developmental
Bensulide	741-58-2	46 Minimum Criteria Systemic Toxicant	NA	NA	460	-None Specified
Bentazon	25057-89-0	210 Minimum Criteria Systemic Toxicant	NA	NA	2100	-Blood
Benzaldehyde	100-52-7	700 Minimum Criteria Systemic Toxicant	54 Toxicity Criteria	54 Toxicity Criteria	7000	-Gastrointestinal -Kidney
Benzene	71-43-2	* Primary Standard	**	**	***	-Blood -Carcinogen

**Table I  
Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Benzenethiol	108-98-5	0.07 Minimum Criteria Systemic Toxicant	NA	NA	0.7	-Liver
Benzdine	92-87-5	0.0002 Minimum Criteria Carcinogen	0.0002 Human Health	0.0002 Human Health	0.002	-Carcinogen -Liver -Neurological
Benzo(a)anthracene	56-55-3	0.05 Minimum Criteria Carcinogen	**	**	0.5	-Carcinogen
Benzo(a)pyrene	50-32-8	* Primary Standard	**	**	***	-Carcinogen
Benzo(b)fluoranthene	205-99-2	0.05 Minimum Criteria Carcinogen	**	**	0.5	-Carcinogen
Benzo(g,h,i)perylene	191-24-2	210 Minimum Criteria Systemic Toxicant	**	**	2100	-Neurological
Benzo(k)fluoranthene	207-08-9	0.5 Minimum Criteria Carcinogen	**	**	5	-Carcinogen
Benzoic acid	65-85-0	28000 Minimum Criteria Systemic Toxicant	9000 Toxicity Criteria	9000 Toxicity Criteria	280000	-None Specified
Benzotrifluoride	98-07-7	0.003 Minimum Criteria Carcinogen	0.002 Human Health	0.002 Human Health	0.03	-Carcinogen
Benzyl alcohol	100-51-6	2100 Minimum Criteria Systemic Toxicant	500 Toxicity Criteria	500 Toxicity Criteria	21000	-Gastrointestinal
Benzyl chloride	100-44-7	0.2 Minimum Criteria Carcinogen	2 Human Health	2 Human Health	2	-Carcinogen
Beryllium	7440-41-7	* Primary Standard	**	**	***	-Carcinogen -Gastrointestinal -Respiratory
Beta radiation	NOCAS	* Primary Standard	NA	NA	***	-Carcinogen
BHC, alpha- [see Hexachlorocyclohexane, alpha-]	(b)					

**Table I  
Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
BHC, beta- [see Hexachlorocyclohexane, beta-] (b)						
BHC, delta- [see Hexachlorocyclohexane, delta-] (b)						
BHC, gamma- [see Hexachlorocyclohexane, gamma-] (b)						
BHC, technical [see Hexachlorocyclohexane, technical] (b)						
Bidrin [or Dicrotophos]	141-66-2	0.7 Minimum Criteria Systemic Toxicant	22 Toxicity Criteria	22 Toxicity Criteria	7	-Developmental
Bioallethrin	28057-48-9	35 Minimum Criteria Systemic Toxicant	NA	NA	350	-Liver
Biphenyl, 1,1- [or Diphenyl]	92-52-4	0.5 Minimum Criteria Organoleptic	18 Toxicity Criteria	18 Toxicity Criteria	5	-Kidney
Bis(2-chloro-1-methylethyl)ether [see Bis(2-chloroisopropyl)ether]						
Bis(2-chloroethyl)ether	111-44-4	0.03 Minimum Criteria Carcinogen	0.5 Human Health	0.5 Human Health	0.3	-Carcinogen
Bis(2-chloroisopropyl)ether [or Bis(2-chloro-1-methylethyl)ether]	39638-32-9	0.5 Minimum Criteria Carcinogen	23 Human Health	23 Human Health	5	-Blood -Carcinogen
Bis(2-ethylhexyl)adipate	103-23-1	* Primary Standard	33 Toxicity Criteria	33 Toxicity Criteria	***	-Body Weight -Carcinogen
Bis(2-ethylhexyl)phthalate [or DEHP]	117-81-7	* Primary Standard	2.2 Human Health	2.2 Human Health	***	-Carcinogen -Liver
Bisphenol A	80-05-7	350 Minimum Criteria Systemic Toxicant	55 Toxicity Criteria	55 Toxicity Criteria	3500	-Body Weight
Blazer [see Acifluorfen, sodium]						

**Table I**  
**Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Boron	7440-42-8	1400 Minimum Criteria Systemic Toxicant	NA	NA	14000	-Reproductive -Respiratory
Bravo [see Chlorothalonil]						
Bromacil	314-40-9	70# Minimum Criteria Systemic Toxicant	97 Toxicity Criteria	97 Toxicity Criteria	700	-Body Weight
Bromate	15541-45-4	0.05 Minimum Criteria Carcinogen	NA	**	0.5	-Carcinogen -Kidney
Bromochloromethane	74-97-5	91 Minimum Criteria Systemic Toxicant	NA	NA	910	-None Specified
Bromodichloromethane	75-27-4	0.6 Minimum Criteria Carcinogen	**	**	6	-Carcinogen -Kidney
Bromoform	75-25-2	4.4 Minimum Criteria Carcinogen	**	**	44	-Carcinogen -Liver
Bromomethane [or Methyl bromide]	74-83-9	9.8 Minimum Criteria Systemic Toxicant	35 Toxicity Criteria	35 Toxicity Criteria	98	-Gastrointestinal -Respiratory
Bromoxynil	1689-84-5	140 Minimum Criteria Systemic Toxicant	NA	NA	1400	-None Specified
Bromoxynil octanoate	1689-99-2	140 Minimum Criteria Systemic Toxicant	NA	NA	1400	-Neurological
Butane	106-97-8	9100 Minimum Criteria Systemic Toxicant	NA	NA	91000	-Neurological -Respiratory
Butanol, n-	71-36-3	700 Minimum Criteria Systemic Toxicant	25000 Toxicity Criteria	25000 Toxicity Criteria	7000	-Neurological
Butanol, tert- [see Butyl alcohol, tert-]						
Butanone, 2- [see Methyl ethyl ketone]						

**Table I  
Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Butyl acetate, n-	123-86-4	43 Minimum Criteria Organoleptic	1000 Toxicity Criteria	1000 Toxicity Criteria	430	-None Specified
Butyl alcohol, tert- [or Butanol, tert-]	75-65-0	1400 Minimum Criteria Systemic Toxicant	NA	NA	14000	-Kidney -Neurological
Butyl benzyl phthalate	85-68-7	140# Minimum Criteria Systemic Toxicant	26 Toxicity Criteria	26 Toxicity Criteria	1400	-Liver
Butylate	2008-41-5	350 Minimum Criteria Systemic Toxicant	11 Toxicity Criteria	11 Toxicity Criteria	3500	-Liver
Butylphthalyl butylglycolate	85-70-1	7000 Minimum Criteria Systemic Toxicant	NA	NA	70000	-None Specified
Cadmium	7440-43-9	* Primary Standard	**	**	***	-Carcinogen -Kidney
Calcium cyanide	592-01-8	280 Minimum Criteria Systemic Toxicant	NA	NA	2800	-Neurological -Thyroid
Captainol	2425-06-1	4.1 Minimum Criteria Carcinogen	0.9 Toxicity Criteria	0.9 Toxicity Criteria	41	-Carcinogen -Kidney
Captan	133-06-2	10 Minimum Criteria Carcinogen	1.9 Toxicity Criteria	1.9 Toxicity Criteria	100	-Body Weight -Carcinogen
Carbaryl [or Sevin]	63-25-2	700 Minimum Criteria Systemic Toxicant	0.06 Toxicity Criteria	0.06 Toxicity Criteria	7000	-Kidney -Liver
Carbazole	86-74-8	1.8 Minimum Criteria Carcinogen	47 Toxicity Criteria	47 Toxicity Criteria	18	-Carcinogen
Carbofuran	1563-66-2	* Primary Standard	0.1 Toxicity Criteria	0.1 Toxicity Criteria	***	-Neurological -Reproductive
Carbon disulfide	75-15-0	700 Minimum Criteria Systemic Toxicant	110 Toxicity Criteria	110 Toxicity Criteria	7000	-Developmental -Neurological
Carbon tetrachloride	56-23-5	* Primary Standard	**	**	***	-Carcinogen -Liver

**Table I  
Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Carbophenothion [or Trithion]	786-19-6	0.9 Minimum Criteria Systemic Toxicant	0.1 Toxicity Criteria	0.1 Toxicity Criteria	9	-Neurological
Carboxin	5234-68-4	700 Minimum Criteria Systemic Toxicant	60 Toxicity Criteria	60 Toxicity Criteria	7000	-Body Weight
CFC 113 [see Trichloro-1,2,2-trifluoroethane, 1,1,2-]						-Adrenals
Chloral hydrate	302-17-0	70# Minimum Criteria Systemic Toxicant	NA	NA	700	-Gastrointestinal -Neurological
Chloramben	133-90-4	110 Minimum Criteria Systemic Toxicant	NA	NA	1100	-Liver
Chlordane (total)	(g)	* Primary Standard	**	**	***	-Carcinogen -Liver
Chloride	16887-00-6	* Secondary Standard	NA	**	***	-None Specified
Chlorine	7782-50-5	700 Minimum Criteria Systemic Toxicant	**	**	7000	-Respiratory
Chlorine cyanide [or Cyanogen chloride]	506-77-4	350 Minimum Criteria Systemic Toxicant	1.4 Toxicity Criteria	1.4 Toxicity Criteria	3500	-Neurological -Thyroid
Chlorite (sodium salt) [or Sodium chlorite]	7758-19-2	210 Minimum Criteria Systemic Toxicant	29 Toxicity Criteria	29 Toxicity Criteria	2100	-Developmental -Neurological
Chloro-1,3-butadiene [or Chloroprene]	126-99-8	140 Minimum Criteria Systemic Toxicant	NA	NA	1400	-Hair Loss -Nasal
Chloro-3-methylphenol, 4- [see Chloro-m-cresol, p-]						
Chloroacetic acid	79-11-8	14 Minimum Criteria Systemic Toxicant	2500 Human Health	2500 Human Health	140	-Cardiovascular
Chloroaniline, p-	106-47-8	28 Minimum Criteria Systemic Toxicant	2.5 Toxicity Criteria	2.5 Toxicity Criteria	280	-Spleen

**Table I**  
**Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Chlorobenzene	108-90-7	* Primary Standard	17 Toxicity Criteria	17 Toxicity Criteria	***	-Liver
Chlorobenzilate	510-15-6	0.1 Minimum Criteria Carcinogen	0.02 Human Health	0.02 Human Health	1	-Body Weight -Carcinogen
Chloroethane [see Ethyl chloride]						
Chloroform	67-66-3	70 Minimum Criteria Systemic Toxicant	**	**	700	-Carcinogen -Liver
Chloro-m-cresol, p- [or Chloro-3-methylphenol, 4-]	59-50-7	63 Minimum Criteria Systemic Toxicant	100 Toxicity Criteria	100 Toxicity Criteria	630	-Body Weight
Chloromethane [see Methyl chloride]						
Chloronaphthalene, beta-	91-58-7	560 Minimum Criteria Systemic Toxicant	1600 Human Health	1600 Human Health	5600	-Liver -Respiratory
Chloronitrobenzene, p-	100-00-5	1.9 Minimum Criteria Carcinogen	110 Toxicity Criteria	110 Toxicity Criteria	19	-Carcinogen
Chlorophenol, 2-	95-57-8	35 Minimum Criteria Systemic Toxicant	130 Toxicity Criteria	130 Toxicity Criteria	350	-Reproductive
Chlorophenol, 3-	108-43-0	0.1 Minimum Criteria Organoleptic	170 Toxicity Criteria	170 Toxicity Criteria	1	-Reproductive
Chlorophenol, 4-	106-48-9	0.1 Minimum Criteria Organoleptic	180 Toxicity Criteria	180 Toxicity Criteria	1	-Reproductive
Chloropicrin	76-06-2	7.3 Minimum Criteria Organoleptic	NA	NA	73	-None Specified
Chloroprene [see Chloro-1,3-butadiene]						
Chloroethalonil [or Bravo]	1897-45-6	3.2 Minimum Criteria Carcinogen	0.8 Toxicity Criteria	0.8 Toxicity Criteria	32	-Carcinogen -Kidney

**Table I  
Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Chlorotoluene, o-	95-49-8	140 Minimum Criteria Systemic Toxicant	390 Toxicity Criteria	390 Toxicity Criteria	1400	-Body Weight
Chlorotoluene, p-	106-43-4	140 Minimum Criteria Systemic Toxicant	NA	NA	1400	-None Specified
Chloroprotham	101-21-3	1400 Minimum Criteria Systemic Toxicant	190 Toxicity Criteria	190 Toxicity Criteria	14000	-Bone Marrow -Kidney -Liver -Spleen
Chlorpyrifos	2921-88-2	21 Minimum Criteria Systemic Toxicant	0.002 Toxicity Criteria	0.002 Toxicity Criteria	210	-Neurological
Chlorpyrifos, methyl	5598-13-0	70 Minimum Criteria Systemic Toxicant	0.04 Toxicity Criteria	0.04 Toxicity Criteria	700	-Reproductive
Chlorsulfuron	64902-72-3	350 Minimum Criteria Systemic Toxicant	16 Toxicity Criteria	16 Toxicity Criteria	3500	-Body Weight
Chromium (hexavalent)	18540-29-9	*	**	**	***	-Carcinogen -Respiratory
Chromium (total)	NOCAS	*	11	50	***	-Carcinogen
Chromium (trivalent)	16065-83-1	*	(f)	(f)	***	-None Specified
Chrysene	218-01-9	4.8 Minimum Criteria Carcinogen	**	**	48	-Carcinogen
Cobalt	7440-48-4	140 Minimum Criteria Systemic Toxicant	NA	NA	1400	-Cardiovascular -Immunological - Neurological -Reproductive
Copper	7440-50-8	*	**	**	***	-Gastrointestinal
Copper cyanide	544-92-3	35 Minimum Criteria Systemic Toxicant	NA	NA	350	-Kidney
Coumaphos	56-72-4	1.8 Minimum Criteria Systemic Toxicant	0.004 Toxicity Criteria	0.004 Toxicity Criteria	18	-Neurological

**Table I  
Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Cresol, m- [see Methylphenol, 3-]						
Cresol, o- [see Methylphenol, 2-]						
Cresol, p- [see Methylphenol, 4-]						
Crotonaldehyde	123-73-9	0.02 Minimum Criteria Carcinogen	NA	NA	0.2	-Carcinogen
Cumene [or Isopropyl benzene]	98-82-8	0.8 Minimum Criteria Organoleptic	260 Toxicity Criteria	260 Toxicity Criteria	8	-Adrenals -Kidney
Cyanazine	21725-46-2	0.04 Minimum Criteria Carcinogen	5.5 Toxicity Criteria	5.5 Toxicity Criteria	0.4	-Carcinogen
Cyanide, free	57-12-5	* Primary Standard	**	**	***	-Neurological -Thyroid
Cyanogen	460-19-5	280 Minimum Criteria Systemic Toxicant	NA	NA	2800	-Neurological -Thyroid
Cyanogen chloride [see Chlorine cyanide]						
Cycloate	1134-23-2	35 Minimum Criteria Systemic Toxicant	130 Toxicity Criteria	130 Toxicity Criteria	350	-Neurological
Cyclohexanone	108-94-1	35000 Minimum Criteria Systemic Toxicant	26000 Toxicity Criteria	26000 Toxicity Criteria	350000	
Cyclohexylamine	108-91-8	1400 Minimum Criteria Systemic Toxicant	4000 Toxicity Criteria	4000 Toxicity Criteria	14000	-Reproductive
Cyhalothrin [or Karate]	68085-85-8	35 Minimum Criteria Systemic Toxicant	18 Human Health	18 Human Health	350	-Developmental
Cypermethrin	52315-07-8	7# Minimum Criteria Systemic Toxicant	0.0005 Toxicity Criteria	0.0005 Toxicity Criteria	70	-Gastrointestinal

**Table I**  
**Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Dacthal [or DCPA]	1861-32-1	70 Minimum Criteria Systemic Toxicant	310 Toxicity Criteria	310 Toxicity Criteria	700	-Eye -Kidney -Liver -Respiratory -Thyroid
Dalapon	75-99-0	* Primary Standard	5000 Toxicity Criteria	5000 Toxicity Criteria	***	-Kidney
DB, 2,4- [see Dichlorophenoxy butyric acid, 2,4-]						
DBCP, 1,2- [see Dibromo-3-chloropropane, 1,2-]						
DCPA [see Dacthal]						
DDD, 4,4'- [see Dichlorodiphenyldichloroethane, p,p']						
DDE, 4,4'- [see Dichlorodiphenyldichloroethylene, p,p']						
DDT, 4,4'- [see Dichlorodiphenyltrichloroethane, p,p']						
Decabromodiphenyl ether	1163-19-5	7# Minimum Criteria Systemic Toxicant	NA	NA	70	-None Specified
DEET	134-62-3	6300 Minimum Criteria Systemic Toxicant	NA	NA	63000	-Body Weight
DEHP [see Bis(2-ethylhexyl)phthalate]						
Demeton	8065-48-3	0.3 Minimum Criteria Systemic Toxicant	**	**	3	-Eye -Neurological
Diallate	2303-16-4	0.6 Minimum Criteria Carcinogen	NA	NA	6	-Carcinogen -None Specified
Diazinon	333-41-5	6.3 Minimum Criteria Systemic Toxicant	0.002 Toxicity Criteria	0.002 Toxicity Criteria	63	-Neurological

**Table I**  
**Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Dibenz(a,h)anthracene	53-70-3	0.005 Minimum Criteria Carcinogen	**	**	0.05	-Carcinogen
Dibenzofuran	132-64-9	28 Minimum Criteria Systemic Toxicant	67 Toxicity Criteria	67 Toxicity Criteria	280	-None Specified
Dibromo-3-chloropropane, 1,2- [or DBCP, 1,2-]	96-12-8	* Primary Standard	NA	NA	***	-Carcinogen -Reproductive
Dibromobenzene, 1,4-	106-37-6	70 Minimum Criteria Systemic Toxicant	240 Human Health	240 Human Health	700	-Liver
Dibromochloromethane	124-48-1	0.4 Minimum Criteria Carcinogen	**	**	4	-Carcinogen -Liver
Dibromoethane, 1,2- [or EDB]	106-93-4	* Primary Standard	13 Toxicity Criteria	13 Toxicity Criteria	***	-Carcinogen -Reproductive
Dibutyl phthalate	84-74-2	700 Minimum Criteria Systemic Toxicant	23 Toxicity Criteria	23 Toxicity Criteria	7000	-Mortality
Dicamba	1918-00-9	210 Minimum Criteria Systemic Toxicant	200 Toxicity Criteria	200 Toxicity Criteria	2100	-Developmental
Dichloroacetic acid	79-43-6	0.7 Minimum Criteria Carcinogen	1200 Toxicity Criteria	1200 Toxicity Criteria	7	-Carcinogen -Liver -Neurological - Reproductive
Dichloroacetonitrile	3018-12-0	5.6# Minimum Criteria Systemic Toxicant	NA	NA	56	-None Specified
Dichlorobenzene, 1,2-	95-50-1	* Primary Standard	99 Toxicity Criteria	99 Toxicity Criteria	***	-Body Weight
Dichlorobenzene, 1,3-	541-73-1	210 Minimum Criteria Systemic Toxicant	85 Toxicity Criteria	85 Toxicity Criteria	2100	-None Specified
Dichlorobenzene, 1,4-	106-46-7	* Primary Standard	3 Human Health	3 Human Health	***	-Carcinogen -Liver
Dichlorobenzidine, 3,3'-	91-94-1	0.08 Minimum Criteria Carcinogen	0.03 Human Health	0.03 Human Health	0.8	-Carcinogen

**Table I**  
**Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Dichlorobenzophenone, 4,4'-	90-98-2	210 Minimum Criteria Systemic Toxicant	1600 Human Health	1600 Human Health	2100	-None Specified
Dichlorodifluoromethane	75-71-8	1400 Minimum Criteria Systemic Toxicant	NA	NA	14000	-Liver
Dichlorodiphenyldichloroethane, p,p'- [or DDD, 4,4']	72-54-8	0.1 Minimum Criteria Carcinogen	0.0003 Human Health	0.0003 Human Health	1	-Carcinogen
Dichlorodiphenyldichloroethylene, p,p'- [or DDE, 4,4']	72-55-9	0.1 Minimum Criteria Carcinogen	0.0002 Human Health	0.0002 Human Health	1	-Carcinogen
Dichlorodiphenyltrichloroethane, p,p'- [or DDT, 4,4']	50-29-3	0.1 Minimum Criteria Carcinogen	**	**	1	-Carcinogen -Liver
Dichloroethane, 1,1-	75-34-3	70# Minimum Criteria Systemic Toxicant	NA	NA	700	-Kidney
Dichloroethane, 1,2- [or EDC]	107-06-2	* Primary Standard	37 Human Health	37 Human Health	***	-Carcinogen -None Specified
Dichloroethene, 1,1-	75-35-4	* Primary Standard	**	**	***	-Liver
Dichloroethene, 1,2- (mixture)	540-59-0	63 Minimum Criteria Systemic Toxicant	7000 Toxicity Criteria	7000 Toxicity Criteria	630	-Blood -Liver
Dichloroethene, cis-1,2-	156-59-2	* Primary Standard	NA	NA	***	-Blood
Dichloroethene, trans-1,2-	156-60-5	* Primary Standard	11000 Toxicity Criteria	11000 Toxicity Criteria	***	-Blood -Liver
Dichlorophenol, 2,3-	576-24-9	0.04 Minimum Criteria Organoleptic	56 Toxicity Criteria	56 Toxicity Criteria	0.4	-Immunological
Dichlorophenol, 2,4-	120-83-2	0.3 Minimum Criteria Organoleptic	13 Toxicity Criteria	13 Toxicity Criteria	3	-Immunological
Dichlorophenol, 2,5-	583-78-8	0.5 Minimum Criteria Organoleptic	90 Toxicity Criteria	90 Toxicity Criteria	5	-Immunological

**Table I**  
**Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Dichlorophenol, 2,6-	87-65-0	0.2 Minimum Criteria Organoleptic	73 Toxicity Criteria	73 Toxicity Criteria	2	-Immunological
Dichlorophenol, 3,4-	95-77-2	0.3 Minimum Criteria Organoleptic	61 Toxicity Criteria	61 Toxicity Criteria	3	-Immunological
Dichlorophenoxy acetic acid, 2,4-	94-75-7	* Primary Standard	80 Toxicity Criteria	80 Toxicity Criteria	***	-Blood -Kidney -Liver
Dichlorophenoxy butyric acid, 2,4- [or DB, 2,4-]	94-82-6	56 Minimum Criteria Systemic Toxicant	NA	NA	560	-Blood -Cardiovascular
Dichloropropane, 1,2-	78-87-5	* Primary Standard	14 Human Health	14 Human Health	***	-Carcinogen -Nasal
Dichloropropene, 1,3-	542-75-6	0.4 Minimum Criteria Carcinogen	12 Toxicity Criteria	12 Toxicity Criteria	4	-Carcinogen -Gastrointestinal -Nasal
Dichloroprop	120-36-5	35 Minimum Criteria Systemic Toxicant	42 Toxicity Criteria	42 Toxicity Criteria	350	-None Specified
Dichlorvos	62-73-7	0.1 Minimum Criteria Carcinogen	0.005 Toxicity Criteria	0.005 Toxicity Criteria	1	-Carcinogen -Neurological
Dicofof [or Kelthane]	115-32-2	0.08 Minimum Criteria Carcinogen	0.006 Human Health	0.006 Human Health	0.8	-Adrenals -Carcinogen
Dicrotophos [see Bidrin]						
Dieldrin	60-57-1	0.002 Minimum Criteria Carcinogen	**	**	0.02	-Carcinogen -Liver
Diethyl phthalate	84-66-2	5600 Minimum Criteria Systemic Toxicant	380 Toxicity Criteria	380 Toxicity Criteria	56000	-Body Weight
Diethylene glycol, monoethyl ether	111-90-0	14000 Minimum Criteria Systemic Toxicant	170000 Toxicity Criteria	170000 Toxicity Criteria	140000	-Kidney
Diethylstilbestrol	56-53-1	0.000007 Minimum Criteria Carcinogen	NA	NA	0.00007	-Carcinogen

**Table I**  
**Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Diisopropyl methylphosphonate	1445-75-6	560 Minimum Criteria Systemic Toxicant	13000 Toxicity Criteria	13000 Toxicity Criteria	5600	-None Specified
Dimethoate	60-51-5	1.4 Minimum Criteria Systemic Toxicant	0.1 Toxicity Criteria	0.1 Toxicity Criteria	14	-Neurological
Dimethoxybenzidine, 3,3'-	119-90-4	2.5 Minimum Criteria Carcinogen	NA	NA	25	-Carcinogen
Dimethrin	70-38-2	2100 Minimum Criteria Systemic Toxicant	1.1 Toxicity Criteria	1.1 Toxicity Criteria	21000	-Liver
Dimethylaniline, 2,4-	95-68-1	0.05 Minimum Criteria Carcinogen	1700 Toxicity Criteria	1700 Toxicity Criteria	0.5	-Blood -Carcinogen -Spleen
Dimethylaniline, N,N-	121-69-7	14 Minimum Criteria Systemic Toxicant	1700 Toxicity Criteria	1700 Toxicity Criteria	140	-Spleen
Dimethylbenzidine, 3,3'-	119-93-7	0.004 Minimum Criteria Carcinogen	NA	NA	0.04	-Carcinogen
Dimethylformamide, N,N-	68-12-2	700 Minimum Criteria Systemic Toxicant	50000 Toxicity Criteria	50000 Toxicity Criteria	7000	-Gastrointestinal -Liver
Dimethylphenol, 2,4-	105-67-9	140 Minimum Criteria Systemic Toxicant	160 Toxicity Criteria	160 Toxicity Criteria	1400	-Blood -Neurological
Dimethylphenol, 2,6-	576-26-1	4.2 Minimum Criteria Systemic Toxicant	560 Toxicity Criteria	560 Toxicity Criteria	42	-Kidney -Liver -Spleen
Dimethylphenol, 3,4-	95-65-8	7 Minimum Criteria Systemic Toxicant	380 Human Health	380 Human Health	70	-Kidney -Liver -Spleen
Dimethylphthalate	131-11-3	70000 Minimum Criteria Systemic Toxicant	1400 Toxicity Criteria	1400 Toxicity Criteria	700000	-Kidney
Dinitrobenzene, 1,2- (o)	528-29-0	2.8 Minimum Criteria Systemic Toxicant	30 Toxicity Criteria	30 Toxicity Criteria	28	-Spleen
Dinitrobenzene, 1,3- (m)	99-65-0	0.7 Minimum Criteria Systemic Toxicant	72 Toxicity Criteria	72 Toxicity Criteria	7	-Spleen

**Table I**  
**Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Dinitrobenzene, 1,4- (p)	100-25-4	2.8 Minimum Criteria Systemic Toxicant	30 Toxicity Criteria	30 Toxicity Criteria	28	-Spleen
Dinitro-o-cyclohexylphenol	131-89-5	14 Minimum Criteria Systemic Toxicant	NA	NA	140	-Eye
Dinitrophenol, 2,4-	51-28-5	14 Minimum Criteria Systemic Toxicant	3 Toxicity Criteria	3 Toxicity Criteria	140	-Eye
Dinitrotoluene, 2,4-	121-14-2	0.05 Minimum Criteria Carcinogen	**	**	0.5	-Carcinogen -Liver -Neurological
Dinitrotoluene, 2,6-	606-20-2	0.05 Minimum Criteria Carcinogen	0.7 Human Health	0.7 Human Health	0.5	-Blood -Carcinogen -Kidney -Neurological
Di-n-octylphthalate	117-84-0	140 Minimum Criteria Systemic Toxicant	NA	NA	1400	-Kidney -Liver
Dinoseb	88-85-7	* Primary Standard	5.9 Toxicity Criteria	5.9 Toxicity Criteria	***	-Developmental
Dioxane, 1,4-	123-91-1	3.2 Minimum Criteria Carcinogen	120 Human Health	120 Human Health	32	-Carcinogen
Dioxins, as total 2,3,7,8-TCDD equivalents	1746-01-6	* Primary Standard	0.000000005 Human Health	0.000000005 Human Health	***	-Carcinogen
Diphenamid	957-51-7	210 Minimum Criteria Systemic Toxicant	1600 Toxicity Criteria	1600 Toxicity Criteria	2100	-Liver
Diphenyl [see Biphenyl, 1,1-]						
Diphenylamine, N,N-	122-39-4	180 Minimum Criteria Systemic Toxicant	NA	NA	1800	-Kidney -Liver
Diphenylhydrazine, 1,2-	122-66-7	0.04 Minimum Criteria Carcinogen	0.2 Human Health	0.2 Human Health	0.4	-Carcinogen
Diquat	85-00-7	* Primary Standard	1.5 Toxicity Criteria	1.5 Toxicity Criteria	***	-Eye

**Table I**  
**Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Disulfoton	298-04-4	0.3 Minimum Criteria Systemic Toxicant	0.3 Toxicity Criteria	0.3 Toxicity Criteria	3	-Neurological
Diuron	330-54-1	14 Minimum Criteria Systemic Toxicant	8 Toxicity Criteria	8 Toxicity Criteria	140	-Blood
Dyrene [see Anilazine]						
EDB [see Dibromoethane, 1,2-]						
EDC [see Dichloroethane, 1,2-]						
Endosulfan (alpha+beta+sulfate)	115-29-7	42 Minimum Criteria Systemic Toxicant	**	**	420	-Cardiovascular -Kidney
Endothall	145-73-3	* Primary Standard	110 Toxicity Criteria	110 Toxicity Criteria	***	-Gastrointestinal
Endrin	72-20-8	* Primary Standard	**	**	***	-Liver
EPEG [see Ethylphthalyl ethylglycolate]						
Epichlorohydrin	106-89-8	3.5 Minimum Criteria Carcinogen	130 Human Health	130 Human Health	35	-Carcinogen -Kidney -Nasal
EPN [see Ethyl p-nitrophenyl phenylphosphorothioate]						
EPTC [see Ethyl dipropylthiocarbamate, S-]						
Ethanol	64-17-5	10000 Minimum Criteria Organoleptic	NA	NA	100000	-Developmental
Ethion	563-12-2	3.5 Minimum Criteria Systemic Toxicant	0.007 Toxicity Criteria	0.007 Toxicity Criteria	35	-Neurological

**Table I**  
**Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Ethoprop	13194-48-4	0.7 Minimum Criteria Systemic Toxicant	0.3 Toxicity Criteria	0.3 Toxicity Criteria	7	-Neurological
Ethoxyethanol acetate, 2-	111-15-9	2100 Minimum Criteria Systemic Toxicant	2000 Toxicity Criteria	2000 Toxicity Criteria	21000	-Developmental
Ethoxyethanol, 2-	110-80-5	2800 Minimum Criteria Systemic Toxicant	NA	NA	28000	-Reproductive
Ethyl acetate	141-78-6	6300 Minimum Criteria Systemic Toxicant	6300 Toxicity Criteria	6300 Toxicity Criteria	63000	-Body Weight
Ethyl acrylate	140-88-5	0.4 Minimum Criteria Organoleptic	130 Toxicity Criteria	130 Toxicity Criteria	4	-Carcinogen
Ethyl chloride [or Chloroethane]	75-00-3	12 Minimum Criteria Carcinogen	NA	NA	120	-Carcinogen - Developmental
Ethyl dipropylthiocarbamate, S- [or EPTC]	759-94-4	180 Minimum Criteria Systemic Toxicant	240 Toxicity Criteria	240 Toxicity Criteria	1800	-Cardiovascular
Ethyl ether	60-29-7	750 Minimum Criteria Organoleptic	130000 Toxicity Criteria	130000 Toxicity Criteria	7500	-Body Weight
Ethyl methacrylate	97-63-2	630 Minimum Criteria Systemic Toxicant	NA	NA	6300	-Kidney
Ethyl p-nitrophenyl phenylphosphorothioate [or EPN]	2104-64-5	0.07 Minimum Criteria Systemic Toxicant	0.02 Toxicity Criteria	0.02 Toxicity Criteria	0.7	-Neurological
Ethylbenzene	100-41-4	* Secondary Standard	610 Toxicity Criteria	610 Toxicity Criteria	***	-Developmental -Kidney -Liver
Ethylene diamine	107-15-3	140 Minimum Criteria Systemic Toxicant	800 Toxicity Criteria	800 Toxicity Criteria	1400	-Blood -Cardiovascular
Ethylene glycol	107-21-1	14000 Minimum Criteria Systemic Toxicant	16000 Toxicity Criteria	16000 Toxicity Criteria	140000	-Kidney
Ethylene oxide	75-21-8	0.03 Minimum Criteria Carcinogen	4200 Toxicity Criteria	4200 Toxicity Criteria	0.3	-Carcinogen

**Table I**  
**Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Ethylene thiourea [or ETU]	96-45-7	0.3 Minimum Criteria Carcinogen	1300 Toxicity Criteria	1300 Toxicity Criteria	3	-Carcinogen -Thyroid
Ethylphthalyl ethylglycolate [or EPEG]	84-72-0	21000 Minimum Criteria Systemic Toxicant	NA	NA	210000	-Kidney
ETU [see Ethylene thiourea]						
Famphur	52-85-7	3.5 Minimum Criteria Systemic Toxicant	NA	NA	35	-Blood
Fenamiphos	22224-92-6	1.8 Minimum Criteria Systemic Toxicant	0.2 Toxicity Criteria	0.2 Toxicity Criteria	18	-Neurological
Fensulfithion	115-90-2	1.8 Minimum Criteria Systemic Toxicant	0.5 Toxicity Criteria	0.5 Toxicity Criteria	18	-Neurological
Fenvalerate [see Pydrin]						
Fluometuron	2164-17-2	91 Minimum Criteria Systemic Toxicant	190 Toxicity Criteria	190 Toxicity Criteria	910	-None Specified
Fluoranthene	206-44-0	280 Minimum Criteria Systemic Toxicant	0.3 Toxicity Criteria	0.3 Toxicity Criteria	2800	-Blood -Kidney -Liver
Fluorene	86-73-7	280 Minimum Criteria Systemic Toxicant	30 Toxicity Criteria	30 Toxicity Criteria	2800	-Blood
Fluoride	7782-41-4	* Secondary Standard	**	**	***	-Teeth mottling
Fluoridone	59756-60-4	560 Minimum Criteria Systemic Toxicant	110 Toxicity Criteria	110 Toxicity Criteria	5600	-Kidney -Reproductive
Fonofos	944-22-9	14 Minimum Criteria Systemic Toxicant	0.1 Toxicity Criteria	0.1 Toxicity Criteria	140	-Liver -Neurological
Formaldehyde	50-00-0	600 Minimum Criteria Organoleptic	110 Toxicity Criteria	110 Toxicity Criteria	6000	-Carcinogen -Gastrointestinal

**Table I  
Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Formic acid	64-18-6	14000 Minimum Criteria Systemic Toxicant	4500 Toxicity Criteria	4500 Toxicity Criteria	140000	-Body Weight
Furan	110-00-9	7 Minimum Criteria Systemic Toxicant	NA	NA	70	-Liver
Furfural	98-01-1	21 Minimum Criteria Systemic Toxicant	650 Toxicity Criteria	650 Toxicity Criteria	210	-Liver -Nasal
Glycidaldehyde	765-34-4	2.8 Minimum Criteria Systemic Toxicant	NA	NA	28	-Adrenals -Blood -Kidney
Glyphosate [or Roundup]	1071-83-6	* Primary Standard	120 Toxicity Criteria	120 Toxicity Criteria	***	-Kidney
Gross alpha radiation	14127-62-9	* Primary Standard	**	**	***	-Carcinogen
Guthion [or Methyl azinphos]	86-50-0	11 Minimum Criteria Systemic Toxicant	**	**	110	-Neurological
Heptachlor	76-44-8	* Primary Standard	**	**	***	-Carcinogen -Liver
Heptachlor epoxide	1024-57-3	* Primary Standard	0.00004 Human Health	0.00004 Human Health	***	-Carcinogen -Liver
Hexachloro-1,3-butadiene	87-68-3	0.4 Minimum Criteria Carcinogen	**	**	4	-Carcinogen -Kidney
Hexachlorobenzene	118-74-1	* Primary Standard	0.0003 Human Health	0.0003 Human Health	***	-Carcinogen -Liver
Hexachlorocyclohexane, alpha- [or BHC, alpha-]	319-84-6	0.006 Minimum Criteria Carcinogen	0.005 Human Health	0.005 Human Health	0.06	-Carcinogen
Hexachlorocyclohexane, beta- [BHC, beta-]	319-85-7	0.02 Minimum Criteria Carcinogen	**	**	0.2	-Carcinogen
Hexachlorocyclohexane, delta- [or BHC, delta-]	319-86-8	2.1 Minimum Criteria Systemic Toxicant	NA	NA	21	-Kidney -Liver

**Table I**  
**Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Hexachlorocyclohexane, gamma- [or Lindane or BHC, gamma-]	58-89-9	* Primary Standard	**	**	***	-Carcinogen -Kidney -Liver
Hexachlorocyclohexane, technical [ or BHC, technical]	608-73-1	0.02 Minimum Criteria Carcinogen	0.02 Toxicity Criteria	0.02 Toxicity Criteria	0.2	-Carcinogen
Hexachlorocyclopentadiene	77-47-4	* Primary Standard	3 Toxicity Criteria	3 Toxicity Criteria	***	-Gastrointestinal
Hexachlorodibenzo-p-dioxin (mixture)	19408-74-3	0.000006 Minimum Criteria Carcinogen	NA	NA	0.000006	-Carcinogen
Hexachloroethane	67-72-1	2.5 Minimum Criteria Carcinogen	3.3 Human Health	3.3 Human Health	25	-Carcinogen -Kidney
Hexachlorophene	70-30-4	2.1 Minimum Criteria Systemic Toxicant	1.1 Toxicity Criteria	1.1 Toxicity Criteria	21	-Neurological
Hexahydro-1,3,5-trinitro-1,3,5-triazine [or RDX]	121-82-4	0.3 Minimum Criteria Carcinogen	180 Toxicity Criteria	180 Toxicity Criteria	3	-Carcinogen -Reproductive
Hexane, n-	110-54-3	6 Minimum Criteria Organoleptic	3400 Toxicity Criteria	3400 Toxicity Criteria	60	-Neurological
Hexanone, 2- [or Methyl butyl ketone]	591-78-6	280 Minimum Criteria Systemic Toxicant	NA	NA	2800	-None Specified
Hexazinone	51235-04-2	230 Minimum Criteria Systemic Toxicant	25000 Human Health	25000 Human Health	2300	-Body Weight
HMX [see Octahydro-1,3,5,7-tetranitro-tetrazocine]						
Hydrogen cyanide (as Cyanide)	74-90-8	140 Minimum Criteria Systemic Toxicant	3.5 Toxicity Criteria	3.5 Toxicity Criteria	1400	-Neurological -Thyroid
Hydrogen sulfide	7783-06-4	21 Minimum Criteria Systemic Toxicant	0.1 Toxicity Criteria	0.1 Toxicity Criteria	210	-Gastrointestinal -Nasal
Hydroquinone	123-31-9	280 Minimum Criteria Systemic Toxicant	4.5 Toxicity Criteria	4.5 Toxicity Criteria	2800	-Blood

**Table I**  
**Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Indeno(1,2,3-cd)pyrene	193-39-5	0.05 Minimum Criteria Carcinogen	**	**	0.5	-Carcinogen
Iprodione	36734-19-7	280 Minimum Criteria Systemic Toxicant	150 Toxicity Criteria	150 Toxicity Criteria	2800	-Blood
Iron	7439-89-6	* Secondary Standard	**	**	***	-Gastrointestinal
Isobutyl alcohol	78-83-1	2100 Minimum Criteria Systemic Toxicant	47000 Toxicity Criteria	47000 Toxicity Criteria	21000	-Neurological
Isophorone	78-59-1	37 Minimum Criteria Carcinogen	650 Toxicity Criteria	650 Toxicity Criteria	370	-Carcinogen -None Specified
Isopropyl benzene [see Cumene]						
Kelthane [see Dicofof]						
Kepon	143-50-0	0.004 Minimum Criteria Carcinogen	NA	NA	0.04	-Carcinogen
Lead	7439-92-1	* Primary Standard	**	**	***	-Neurological
Limonene	138-86-3	700 Minimum Criteria Systemic Toxicant	NA	NA	7000	-Kidney -Liver
Lindane [see Hexachlorocyclohexane, gamma-]						
Linuron	330-55-2	1.4# Minimum Criteria Systemic Toxicant	45 Toxicity Criteria	45 Toxicity Criteria	14	-Blood
Lithium	7439-93-2	140 Minimum Criteria Systemic Toxicant	NA	NA	1400	-None Specified
Malathion	121-75-5	140 Minimum Criteria Systemic Toxicant	**	**	1400	-Neurological

**Table I**  
**Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Maleic anhydride	108-31-6	700 Minimum Criteria Systemic Toxicant	NA	NA	7000	-Kidney
Maleic hydrazide	123-33-1	3500 Minimum Criteria Systemic Toxicant	750 Toxicity Criteria	750 Toxicity Criteria	35000	-Kidney
Mancozeb	8018-01-7	210 Minimum Criteria Systemic Toxicant	3.5 Toxicity Criteria	3.5 Toxicity Criteria	2100	-Thyroid
Maneb	12427-38-2	35 Minimum Criteria Systemic Toxicant	5.5 Toxicity Criteria	5.5 Toxicity Criteria	350	-Thyroid
Manganese	7439-96-5	50 Secondary Standard	NA	NA	500	-Neurological
MCPA [see Methyl-4-chlorophenoxy acetic acid, 2- ]						
MCPP [see Propionic acid, 2-(2-methyl-4-chlorophenoxy)]						
Mercuric chloride (as Mercury)	7487-94-7	0.2# Minimum Criteria Systemic Toxicant	0.05 Toxicity Criteria	0.05 Toxicity Criteria	2	-Immunological -Kidney
Mercury	7439-97-6	* Primary Standard	**	**	***	-Neurological
Mercury, methyl- [see Methylmercury]						
Merphos	150-50-5	0.2 Minimum Criteria Systemic Toxicant	NA	NA	2	-Neurological
Merphos oxide	78-48-8	0.2 Minimum Criteria Systemic Toxicant	0.2 Toxicity Criteria	0.2 Toxicity Criteria	2	-Neurological
Metalaxyl	57837-19-1	420 Minimum Criteria Systemic Toxicant	37 Toxicity Criteria	37 Toxicity Criteria	4200	-Blood -Liver -Neurological
Methacrylonitrile	126-98-7	0.7 Minimum Criteria Systemic Toxicant	NA	NA	7	-Liver

**Table I**  
**Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Methamidophos	10265-92-6	0.4 Minimum Criteria Systemic Toxicant	0.00001 Toxicity Criteria	0.00001 Toxicity Criteria	4	-Neurological
Methanol	67-56-1	3500 Minimum Criteria Systemic Toxicant	45000 Toxicity Criteria	45000 Toxicity Criteria	35000	-Developmental -Eye -Neurological
Methidathion	950-37-8	0.7# Minimum Criteria Systemic Toxicant	0.03 Toxicity Criteria	0.03 Toxicity Criteria	7	-Liver
Methyl	16752-77-5	180 Minimum Criteria Systemic Toxicant	1 Toxicity Criteria	1 Toxicity Criteria	1800	-Kidney -Spleen
Methoxy-5-nitroaniline, 2-	99-59-2	0.8 Minimum Criteria Carcinogen	NA	NA	8	-Carcinogen
Methoxychlor	72-43-5	* Primary Standard	**	**	***	-Developmental -Reproductive
Methoxyethanol, 2-	109-86-4	7 Minimum Criteria Systemic Toxicant	NA	NA	70	-Reproductive
Methyl acetate	79-20-9	3000 Minimum Criteria Organoleptic	NA	NA	30000	-Liver
Methyl acrylate	96-33-3	210 Minimum Criteria Systemic Toxicant	NA	NA	2100	-None Specified
Methyl azinphos [see Guthion]						
Methyl bromide [see Bromomethane]						
Methyl butyl ketone [see Hexanone, 2-]						
Methyl chloride [or Chloromethane]	74-87-3	2.7 Minimum Criteria Carcinogen	**	**	27	-Carcinogen -Neurological
Methyl chloroform [see Trichloroethane, 1,1,1-]						

**Table I**  
**Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Methyl ethyl ketone [or Butanone, 2-]	78-93-3	4200 Minimum Criteria Systemic Toxicant	120000 Toxicity Criteria	120000 Toxicity Criteria	42000	-Developmental
Methyl isobutyl ketone [or MIBK]	108-10-1	560 Minimum Criteria Systemic Toxicant	23000 Toxicity Criteria	23000 Toxicity Criteria	5600	-Kidney -Liver
Methyl methacrylate	80-62-6	25 Minimum Criteria Organoleptic	6500 Toxicity Criteria	6500 Toxicity Criteria	250	-Nasal
Methyl parathion [or Parathion, methyl]	298-00-0	1.8 Minimum Criteria Systemic Toxicant	0.01 Toxicity Criteria	0.01 Toxicity Criteria	18	-Blood -Neurological
Methyl tert-butyl ether [or MTBE]	1634-04-4	20 Minimum Criteria Organoleptic	34000 Toxicity Criteria	34000 Toxicity Criteria	200	-Eye -Kidney -Liver
Methyl-4-chlorophenoxy acetic acid, 2- [or MCPA]	94-74-6	3.5 Minimum Criteria Systemic Toxicant	72 Toxicity Criteria	72 Toxicity Criteria	35	-Kidney -Liver
Methyl-5-nitroaniline, 2-	99-55-8	1.1 Minimum Criteria Carcinogen	NA	NA	11	-Carcinogen
Methylaniline, 2-	95-53-4	0.1 Minimum Criteria Carcinogen	26 Toxicity Criteria	26 Toxicity Criteria	1	-Carcinogen
Methylene bis(2-chloroaniline), 4,4-	101-14-4	0.3 Minimum Criteria Carcinogen	NA	NA	3	-Carcinogen -Liver -Bladder
Methylene bromide	74-95-3	70 Minimum Criteria Systemic Toxicant	NA	NA	700	-Blood
Methylene chloride	75-09-2	* Primary Standard	**	**	***	-Carcinogen -Liver
Methylmercury [or Mercury, methyl]	22967-92-6	0.07# Minimum Criteria Systemic Toxicant	NA	NA	0.7	-Neurological
Methylnaphthalene, 1-	90-12-0	28 Minimum Criteria Systemic Toxicant	95 Toxicity Criteria	95 Toxicity Criteria	280	-Nasal
Methylnaphthalene, 2-	91-57-6	28 Minimum Criteria Systemic Toxicant	30 Toxicity Criteria	30 Toxicity Criteria	280	-Nasal

**Table I**  
**Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Methylphenol, 2- [or Cresol, o-]	95-48-7	35# Minimum Criteria Systemic Toxicant	250 Toxicity Criteria	250 Toxicity Criteria	350	-Neurological
Methylphenol, 3- [or Cresol, m-]	108-39-4	35# Minimum Criteria Systemic Toxicant	450 Toxicity Criteria	450 Toxicity Criteria	350	-Neurological
Methylphenol, 4- [or Cresol, p-]	106-44-5	3.5# Minimum Criteria Systemic Toxicant	70 Toxicity Criteria	70 Toxicity Criteria	35	-Neurological -Respiratory
Metolachlor	51218-45-2	110# Minimum Criteria Systemic Toxicant	1.1 Toxicity Criteria	1.1 Toxicity Criteria	1100	-Body Weight
Metribuzin	21087-64-9	180 Minimum Criteria Systemic Toxicant	64 Toxicity Criteria	64 Toxicity Criteria	1800	-Kidney -Liver
Metsulfuron, methyl [see Ally]						
Mevinphos	7786-34-7	1.8 Minimum Criteria Systemic Toxicant	0.05 Toxicity Criteria	0.05 Toxicity Criteria	18	-Neurological
MIBK [see Methyl isobutyl ketone]						
Mifex	2385-85-5	1.4 Minimum Criteria Systemic Toxicant	**	**	14	-Liver -Thyroid
Molinate	2212-67-1	14 Minimum Criteria Systemic Toxicant	17 Toxicity Criteria	17 Toxicity Criteria	140	-Reproductive
Molybdenum	7439-98-7	35 Minimum Criteria Systemic Toxicant	NA	NA	350	-Gout
MTBE [see Methyl tert-butyl ether]						
Naled	300-76-5	14 Minimum Criteria Systemic Toxicant	0.02 Toxicity Criteria	0.02 Toxicity Criteria	140	-Neurological
Naphthalene	91-20-3	14# Minimum Criteria Systemic Toxicant	26 Toxicity Criteria	26 Toxicity Criteria	140	-Nasal

**Table I**  
**Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Naphthylamine, 2-	91-59-8	0.0003 Minimum Criteria Carcinogen	NA	NA	0.003	-Carcinogen
Napropamide	15299-99-7	700 Minimum Criteria Systemic Toxicant	210 Toxicity Criteria	210 Toxicity Criteria	7000	-Body Weight
Nickel	7440-02-0	* Primary Standard	**	**	***	-Body Weight
Nickel subsulfide	12035-72-2	* Primary Standard	**	**	***	-Carcinogen
Nitrate	14797-55-8	* Primary Standard	NA	NA	***	-Blood
Nitrate+Nitrite	NOCAS	* Primary Standard	NA	NA	***	-Blood
Nitrite	14797-65-0	* Primary Standard	NA	NA	***	-Blood
Nitroaniline, m-	99-09-2	1.7 Minimum Criteria Carcinogen	NA	NA	17	-Blood -Carcinogen
Nitroaniline, o-	88-74-4	21 Minimum Criteria Systemic Toxicant	NA	NA	210	-Blood
Nitroaniline, p-	100-01-6	1.7 Minimum Criteria Carcinogen	1200 Toxicity Criteria	1200 Toxicity Criteria	17	-Blood -Carcinogen
Nitrobenzene	98-95-3	3.5 Minimum Criteria Systemic Toxicant	90 Toxicity Criteria	90 Toxicity Criteria	35	-Adrenals -Blood -Kidney -Liver
Nitrophenol, 4-	100-02-7	56 Minimum Criteria Systemic Toxicant	55 Toxicity Criteria	55 Toxicity Criteria	560	-None Specified
Nitroso-di-ethylamine, N-	55-18-5	0.0002 Minimum Criteria Carcinogen	0.008 Human Health	0.008 Human Health	0.002	-Carcinogen
Nitroso-dimethylamine, N-	62-75-9	0.0007 Minimum Criteria Carcinogen	3 Human Health	3 Human Health	0.007	-Carcinogen

**Table I**  
**Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Nitroso-di-n-butylamine, N-	924-16-3	0.006 Minimum Criteria Carcinogen	0.04 Human Health	0.04 Human Health	0.06	-Carcinogen
Nitroso-di-n-propylamine, N-	621-64-7	0.005 Minimum Criteria Carcinogen	0.5 Human Health	0.5 Human Health	0.05	-Carcinogen
Nitroso-diphenylamine, N-	86-30-6	7.1 Minimum Criteria Carcinogen	6 Human Health	6 Human Health	71	-Carcinogen
Nitroso-N-methylethylamine, N-	10595-95-6	0.002 Minimum Criteria Carcinogen	0.06 Human Health	0.06 Human Health	0.02	-Carcinogen
Nitrosopyrrolidine, N-	930-55-2	0.02 Minimum Criteria Carcinogen	NA	NA	0.2	-Carcinogen
Nitrotoluene, m-	99-08-1	140 Minimum Criteria Systemic Toxicant	380 Toxicity Criteria	380 Toxicity Criteria	1400	-Spleen
Nitrotoluene, o-	88-72-2	70 Minimum Criteria Systemic Toxicant	550 Toxicity Criteria	550 Toxicity Criteria	700	-Spleen
Nitrotoluene, p-	99-99-0	70 Minimum Criteria Systemic Toxicant	550 Toxicity Criteria	550 Toxicity Criteria	700	-Spleen
Nonylphenol	25154-52-3	8.4 Minimum Criteria Systemic Toxicant	5.9 Toxicity Criteria	1.4 Toxicity Criteria	84	-Kidney
Norflurazon	27314-13-2	280 Minimum Criteria Systemic Toxicant	NA	NA	2800	-Kidney -Liver -Thyroid
Octahydro-1,3,5,7-tetranitro-tetrazocine [or HMX]	2691-41-0	350 Minimum Criteria Systemic Toxicant	1300 Toxicity Criteria	1300 Toxicity Criteria	3500	-Blood -Liver
Octamethylpyrophosphoramide	152-16-9	14 Minimum Criteria Systemic Toxicant	NA	NA	140	-Neurological
Oryzalin	19044-88-3	35# Minimum Criteria Systemic Toxicant	NA	NA	350	-Adrenals -Blood -Kidney -Liver
Oxadiazon	19666-30-9	35 Minimum Criteria Systemic Toxicant	44 Toxicity Criteria	44 Toxicity Criteria	350	-Liver

**Table I**  
**Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Oxamyl	23135-22-0	* Primary Standard	8.5 Toxicity Criteria	8.5 Toxicity Criteria	***	-Body Weight
Paraquat	1910-42-5	3.2# Minimum Criteria Systemic Toxicant	47 Toxicity Criteria	47 Toxicity Criteria	32	-Respiratory
Parathion	56-38-2	4.2# Minimum Criteria Systemic Toxicant	**	**	42	-Neurological
Parathion, methyl [see Methyl parathion]						
PCBs [or Aroclor mixture]	1336-36-3	* Primary Standard	**	**	***	-Carcinogen -Immunological
PCE [see Tetrachloroethene]						
Pebulate	1114-71-2	350 Minimum Criteria Systemic Toxicant	310 Toxicity Criteria	310 Toxicity Criteria	3500	-Blood
Pendimethalin	40487-42-1	280 Minimum Criteria Systemic Toxicant	10 Toxicity Criteria	10 Toxicity Criteria	2800	-Liver
Pentachlorobenzene	608-93-5	5.6 Minimum Criteria Systemic Toxicant	1.7 Human Health	1.7 Human Health	56	-Kidney -Liver
Pentachloronitrobenzene	82-68-8	0.1 Minimum Criteria Carcinogen	0.02 Human Health	0.02 Human Health	1	-Carcinogen -Liver
Pentachlorophenol	87-86-5	* Primary Standard	**	**	***	-Carcinogen -Kidney -Liver
Perchlorate	7601-90-3	4 Minimum Criteria Systemic Toxicant	NA	NA	40	-Thyroid
Permethrin	52645-53-1	350 Minimum Criteria Systemic Toxicant	0.001 Toxicity Criteria	0.001 Toxicity Criteria	3500	-Liver
Phenanthrene	85-01-8	210 Minimum Criteria Systemic Toxicant	**	**	2100	-Kidney

**Table I  
Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Phenmedipham [or Betanal]	13684-63-4	1800 Minimum Criteria Systemic Toxicant	200 Toxicity Criteria	200 Toxicity Criteria	18000	-None Specified
Phenol	108-95-2	10 Minimum Criteria Organoleptic	6.5 Toxicity Criteria	6.5 Toxicity Criteria	100	-Developmental
Phenylenediamine, m-	108-45-2	42 Minimum Criteria Systemic Toxicant	NA	NA	420	-Liver
Phenylenediamine, p-	106-50-3	1300 Minimum Criteria Systemic Toxicant	NA	NA	13000	-Whole Body
Phenylphenol, 2-	90-43-7	18 Minimum Criteria Carcinogen	36 Toxicity Criteria	36 Toxicity Criteria	180	-Carcinogen
Phorate	298-02-2	1.4 Minimum Criteria Systemic Toxicant	0.005 Toxicity Criteria	0.005 Toxicity Criteria	14	-Neurological
Phosmet	732-11-6	140 Minimum Criteria Systemic Toxicant	0.1 Toxicity Criteria	0.1 Toxicity Criteria	1400	-Liver -Neurological
Phosphine	7803-51-2	2.1 Minimum Criteria Systemic Toxicant	NA	NA	21	-Body Weight
Phthalic anhydride	85-44-9	14000 Minimum Criteria Systemic Toxicant	NA	NA	140000	-Kidney -Nasal -Respiratory
Picloram	1918-02-1	* Primary Standard	70 Toxicity Criteria	70 Toxicity Criteria	***	-Liver
Polychlorinated dibenzo-p-dioxins [see Dioxins]						
Polycyclic Aromatic Hydrocarbons (PAHs)			**	**		-Various Endpoints
Potassium cyanide	151-50-8	350 Minimum Criteria Systemic Toxicant	5.5 Toxicity Criteria	5.5 Toxicity Criteria	3500	-Neurological -Thyroid
Profluralin	26399-36-0	42 Minimum Criteria Systemic Toxicant	NA	NA	420	-None Specified

**Table I**  
**Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Prometon	1610-18-0	110 Minimum Criteria Systemic Toxicant	600 Toxicity Criteria	600 Toxicity Criteria	1100	-None Specified
Prometryn	7287-19-6	28 Minimum Criteria Systemic Toxicant	21 Toxicity Criteria	21 Toxicity Criteria	280	-Bone Marrow -Kidney -Liver
Pronamide	23950-58-5	53# Minimum Criteria Systemic Toxicant	NA	NA	530	-None Specified
Propachlor	1918-16-7	91 Minimum Criteria Systemic Toxicant	12 Toxicity Criteria	12 Toxicity Criteria	910	-Liver
Propanil	709-98-8	35 Minimum Criteria Systemic Toxicant	20 Toxicity Criteria	20 Toxicity Criteria	350	-Spleen
Propargite	2312-35-8	140 Minimum Criteria Systemic Toxicant	1.6 Toxicity Criteria	1.6 Toxicity Criteria	1400	-None Specified
Propazine	139-40-2	14# Minimum Criteria Systemic Toxicant	190 Toxicity Criteria	190 Toxicity Criteria	140	-Body Weight
Proptham	122-42-9	140 Minimum Criteria Systemic Toxicant	500 Toxicity Criteria	500 Toxicity Criteria	1400	-Neurological
Propiconazole	60207-90-1	91 Minimum Criteria Systemic Toxicant	26 Toxicity Criteria	26 Toxicity Criteria	910	-Gastrointestinal
Propionic acid, 2-(2-methyl-4-chlorophenoxy) [or MCPP]	93-65-2	7 Minimum Criteria Systemic Toxicant	NA	NA	70	-Kidney
Propoxur [see Baygon]						
Propylene glycol	57-55-6	140000 Minimum Criteria Systemic Toxicant	36000 Toxicity Criteria	36000 Toxicity Criteria	1400000	-Blood -Bone Marrow
Propylene glycol monomethyl ether	107-98-2	4900 Minimum Criteria Systemic Toxicant	NA	NA	49000	-Kidney -Liver -Neurological
Propylene oxide	75-56-9	0.1 Minimum Criteria Carcinogen	NA	NA	1	-Carcinogen -Nasal -Respiratory

**Table I  
Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Pydrin [or Fenvalerate]	51630-58-1	180 Minimum Criteria Systemic Toxicant	0.0004 Toxicity Criteria	0.0004 Toxicity Criteria	1800	-Neurological
Pyrene	129-00-0	210 Minimum Criteria Systemic Toxicant	0.3 Toxicity Criteria	0.3 Toxicity Criteria	2100	-Kidney
Pyridine	110-86-1	7 Minimum Criteria Systemic Toxicant	1300 Toxicity Criteria	1300 Toxicity Criteria	70	-Liver
Quinoline	91-22-5	0.01 Minimum Criteria Carcinogen	NA	NA	0.1	-Carcinogen
Radium, 226 and 228 (combined)	7440-14-4	* Primary Standard	**	**	***	-Carcinogen
RDX [see Hexahydro-1,3,5-trinitro-1,3,5-triazine]						
Resmethrin	10453-86-8	210 Minimum Criteria Systemic Toxicant	0.003 Toxicity Criteria	0.003 Toxicity Criteria	2100	-Reproductive
Ronnel	299-84-3	350 Minimum Criteria Systemic Toxicant	0.06 Toxicity Criteria	0.06 Toxicity Criteria	3500	-Liver
Rotenone	83-79-4	28 Minimum Criteria Systemic Toxicant	0.1 Toxicity Criteria	0.1 Toxicity Criteria	280	-Developmental
Roundup [see Glyphosate]						
Selenious acid (as Selenium)	7783-00-8	35 Minimum Criteria Systemic Toxicant	40 Toxicity Criteria	40 Toxicity Criteria	350	-Hair Loss -Neurological -Skin
Selenium	7782-49-2	* Primary Standard	**	**	***	-Hair Loss -Neurological -Skin
Sevin [see Carbaryl]						
Silver	7440-22-4	* Secondary Standard	**	0.4 Toxicity Criteria (e)	***	-Skin

**Table I  
Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Silvex [see Trichlorophenoxy propionic acid]						
Simazine	122-34-9	* Primary Standard	7.3 Human Health	7.3 Human Health	***	-Blood -Carcinogen
Sodium	7440-23-5	* Primary Standard	NA	NA	***	-None Specified
Sodium chlorite [see Chlorite (sodium salt)]						
Sodium cyanide (as Cyanide)	143-33-9	280 Minimum Criteria Systemic Toxicant	3.8 Toxicity Criteria	3.8 Toxicity Criteria	2800	-Neurological
Strontium	7440-24-6	4200 Minimum Criteria Systemic Toxicant	NA	NA	42000	-Bone
Strychnine	57-24-9	2.1 Minimum Criteria Systemic Toxicant	38 Toxicity Criteria	38 Toxicity Criteria	21	-Mortality
Styrene	100-42-5	* Primary Standard	460 Toxicity Criteria	460 Toxicity Criteria	***	-Blood -Liver -Neurological
Sulfate	14808-79-8	* Secondary Standard	NA	NA	***	-None Specified
TCDD, 2,3,7,8- [see Dioxins, as total 2,3,7,8-TCDD equivalents]						
TCE [see Trichloroethene]						
TCMTB [see Thiocyanomethylthio-benzothiazole, 2-]						
TDS [see Total dissolved solids]						
Tebuthiuron	34014-18-1	490 Minimum Criteria Systemic Toxicant	310 Toxicity Criteria	310 Toxicity Criteria	4900	-Body Weight

**Table I**  
**Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Temephos	3383-96-8	140 Minimum Criteria Systemic Toxicant	0.002 Toxicity Criteria	0.002 Toxicity Criteria	1400	-None Specified
Temik [see Aldicarb]						
Terbacil	5902-51-2	91 Minimum Criteria Systemic Toxicant	2500 Toxicity Criteria	2500 Toxicity Criteria	910	-Liver -Thyroid
Terbufos	13071-79-9	0.2 Minimum Criteria Systemic Toxicant	0.01 Toxicity Criteria	0.01 Toxicity Criteria	2	-Neurological
Terbutryn	886-50-0	7 Minimum Criteria Systemic Toxicant	3.1 Toxicity Criteria	3.1 Toxicity Criteria	70	-Blood
Tetrachlorobenzene, 1,2,4,5-	95-94-3	2.1 Minimum Criteria Systemic Toxicant	1.6 Human Health	1.6 Human Health	21	-Kidney
Tetrachloroethane, 1,1,1,2-	630-20-6	1.3 Minimum Criteria Carcinogen	NA	NA	13	-Carcinogen -Kidney -Liver
Tetrachloroethane, 1,1,2,2-	79-34-5	0.2 Minimum Criteria Carcinogen	**	**	2	-Carcinogen -Liver
Tetrachloroethene [or PCE]	127-18-4	* Primary Standard	**	**	***	-Carcinogen -Liver
Tetrachlorophenol, 2,3,4,6-	58-90-2	210 Minimum Criteria Systemic Toxicant	4.5 Toxicity Criteria	4.5 Toxicity Criteria	2100	-Liver
Tetraethyl dithiopyrophosphate	3689-24-5	3.5 Minimum Criteria Systemic Toxicant	0.01 Toxicity Criteria	0.01 Toxicity Criteria	35	-Bone Marrow -Neurological
Thallium	7440-28-0	* Primary Standard	**	**	***	-Hair Loss -Liver
Thallium sulfate (as Thallium)	7446-18-6	0.6 Minimum Criteria Systemic Toxicant	26 Toxicity Criteria	26 Toxicity Criteria	6	-Blood -Hair Loss -Liver
Thiobencarb	28249-77-6	70 Minimum Criteria Systemic Toxicant	NA	NA	700	-Kidney

**Table I  
Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Thiocyanomethylthio-benzothiazole, 2-[or TCM/MTB]	21564-17-0	2.8# Minimum Criteria Systemic Toxicant	0.4 Toxicity Criteria	0.4 Toxicity Criteria	28	-Gastrointestinal
Thiram	137-26-8	35 Minimum Criteria Systemic Toxicant	0.2 Toxicity Criteria	0.2 Toxicity Criteria	350	-Neurological
Tin	7440-31-5	4200 Minimum Criteria Systemic Toxicant	NA	NA	42000	-Kidney -Liver
Titanium Dioxide	13463-67-7	28000 Minimum Criteria Systemic Toxicant	NA	NA	280000	
Toluene	108-88-3	* Secondary Standard	480 Toxicity Criteria	480 Toxicity Criteria	***	-Kidney -Liver -Neurological
Toluene-2,4-diamine	95-80-7	0.01 Minimum Criteria Carcinogen	NA	NA	0.1	-Carcinogen
Toluidine, p-	106-49-0	0.2 Minimum Criteria Carcinogen	NA	NA	2	-Carcinogen
Total dissolved solids [or TDS]	C-010	* Secondary Standard	NA	NA	***	-None Specified
Toxaphene	8001-35-2	* Primary Standard	**	**	***	-Carcinogen -Developmental
Triallate	2303-17-5	91 Minimum Criteria Systemic Toxicant	65 Toxicity Criteria	65 Toxicity Criteria	910	-Liver -Spleen
Tributyltin oxide	56-35-9	2.1 Minimum Criteria Systemic Toxicant	0.05 Toxicity Criteria	0.05 Toxicity Criteria	21	-Immunological
Trichloro-1,2,2-trifluoroethane, 1,1,2-[or CFC 113]	76-13-1	210000 Minimum Criteria Systemic Toxicant	NA	NA	2100000	-Neurological
Trichloroacetic acid	76-03-9	9.1 Minimum Criteria Systemic Toxicant	100000 Toxicity Criteria	100000 Toxicity Criteria	91	-None Specified
Trichlorobenzene, 1,2,3-	87-61-6	70 Minimum Criteria Systemic Toxicant	85 Toxicity Criteria	85 Toxicity Criteria	700	-Adrenals

**Table I  
Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater	Marine	Groundwater	Target Organs/Systems or Effects†
		(ug/L)	Surface Water Criteria (ug/L)	Surface Water Criteria (ug/L)	of Low Yield/Poor Quality Criteria (ug/L)	
Trichlorobenzene, 1,2,4-	120-82-1	* Primary Standard	23 Toxicity Criteria	23 Toxicity Criteria	***	-Adrenals
Trichlorobenzene, 1,3,5-	108-70-3	40 Minimum Criteria Systemic Toxicant	NA	NA	400	-None Specified
Trichloroethane, 1,1,1- [or Methyl chloroform]	71-55-6	* Primary Standard	270 Toxicity Criteria	270 Toxicity Criteria	***	-None Specified
Trichloroethane, 1,1,2-	79-00-5	* Primary Standard	16 Human Health	16 Human Health	***	-Carcinogen -Liver
Trichloroethene [or TCE]	79-01-6	* Primary Standard	**	**	***	-Carcinogen -None Specified
Trichlorofluoromethane	75-69-4	2100 Minimum Criteria Systemic Toxicant	NA	NA	21000	-Cardiovascular -Kidney -Respiratory
Trichlorophenol, 2,4,5-	95-95-4	1 Minimum Criteria Organoleptic	23 Toxicity Criteria	23 Toxicity Criteria	10	-Kidney -Liver
Trichlorophenol, 2,4,6-	88-06-2	3.2 Minimum Criteria Carcinogen	**	**	32	-Carcinogen
Trichlorophenoxy acetic acid, 2,4,5-	93-76-5	70 Minimum Criteria Systemic Toxicant	140 Toxicity Criteria	140 Toxicity Criteria	700	-Kidney
Trichlorophenoxy propionic acid, 2, (2, 4, 5-) [or Silvex]	93-72-1	* Primary Standard	NA	NA	***	-Liver
Trichloropropane, 1,1,2-	598-77-6	35 Minimum Criteria Systemic Toxicant	NA	NA	350	-Kidney -Liver -Thyroid
Trichloropropane, 1,2,3-	96-18-4	0.02 Minimum Criteria Carcinogen	0.2 Human Health	0.2 Human Health	0.2	-Carcinogen -Kidney -Liver
Trichloropropene, 1,2,3-	96-19-5	35 Minimum Criteria Systemic Toxicant	NA	NA	350	-Eye
Trifluralin	1582-09-8	4.5 Minimum Criteria Carcinogen	0.2 Human Health	0.2 Human Health	45	-Blood -Carcinogen -Liver

**Table I**  
**Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Trimethyl phosphate	512-56-1	0.9 Minimum Criteria Carcinogen	NA	NA	9	-Carcinogen
Trimethylbenzene, 1,2,3-	526-73-8	10 Minimum Criteria Organoleptic	NA	NA	100	-None Specified
Trimethylbenzene, 1,2,4-	95-63-6	10 Minimum Criteria Organoleptic	220 Toxicity Criteria	220 Toxicity Criteria	100	-None Specified
Trimethylbenzene, 1,3,5-	108-67-8	10 Minimum Criteria Organoleptic	220 Toxicity Criteria	220 Toxicity Criteria	100	-None Specified
Trinitrobenzene, 1,3,5-	99-35-4	210 Minimum Criteria Systemic Toxicant	19 Toxicity Criteria	19 Toxicity Criteria	2100	-Blood -Spleen
Trinitrophenyl(methyl)nitramine	479-45-8	70 Minimum Criteria Systemic Toxicant	NA	NA	700	-Kidney -Liver -Spleen
Trinitrotoluene, 2,4,6-	118-96-7	1.2 Minimum Criteria Carcinogen	49 Toxicity Criteria	49 Toxicity Criteria	12	-Carcinogen -Liver
Trithion [see Carbophenothion]						
TRPH	NOCAS	5000 Minimum Criteria	5000 NA	5000 NA	50000	-Multiple Endpoints Mixed Contaminants
Uranium, soluble salts	7440-61-1	21 Minimum Criteria Systemic Toxicant	NA	NA	210	-Kidney
Vanadium	7440-62-2	49 Minimum Criteria Systemic Toxicant	NA	NA	490	-Hair Loss
Vanadium pentoxide (as Vanadium)	1314-62-1	63 Minimum Criteria Systemic Toxicant	13 Toxicity Criteria	13 Toxicity Criteria	630	-Hair Loss
Vernam	1929-77-7	7 Minimum Criteria Systemic Toxicant	12 Toxicity Criteria	12 Toxicity Criteria	70	-Body Weight
Vinyl acetate	108-05-4	88 Minimum Criteria Organoleptic	700 Toxicity Criteria	700 Toxicity Criteria	880	-Kidney -Nasal

**Table I  
Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	
Vinyl chloride	75-01-4	* Primary Standard	2.4 Human Health	2.4 Human Health	***	-Carcinogen -Liver
White phosphorus	7723-14-0	0.1 Minimum Criteria Systemic Toxicant	NA	**	1	-Maternal Death -Reproductive
Xylenes, total	1330-20-7	* Secondary Standard	370 Toxicity Criteria	370 Toxicity Criteria	***	-Neurological
Zinc	7440-66-6	* Secondary Standard	**	**	***	-Blood
Zinc chloride	7646-85-7	2100 Minimum Criteria Systemic Toxicant	1.5 Toxicity Criteria	1.5 Toxicity Criteria	21000	-Blood
Zinc phosphide	1314-84-7	2.1 Minimum Criteria Systemic Toxicant	NA	NA	21	-Body Weight
Zineb	12122-67-7	350 Minimum Criteria Systemic Toxicant	14 Toxicity Criteria	14 Toxicity Criteria	3500	-Thyroid

**Table I  
Groundwater and Surface Water Cleanup Target Levels**

Contaminants	CAS#s	Groundwater Criteria	Freshwater Surface Water Criteria	Marine Surface Water Criteria	Groundwater of Low Yield/Poor Quality Criteria	Target Organs/Systems or Effects†
		(ug/L)	(ug/L)	(ug/L)	(ug/L)	

† = These default Target Organ(s)/Systems or Effects are those reported to occur at the doses used to derive the reference dose. Non-default Target Organ(s)/Systems or Effects may be justified through a detailed toxicological analysis of the chemicals present at a specific site.

\* = As provided in Chapter 62-520, F.A.C.

\*\* = As provided in Chapter 62-302, F.A.C.

\*\*\* = Equal to 10 times the value provided in Chapter 62-520, F.A.C.

# = Groundwater CTLs for class C carcinogens with no cancer slope factor were developed using the reference dose divided by a factor of 10, as described in the February 2005 'Final Technical Report: Development of Cleanup Target Levels (CTLs) for Chapter 62-777, F.A.C.'

(a) = Freshwater surface water criterion for ammonia based on unionized ammonia only. All other water criteria for ammonia are based on total ammonia.

(b) = The common name BHC is a misnomer for hexachlorocyclohexane.

(c) = Criteria for Dioxins, as total 2,3,7,8-TCDD equivalents should be compared to the total dioxin equivalents for chlorinated dioxin and dibenzofuran congeners using the approach described in the February 2005 'Final Technical Report: Development of Cleanup Target Levels (CTLs) for Chapter 62-777, F.A.C.'

(d) = Surface water values protective of human health for Vinyl chloride calculated assuming continuous lifetime exposure from birth as described in the February 2005 'Final Technical Report: Development of Cleanup Target Levels (CTLs) for Chapter 62-777, F.A.C.'

(e) = Criteria for these metals are measured as total recoverable metal. However, they may be applied as dissolved metals when, as part of a permit application, a dissolved metals translator has been established according to the procedures described in the document, "Guidance for Establishing a Metals Translator", Florida Department of Environmental Protection, December 17, 2001.

(f) = In the absence of concentration data specific for the III and VI valence states of chromium, total chromium concentrations in surface water should be compared to the criteria for Chromium (hexavalent).

(g) = 12789-03-6 or 57-74-9

Toxicity Criteria = 1/20 of applicable LC50 data.

Organoleptic = Pertaining to or perceived by a sensory organ (i.e., color, taste or odor).

NA = Not available at time of Rule adoption.

None Specified = Target organ(s) not available at time of Rule adoption.

Note: Freshwater and marine surface waters, and groundwater at the point of discharge into surface water shall pass acute and chronic toxicity bioassay tests: The user should consult the standard definitions for acute and chronic toxicity given in FAC 62-302.200(1) and FAC 62-302.200(4), respectively.

Note: If more than one contaminant is present at a site, the GCTL values are to be modified, if necessary, such that the sum of the hazard quotients for non-carcinogenic contaminants affecting the same organ(s) is 1 or less. For carcinogens, the GCTL values shall be modified such that the cumulative lifetime risk level posed by the contaminants is 1.0E-06, as presented in Figure 10 of the February 2005 'Final Technical Report: Development of Cleanup Target Levels (CTLs) for Chapter 62-777, F.A.C.' However, GCTLs for primary and secondary standards shall not be modified.

**Table II**  
**Soil Cleanup Target Levels**

Contaminants	CAS#s	Direct Exposure		Leachability Based on Groundwater Criteria (mg/kg)	Leachability Based on Freshwater Surface Water Criteria (mg/kg)	Leachability Based on Marine Surface Water Criteria (mg/kg)	Leachability Based on Groundwater of Low Yield/Poor Quality (mg/kg)	Target Organs/Systems or Effects†
		Residential (mg/kg)	Commercial/Industrial (mg/kg)					
Acenaphthene	83-32-9	2400	20000	2.1	0.3	0.3	21	-Liver
Acenaphthylene	208-96-8	1800	20000	27	NA	NA	270	-Liver
Acephate	30560-19-1	120	720	0.02	0.8	0.8	0.2	-Carcinogen -Neurological
Acetaldehyde	75-07-0	15	20	NA	NA	NA	NA	-Nasal
Acetone	67-64-1	11000	68000	25	6.8	6.8	250	-Kidney -Liver -Neurological
Acetophenone	98-86-2	3900	32000	3.9	44	44	39	-None Specified
Acifluorfen, sodium [or Blazer]	62476-59-9	28	140	0.1	25	25	1	-Kidney
Acrolein	107-02-8	0.05	0.3	0.01	0.002	0.002	0.1	-Nasal
Acrylamide	79-06-1	0.1	0.4	0.00003	0.001	0.001	0.0003	-Carcinogen -Neurological
Acrylic acid	79-10-7	48	250	14	NA	NA	140	-Developmental
Acrylonitrile	107-13-1	0.3	0.6	0.0003	0.001	0.001	0.003	-Carcinogen -Nasal -Reproductive
Alachlor	15972-60-8	11	44	0.02	0.005	0.005	0.2	-Blood -Carcinogen
Aldicarb [or Temik]	116-06-3	68	920	0.03	0.004	0.004	0.3	-Neurological
Aldrin	309-00-2	0.06	0.3	0.2	0.01	0.01	2	-Carcinogen -Liver
Ally [or Metsulfuron, methyl]	74223-64-6	19000	300000	12	NA	NA	120	-Body Weight
Allyl alcohol	107-18-6	140	970	0.1	0.02	0.02	1	-Kidney -Liver
Allyl chloride	107-05-1	0.5	2.7	0.2	NA	NA	2	-Neurological
Aluminum	7429-90-5	80000	*	***	***	***	***	-Body Weight

**Table II**  
**Soil Cleanup Target Levels**

Contaminants	CAS#s	Direct Exposure		Leachability Based on Groundwater Criteria (mg/kg)	Leachability Based on Freshwater Surface Water Criteria (mg/kg)	Leachability Based on Marine Surface Water Criteria (mg/kg)	Leachability Based on Groundwater of Low Yield/Poor Quality (mg/kg)	Target Organs/Systems or Effects†
		Residential (mg/kg)	Commercial/Industrial (mg/kg)					
Aluminum phosphide	20859-73-8	35	880	***	***	***	***	-Body Weight
Ametryn	834-12-8	670	11000	0.8	0.08	0.08	8	-Liver
Ammonia (a)	7664-41-7	35000	880000	***	***	NA	***	-Respiratory
Aniline	62-53-3	27	150	0.03	0.02	0.02	0.3	-Blood -Carcinogen -Spleen
Anthracene	120-12-7	21000	300000	2500	0.4	0.4	25000	-None Specified
Antimony (b)	7440-36-0	27	370	5.4	3900	3900	54	-Blood
Aroclor mixture [see PCBs]								
Arsenic	NOCAS	2.1	12	***	***	***	***	-Carcinogen -Cardiovascular -Skin
Atrazine	1912-24-9	4.3	19	0.06	0.04	0.04	0.6	-Carcinogen -Cardiovascular
Azinphos, methyl [see Guthion]								
Azobenzene	103-33-3	7.9	31	0.03	0.4	0.4	0.3	-Carcinogen
Barium (soluble salts) (b)	7440-39-3	120**	130000	1600	NA	NA	16000	-Cardiovascular
Baygon [or Propoxur]	114-26-1	280	4100	0.2	0.002	0.002	2	-Blood -Neurological
Bayleton	43121-43-3	2400	46000	4.8	11	11	48	-Blood
Benomyl	17804-35-2	4000	77000	3.1	0.03	0.03	31	-Developmental
Bentazon	25057-89-0	2100	32000	1.2	NA	NA	12	-Blood
Benzaldehyde	100-52-7	3300	24000	4.8	0.4	0.4	48	-Gastrointestinal -Kidney
Benzene	71-43-2	1.2	1.7	0.007	0.5	0.5	0.07	-Blood -Carcinogen

**Table II**  
**Soil Cleanup Target Levels**

Contaminants	CAS#s	Direct Exposure		Leachability Based on Groundwater Criteria (mg/kg)	Leachability Based on Freshwater Surface Water Criteria (mg/kg)	Leachability Based on Marine Surface Water Criteria (mg/kg)	Leachability Based on Groundwater of Low Yield/Poor Quality (mg/kg)	Target Organs/Systems or Effects†
		Residential (mg/kg)	Commercial/Industrial (mg/kg)					
Benzenethiol	108-98-5	0.2	1.3	0.001	NA	NA	0.01	-Liver
Benzidine	92-87-5	0.004	0.02	0.00002	0.00002	0.00002	0.0002	-Carcinogen -Liver -Neurological
Benzo(a)anthracene	56-55-3	#	#	0.8	NA	NA	8	-Carcinogen
Benzo(a)pyrene	50-32-8	0.1	0.7	8	NA	NA	80	-Carcinogen
Benzo(b)fluoranthene	205-99-2	#	#	2.4	NA	NA	24	-Carcinogen
Benzo(g,h,i)perylene	191-24-2	2500	52000	32000	NA	NA	320000	-Neurological
Benzo(k)fluoranthene	207-08-9	#	#	24	NA	NA	240	-Carcinogen
Benzoic acid	65-85-0	180000	*	110	36	36	1100	-None Specified
Benzotrifluoride	98-07-7	0.04	0.09	0.0001	0.00008	0.00008	0.001	-Carcinogen
Benzyl alcohol	100-51-6	26000	670000	9.5	2.3	2.3	95	-Gastrointestinal
Benzyl chloride	100-44-7	1	1.6	0.002	0.02	0.02	0.02	-Carcinogen
Beryllium (b)	7440-41-7	120	1400	63	2.1	2.1	630	-Carcinogen -Gastrointestinal -Respiratory
Betanal [see Phenmedipham]								
BHC, alpha- [see Hexachlorocyclohexane, alpha-] (f)								
BHC, beta- [see Hexachlorocyclohexane, beta-] (f)								
BHC, delta- [see Hexachlorocyclohexane, delta-] (f)								
BHC, gamma- [see Hexachlorocyclohexane, gamma-] (f)								
Bidrin [or Dicrotophos]	141-66-2	7.4	120	0.005	0.1	0.1	0.05	-Developmental

**Table II**  
**Soil Cleanup Target Levels**

Contaminants	CAS#s	Direct Exposure		Leachability Based on Groundwater Criteria (mg/kg)	Leachability Based on Freshwater Surface Water Criteria (mg/kg)	Leachability Based on Marine Surface Water Criteria (mg/kg)	Leachability Based on Groundwater of Low Yield/Poor Quality (mg/kg)	Target Organs/Systems or Effects†
		Residential (mg/kg)	Commercial/Industrial (mg/kg)					
Biphenyl, 1,1- [or Diphenyl]	92-52-4	3000	34000	0.2	5.8	5.8	2	-Kidney
Bis(2-chloro-1-methylethyl)ether [see Bis(2-chloroisopropyl)ether]								
Bis(2-chloroethoxy)methane	111-91-1	250	5700	63	NA	NA	630	-Liver
Bis(2-chloroethyl)ether	111-44-4	0.3	0.5	0.0001	0.002	0.002	0.001	-Carcinogen
Bis(2-chloroisopropyl)ether [or Bis(2-chloro-1-methylethyl)ether]	39638-32-9	6	12	0.009	0.4	0.4	0.09	-Blood -Carcinogen
Bis(2-ethylhexyl)adipate	103-23-1	620	1900	780	64	64	7800	-Body Weight -Carcinogen
Bis(2-ethylhexyl)phthalate [or DEHP]	117-81-7	72	390	3600	1300	1300	36000	-Carcinogen -Liver
Bisphenol A	80-05-7	4000	79000	11	1.7	1.7	110	-Body Weight
Blazer [see Acifluorfen, sodium]								
Boron	7440-42-8	17000	430000	***	NA	NA	***	-Reproductive -Respiratory
Bravo [see Chlorothalonil]								
Bromacil	314-40-9	7500	120000	0.5	0.6	0.6	5	-Body Weight
Bromate	15541-45-4	1	2.8	0.0002	NA	460	0.002	-Carcinogen -Kidney
Bromochloromethane	74-97-5	95	530	0.6	NA	NA	6	-None Specified
Bromodichloromethane	75-27-4	1.5	2.2	0.004	0.1	0.1	0.04	-Carcinogen -Kidney
Bromoform	75-25-2	48	93	0.03	2.7	2.7	0.3	-Carcinogen -Liver
Bromomethane [or Methyl bromide]	74-83-9	3.1	16	0.05	0.2	0.2	0.5	-Gastrointestinal -Respiratory
Bromoxynil	1689-84-5	1600	29000	3	NA	NA	30	-None Specified

**Table II**  
**Soil Cleanup Target Levels**

Contaminants	CAS#s	Direct Exposure		Leachability Based on Groundwater Criteria (mg/kg)	Leachability Based on Freshwater Surface Water Criteria (mg/kg)	Leachability Based on Marine Surface Water Criteria (mg/kg)	Leachability Based on Groundwater of Low Yield/Poor Quality (mg/kg)	Target Organs/Systems or Effects†
		Residential (mg/kg)	Commercial/Industrial (mg/kg)					
Butanol, n-	71-36-3	2900	21000	3	110	110	30	-Neurological
Butanol, tert- [see Butyl alcohol, tert-]								
Butanone, 2- [see Methyl ethyl ketone]								
Butyl alcohol, tert- [or Butanol, tert-]	75-65-0	3200	19000	5.7	NA	NA	57	-Kidney -Neurological
Butyl benzyl phthalate	85-68-7	17000	380000	310	56	56	3100	-Liver
Butylate	2008-41-5	3200	40000	5.2	0.2	0.2	52	-Liver
Butylphthalyl butylglycolate	85-70-1	84000	*	4200	NA	NA	42000	-None Specified
Cadmium (b,c,h)	7440-43-9	82	1700	7.5	NA	14	75	-Carcinogen -Kidney
Calcium cyanide	592-01-8	3500	88000	***	NA	NA	***	-Neurological -Thyroid
Captafol	2425-06-1	110	570	0.5	0.1	0.1	5	-Carcinogen -Kidney
Captan	133-06-2	230	750	0.1	0.03	0.03	1	-Body Weight -Carcinogen
Carbaryl [or Sevin]	63-25-2	7700	130000	8.7	0.0007	0.0007	87	-Kidney -Liver
Carbazole	86-74-8	49	240	0.2	6.5	6.5	2	-Carcinogen
Carbofuran	1563-66-2	130	910	0.2	0.0006	0.0006	2	-Neurological -Reproductive
Carbon disulfide	75-15-0	270	1500	5.6	0.8	0.8	56	-Developmental -Neurological
Carbon tetrachloride	56-23-5	0.5	0.7	0.04	0.06	0.06	0.4	-Carcinogen -Liver
Carbophenothion [or Trithion]	786-19-6	11	250	13	1.5	1.5	130	-Neurological
Carboxin	5234-68-4	7400	120000	5	0.4	0.4	50	-Body Weight

**Table II**  
**Soil Cleanup Target Levels**

Contaminants	CAS#s	Direct Exposure		Leachability Based on Groundwater Criteria (mg/kg)	Leachability Based on Freshwater Surface Water Criteria (mg/kg)	Leachability Based on Marine Surface Water Criteria (mg/kg)	Leachability Based on Groundwater of Low Yield/Poor Quality (mg/kg)	Target Organs/Systems or Effects†
		Residential (mg/kg)	Commercial/Industrial (mg/kg)					
CFC 113 [see Trichloro-1,1,2,2-trifluoroethane, 1,1,2-]								-Adrenals
Chloral hydrate	302-17-0	5700	62000	0.3	NA	NA	3	-Gastrointestinal -Neurological
Chloramben	133-90-4	960	12000	0.5	NA	NA	5	-Liver
Chlordane (total)	(j)	2.8	14	9.6	0.003	0.003	96	-Carcinogen -Liver
Chlorine cyanide [or Cyanogen chloride]	506-77-4	3100	37000	71	0.3	0.3	710	-Neurological -Thyroid
Chloro-1,1-difluoroethane, 1-	75-68-3	16000	84000	NA	NA	NA	NA	-None Specified
Chloro-1,3-butadiene [or Chloroprene]	126-99-8	3.5	19	1.5	NA	NA	15	-Hair Loss -Nasal
Chloro-3-methylphenol, 4- [see Chloro-m-cresol, p-]								
Chloroacetic acid	79-11-8	130	1700	0.07	13	13	0.7	-Cardiovascular
Chloroaniiline, p-	106-47-8	270	3700	0.2	0.02	0.02	2	-Spleen
Chlorobenzene	108-90-7	120	650	1.3	0.2	0.2	13	-Liver
Chlorobenzilate	510-15-6	3.6	18	0.1	0.01	0.01	1	-Body Weight -Carcinogen
Chlorobenzoic acid, p-	74-11-3	16000	290000	28	NA	NA	280	-None Specified
Chlorobenzotrifluoride, 4-	98-56-6	130	710	5.2	NA	NA	52	-Kidney
Chlorobutane, 1-	109-69-3	780	4200	26	NA	NA	260	-Blood -Neurological
Chlorodifluoromethane	75-45-6	16000	82000	NA	NA	NA	NA	-Adrenals -Kidney -Pituitary
Chloroethane [see Ethyl chloride]								
Chloroform	67-66-3	0.4	0.6	0.4	2.8	2.8	4	-Carcinogen -Liver

**Table II**  
**Soil Cleanup Target Levels**

Contaminants	CAS#s	Direct Exposure		Leachability Based on Groundwater Criteria (mg/kg)	Leachability Based on Freshwater Surface Water Criteria (mg/kg)	Leachability Based on Marine Surface Water Criteria (mg/kg)	Leachability Based on Groundwater of Low Yield/Poor Quality (mg/kg)	Target Organs/Systems or Effects†
		Residential (mg/kg)	Commercial/Industrial (mg/kg)					
Chloro-m-cresol, p- [or Chloro-3-methylphenol, 4-]	59-50-7	600	8000	0.4	0.6	0.6	4	-Body Weight
Chloromethane [see Methyl chloride]								
Chloronaphthalene, beta-	91-58-7	5000	61000	260	740	740	2600	-Liver -Respiratory
Chloronitrobenzene, o-	88-73-3	22	51	0.02	NA	NA	0.2	-Carcinogen
Chloronitrobenzene, p-	100-00-5	31	73	0.03	1.6	1.6	0.3	-Carcinogen
Chlorophenol, 2-	95-57-8	130	860	0.7	2.5	2.5	7	-Reproductive
Chlorophenol, 3-	108-43-0	370	5900	0.002	3.1	3.1	0.02	-Reproductive
Chlorophenol, 4-	106-48-9	330	4400	0.0007	1.2	1.2	0.007	-Reproductive
Chloroprene [see Chloro-1,3-butadiene]								
Chloropropane, 2-	75-29-6	47	250	NA	NA	NA	NA	-Liver
Chloroethanol [or Bravo]	1897-45-6	88	420	0.2	0.06	0.06	2	-Carcinogen -Kidney
Chlorotoluene, o-	95-49-8	200	1200	2.8	7.7	7.7	28	-Body Weight
Chlorotoluene, p-	106-43-4	170	990	2.5	NA	NA	25	-None Specified
Chloropropham	101-21-3	16000	310000	51	7	7	510	-Bone Marrow -Kidney -Liver -Spleen
Chloropyrifos	2921-88-2	250	5000	15	0.001	0.001	150	-Neurological
Chromium (hexavalent)	18540-29-9	210	470	NA	4.2	19	NA	-Carcinogen -Respiratory
Chromium (total)	NOCAS	210	470	38	4.2	19	380	-Carcinogen
Chromium (trivalent)	16065-83-1	110000	*	NA	NA	*	NA	-None Specified

**Table II**  
**Soil Cleanup Target Levels**

Contaminants	CAS#s	Direct Exposure		Leachability Based on Groundwater Criteria (mg/kg)	Leachability Based on Freshwater Surface Water Criteria (mg/kg)	Leachability Based on Marine Surface Water Criteria (mg/kg)	Leachability Based on Groundwater of Low Yield/Poor Quality (mg/kg)	Target Organs/Systems or Effects†
		Residential (mg/kg)	Commercial/Industrial (mg/kg)					
Chrysene	218-01-9	#	#	77	NA	NA	770	-Carcinogen
Cobalt	7440-48-4	1700	42000	***	NA	NA	***	-Cardiovascular -Immunological - Neurological -Reproductive
Copper	7440-50-8	150**	89000	***	NA	***	***	-Gastrointestinal
Coumaphos	56-72-4	21	450	0.3	0.0007	0.0007	3	-Neurological
Cresol, m- [see Methylphenol, 3-]								
Cresol, o- [see Methylphenol, 2-]								
Cresol, p- [see Methylphenol, 4-]								
Crotonaldehyde	123-73-9	0.6	3.3	0.00008	NA	NA	0.0008	-Carcinogen
Cumene [or Isopropyl benzene]	98-82-8	220	1200	0.2	56	56	2	-Adrenals -Kidney
Cyanide, free (b)	57-12-5	34**	11000	0.8	0.02	0.004	8	-Neurological -Thyroid
Cyanogen	460-19-5	560	3400	57	NA	NA	570	-Neurological -Thyroid
Cyanogen chloride [see Chlorine cyanide]								
Cycloate	1134-23-2	340	4700	0.7	2.5	2.5	7	-Neurological
Cyclohexanone	108-94-1	150000	*	150	110	110	1500	
Cyclohexylamine	108-91-8	18000	440000	7.9	22	22	79	-Reproductive
Cyhalothrin [or Karate]	68085-85-8	420	9600	290	150	150	2900	-Developmental
Cymene, p-	99-87-6	960	5600	NA	NA	NA	NA	-Gastrointestinal -Skin
Cypermethrin	52315-07-8	840	19000	30	0.002	0.002	300	-Gastrointestinal

**Table II**  
**Soil Cleanup Target Levels**

Contaminants	CAS#s	Direct Exposure		Leachability Based on Groundwater Criteria (mg/kg)	Leachability Based on Freshwater Surface Water Criteria (mg/kg)	Leachability Based on Marine Surface Water Criteria (mg/kg)	Leachability Based on Groundwater of Low Yield/Poor Quality (mg/kg)	Target Organs/Systems or Effects†
		Residential (mg/kg)	Commercial/Industrial (mg/kg)					
DBCP, 1,2- [see Dibromo-3-chloropropane, 1,2-]								
DDD, 4,4'- [see Dichlorodiphenyldichloroethane, p,p']								
DDE, 4,4'- [see Dichlorodiphenyldichloroethylene, p,p']								
DDT, 4,4'- [see Dichlorodiphenyltrichloroethane, p,p']								
Decabromodiphenyl ether	1163-19-5	840	19000	9.3	NA	NA	93	-None Specified
DEHP [see Bis(2-ethylhexyl)phthalate]								
Diallate	2303-16-4	16	82	0.6	NA	NA	6	-Carcinogen -None Specified
Diazinon	333-41-5	70	1200	0.2	0.00005	0.00005	2	-Neurological
Dibenz(a,h)anthracene	53-70-3	#	#	0.7	NA	NA	7	-Carcinogen
Dibenzofuran	132-64-9	320	6300	15	36	36	150	-None Specified
Dibromo-3-chloropropane, 1,2- [or DBCP, 1,2-]	96-12-8	0.7	3.8	0.001	NA	NA	0.01	-Carcinogen -Reproductive
Dibromobenzene, 1,4-	106-37-6	430	3600	7.8	27	27	78	-Liver
Dibromochloromethane	124-48-1	1.5	2.3	0.003	0.2	0.2	0.03	-Carcinogen -Liver
Dibromoethane, 1,2- [or EDB]	106-93-4	0.1	0.2	0.0001	0.07	0.07	0.001	-Carcinogen -Reproductive
Dibutyl phthalate	84-74-2	8200	170000	47	1.5	1.5	470	-Mortality
Dicamba	1918-00-9	2300	40000	2.6	2.4	2.4	26	-Developmental
Dichloroacetic acid	79-43-6	21	120	0.005	8.1	8.1	0.05	-Carcinogen -Liver -Neurological -Reproductive
Dichloroacetonitrile	3018-12-0	340	2900	0.03	NA	NA	0.3	-None Specified

**Table II**  
**Soil Cleanup Target Levels**

Contaminants	CAS#s	Direct Exposure		Leachability Based on Groundwater Criteria (mg/kg)	Leachability Based on Freshwater Surface Water Criteria (mg/kg)	Leachability Based on Marine Surface Water Criteria (mg/kg)	Leachability Based on Groundwater of Low Yield/Poor Quality (mg/kg)	Target Organs/Systems or Effects†
		Residential (mg/kg)	Commercial/Industrial (mg/kg)					
Dichlorobenzene, 1,2-	95-50-1	880	5000	17	2.8	2.8	170	-Body Weight
Dichlorobenzene, 1,3-	541-73-1	380	2200	7	2.8	2.8	70	-None Specified
Dichlorobenzene, 1,4-	106-46-7	6.4	9.9	2.2	0.09	0.09	22	-Carcinogen -Liver
Dichlorobenzidine, 3,3'-	91-94-1	2.1	9.9	0.003	0.0009	0.0009	0.03	-Carcinogen
Dichlorobenzophenone, 4,4'-	90-98-2	2500	51000	25	190	190	250	-None Specified
Dichlorodifluoromethane	75-71-8	77	410	44	NA	NA	440	-Liver
Dichlorodiphenyldichloroethane, p,p'- [or DDD, 4,4']	72-54-8	4.2	22	5.8	0.01	0.01	58	-Carcinogen
Dichlorodiphenyldichloroethylene, p,p'- [or DDE, 4,4']	72-55-9	2.9	15	18	0.04	0.04	180	-Carcinogen
Dichlorodiphenyltrichloroethane, p,p'- [or DDT, 4,4']	50-29-3	2.9	15	11	0.06	0.06	110	-Carcinogen -Liver
Dichloroethane, 1,1-	75-34-3	390	2100	0.4	NA	NA	4	-Kidney
Dichloroethane, 1,2- [or EDC]	107-06-2	0.5	0.7	0.01	0.2	0.2	0.1	-Carcinogen -None Specified
Dichloroethene, 1,1-	75-35-4	95	510	0.06	0.03	0.03	0.6	-Liver
Dichloroethene, cis-1,2-	156-59-2	33	180	0.4	NA	NA	4	-Blood
Dichloroethene, trans-1,2-	156-60-5	53	290	0.7	75	75	7	-Blood -Liver
Dichlorophenol, 2,3-	576-24-9	230	4100	0.0008	1.2	1.2	0.008	-Immunological
Dichlorophenol, 2,4-	120-83-2	190	2400	0.003	0.1	0.1	0.03	-Immunological
Dichlorophenol, 2,5-	583-78-8	240	4600	0.02	4.3	4.3	0.2	-Immunological
Dichlorophenol, 2,6-	87-65-0	220	3600	0.007	2.5	2.5	0.07	-Immunological

**Table II**  
**Soil Cleanup Target Levels**

Contaminants	CAS#s	Direct Exposure		Leachability Based on Groundwater Criteria (mg/kg)	Leachability Based on Freshwater Surface Water Criteria (mg/kg)	Leachability Based on Marine Surface Water Criteria (mg/kg)	Leachability Based on Groundwater of Low Yield/Poor Quality (mg/kg)	Target Organs/Systems or Effects†
		Residential (mg/kg)	Commercial/Industrial (mg/kg)					
Dichlorophenol, 3,4-	95-77-2	230	3700	0.01	2	2	0.1	-Immunological
Dichlorophenoxy acetic acid, 2,4-	94-75-7	770	13000	0.7	0.9	0.9	7	-Blood -Kidney -Liver
Dichloropropane, 1,2-	78-87-5	0.6	0.9	0.03	0.09	0.09	0.3	-Carcinogen -Nasal
Dichloropropene, 1,3-	542-75-6	1.4	2.2	0.002	0.09	0.09	0.02	-Carcinogen -Gastrointestinal -Nasal
Dichloroprop	120-36-5	370	5800	0.3	0.3	0.3	3	-None Specified
Dichlorvos	62-73-7	0.3	0.4	0.0006	0.00002	0.00002	0.006	-Carcinogen -Neurological
Dicofol [or Kelthane]	115-32-2	2.2	11	0.01	0.0008	0.0008	0.1	-Adrenals -Carcinogen
Dicrotophos [see Bidrin]								
Dieldrin	60-57-1	0.06	0.3	0.002	0.0001	0.0001	0.02	-Carcinogen -Liver
Diethyl phthalate	84-66-2	61000	*	86	5.9	5.9	860	-Body Weight
Diethylene glycol, monoethyl ether	111-90-0	130000	*	63	750	750	630	-Kidney
Diisopropyl methylphosphonate	1445-75-6	4500	49000	3.6	85	85	36	-None Specified
Dimethoate	60-51-5	13	170	0.006	0.0004	0.0004	0.06	-Neurological
Dimethoxybenzidine, 3,3'-	119-90-4	69	330	0.2	NA	NA	2	-Carcinogen
Dimethrin	70-38-2	24000	440000	2500	1.3	1.3	25000	-Liver
Dimethylaniline, 2,4-	95-68-1	0.5	1	0.0005	19	19	0.005	-Blood -Carcinogen -Spleen
Dimethylaniline, N,N-	121-69-7	55	380	0.1	12	12	1	-Spleen
Dimethylbenzidine, 3,3'-	119-93-7	0.1	0.6	0.001	NA	NA	0.01	-Carcinogen

**Table II**  
**Soil Cleanup Target Levels**

Contaminants	CAS#s	Direct Exposure		Leachability Based on Groundwater Criteria (mg/kg)	Leachability Based on Freshwater Surface Water Criteria (mg/kg)	Leachability Based on Marine Surface Water Criteria (mg/kg)	Leachability Based on Groundwater of Low Yield/Poor Quality (mg/kg)	Target Organs/Systems or Effects†
		Residential (mg/kg)	Commercial/Industrial (mg/kg)					
Dimethylformamide, N,N-	68-12-2	1400	8600	3	210	210	30	-Gastrointestinal -Liver
Dimethylphenol, 2,4-	105-67-9	1300	18000	1.7	1.9	1.9	17	-Blood -Neurological
Dimethylphenol, 2,6-	576-26-1	34	370	0.04	5.2	5.2	0.4	-Kidney -Liver -Spleen
Dimethylphenol, 3,4-	95-65-8	71	1000	0.06	3.4	3.4	0.6	-Kidney -Liver -Spleen
Dimethylphthalate	131-11-3	690000	*	380	7.8	7.8	3800	-Kidney
Dinitrobenzene, 1,2- (o)	528-29-0	23	240	0.01	0.2	0.2	0.1	-Spleen
Dinitrobenzene, 1,3- (m)	99-65-0	5.8	64	0.004	0.4	0.4	0.04	-Spleen
Dinitrobenzene, 1,4- (p)	100-25-4	35	890	0.04	0.4	0.4	0.4	-Spleen
Dinitro-o-cresol, 4,6-	534-52-1	8.4	180	0.4	NA	NA	4	-Metabolic Disorders
Dinitrophenol, 2,4-	51-28-5	110	1200	0.06	0.01	0.01	0.6	-Eye
Dinitrotoluene, 2,4-	121-14-2	1.2	4.3	0.0004	0.07	0.07	0.004	-Carcinogen -Liver -Neurological
Dinitrotoluene, 2,6-	606-20-2	1.2	3.8	0.0004	0.005	0.005	0.004	-Blood -Carcinogen -Kidney -Neurological
Di-n-octylphthalate	117-84-0	1700	39000	480000	NA	NA	4800000	-Kidney -Liver
Dinoseb	88-85-7	65	840	0.03	0.03	0.03	0.3	-Developmental
Dioxane, 1,4-	123-91-1	23	38	0.01	0.5	0.5	0.1	-Carcinogen
Dioxins, as total 2,3,7,8-TCDD equivalents (e)	1746-01-6	0.000007	0.00003	0.003	0.0000006	0.0000006	0.03	-Carcinogen
Diphenamid	957-51-7	2300	41000	2.6	20	20	26	-Liver
Diphenyl [see Biphenyl, 1,1-]								

**Table II**  
**Soil Cleanup Target Levels**

Contaminants	CAS#s	Direct Exposure		Leachability Based on Groundwater Criteria (mg/kg)	Leachability Based on Freshwater Surface Water Criteria (mg/kg)	Leachability Based on Marine Surface Water Criteria (mg/kg)	Leachability Based on Groundwater of Low Yield/Poor Quality (mg/kg)	Target Organs/Systems or Effects†
		Residential (mg/kg)	Commercial/Industrial (mg/kg)					
Diphenylamine, N,N-	122-39-4	2000	40000	14	NA	NA	140	-Kidney -Liver
Diphenylhydrazine, 1,2-	122-66-7	1.1	4.8	0.002	0.007	0.007	0.02	-Carcinogen
Diquat	85-00-7	190	4300	800	60	60	8000	-Eye
Disulfoton	298-04-4	3.3	66	0.09	0.1	0.1	0.9	-Neurological
Diuron	330-54-1	150	2300	0.3	0.2	0.2	3	-Blood
EDB [see Dibromoethane, 1,2-]								
EDC [see Dichloroethane, 1,2-]								
Endosulfan (alpha+beta+sulfate)	115-29-7	450	7600	3.8	0.005	0.0008	38	-Cardiovascular -Kidney
Endothall	145-73-3	1800	44000	0.4	0.4	0.4	4	-Gastrointestinal
Endrin	72-20-8	25	510	1	0.001	0.001	10	-Liver
EPEG [see Ethylphthalyl ethylglycolate]								
Epichlorohydrin	106-89-8	14	80	0.03	1.1	1.1	0.3	-Carcinogen -Kidney -Nasal
EPN [see Ethyl p-nitrophenyl phenylphosphorothioate]								
EPTC [see Ethyl dipropylthiocarbamate, S-]								
Ethanol	64-17-5	*	*	40	NA	NA	400	-Developmental
Ethion	563-12-2	42	920	1.7	0.003	0.003	17	-Neurological
Ethoprop	13194-48-4	7.4	120	0.005	0.002	0.002	0.05	-Neurological
Ethoxyethanol acetate, 2-	111-15-9	14000	130000	8.8	8.4	8.4	88	-Developmental

**Table II**  
**Soil Cleanup Target Levels**

Contaminants	CAS#s	Direct Exposure		Leachability Based on Groundwater Criteria (mg/kg)	Leachability Based on Freshwater Surface Water Criteria (mg/kg)	Leachability Based on Marine Surface Water Criteria (mg/kg)	Leachability Based on Groundwater of Low Yield/Poor Quality (mg/kg)	Target Organs/Systems or Effects†
		Residential (mg/kg)	Commercial/Industrial (mg/kg)					
Ethoxyethanol, 2-	110-80-5	10000	72000	13	NA	NA	130	-Reproductive
Ethyl acetate	141-78-6	9100	53000	26	26	26	260	-Body Weight
Ethyl acrylate	140-88-5	2	3	0.002	0.6	0.6	0.02	-Carcinogen
Ethyl chloride [or Chloroethane]	75-00-3	3.9	5.4	0.06	NA	NA	0.6	-Carcinogen -Developmental
Ethyl dipropylthiocarbamate, S- [or EPTC]	759-94-4	1400	14000	11	15	15	110	-Cardiovascular
Ethyl ether	60-29-7	260	1400	5	850	850	50	-Body Weight
Ethyl methacrylate	97-63-2	630	3500	3.5	NA	NA	35	-Kidney
Ethyl p-nitrophenyl phenylphosphorothioate [or EPN]	2104-64-5	0.8	18	0.02	0.003	0.003	0.2	-Neurological
Ethylbenzene	100-41-4	1500	9200	0.6	12	12	6	-Developmental -Kidney -Liver
Ethylene diamine	107-15-3	1100	11000	0.6	3.2	3.2	6	-Blood -Cardiovascular
Ethylene glycol	107-21-1	110000	*	56	65	65	560	-Kidney
Ethylene oxide	75-21-8	0.3	0.4	0.0002	20	20	0.002	-Carcinogen
Ethylene thiourea [or ETU]	96-45-7	7	57	0.001	5.6	5.6	0.01	-Carcinogen -Thyroid
Ethylphthalyl ethylglycolate [or EPEG]	84-72-0	260000	*	1200	NA	NA	12000	-Kidney
ETU [see Ethylene thiourea]								
Fenamiphos	22224-92-6	19	340	0.02	0.003	0.003	0.2	-Neurological
Fensulfthion	115-90-2	19	310	0.01	0.004	0.004	0.1	-Neurological
Fenvalerate [see Pydrin]								

**Table II**  
**Soil Cleanup Target Levels**

Contaminants	CAS#s	Direct Exposure		Leachability Based on Groundwater Criteria (mg/kg)	Leachability Based on Freshwater Surface Water Criteria (mg/kg)	Leachability Based on Marine Surface Water Criteria (mg/kg)	Leachability Based on Groundwater of Low Yield/Poor Quality (mg/kg)	Target Organs/Systems or Effects†
		Residential (mg/kg)	Commercial/Industrial (mg/kg)					
Fluometuron	2164-17-2	980	16000	0.9	1.8	1.8	9	-None Specified
Fluoranthene	206-44-0	3200	59000	1200	1.3	1.3	12000	-Blood -Kidney -Liver
Fluorene	86-73-7	2600	33000	160	17	17	1600	-Blood
Fluoride	7782-41-4	840**	130000	6000	30000	15000	60000	-Teeth mottling
Fluoridone	59756-60-4	7000	180000	2500	460	460	25000	-Kidney -Reproductive
Fonofos	944-22-9	140	2100	0.4	0.003	0.003	4	-Liver -Neurological
Formaldehyde	50-00-0	23	31	2.4	0.4	0.4	24	-Carcinogen -Gastrointestinal
Furan	110-00-9	4.8	26	0.09	NA	NA	0.9	-Liver
Furfural	98-01-1	190	2400	0.09	2.7	2.7	0.9	-Liver -Nasal
Glycidaldehyde	765-34-4	15	120	0.01	NA	NA	0.1	-Adrenals -Blood -Kidney
Glyphosate [or Roundup]	1071-83-6	8800	220000	3.3	0.5	0.5	33	-Kidney
Guthion [or Methyl azinphos]	86-50-0	120	2400	0.2	0.0002	0.0002	2	-Neurological
Heptachlor	76-44-8	0.2	1	23	0.01	0.01	230	-Carcinogen -Liver
Heptachlor epoxide	1024-57-3	0.1	0.5	0.6	0.0001	0.0001	6	-Carcinogen -Liver
Hexachloro-1,3-butadiene	87-68-3	6.2	13	1	110	110	10	-Carcinogen -Kidney
Hexachlorobenzene	118-74-1	0.4	1.2	2.2	0.0006	0.0006	22	-Carcinogen -Liver
Hexachlorocyclohexane, alpha- [or BHC, alpha-]	319-84-6	0.1	0.6	0.0003	0.0003	0.0003	0.003	-Carcinogen
Hexachlorocyclohexane, beta- [BHC, beta-]	319-85-7	0.5	2.4	0.001	0.003	0.003	0.01	-Carcinogen

**Table II**  
**Soil Cleanup Target Levels**

Contaminants	CAS#s	Direct Exposure		Leachability Based on Groundwater Criteria (mg/kg)	Leachability Based on Freshwater Surface Water Criteria (mg/kg)	Leachability Based on Marine Surface Water Criteria (mg/kg)	Leachability Based on Groundwater of Low Yield/Poor Quality (mg/kg)	Target Organs/Systems or Effects†
		Residential (mg/kg)	Commercial/Industrial (mg/kg)					
Hexachlorocyclohexane, delta- [or BHC, delta-]	319-86-8	24	490	0.2	NA	NA	2	-Kidney -Liver
Hexachlorocyclohexane, gamma- [or Lindane or BHC, gamma-]	58-89-9	0.7	2.5	0.009	0.003	0.003	0.09	-Carcinogen -Kidney -Liver
Hexachlorocyclopentadiene	77-47-4	9.5	50	400	24	24	4000	-Gastrointestinal
Hexachloroethane	67-72-1	38	87	0.2	0.2	0.2	2	-Carcinogen -Kidney
Hexachlorophene	70-30-4	26	670	53	26	26	530	-Neurological
Hexahydro-1,3,5-trinitro-1,3,5-triazine [or RDX]	121-82-4	7.7	28	0.002	1.3	1.3	0.02	-Carcinogen -Reproductive
Hexane, n-	110-54-3	680	3900	2.1	1200	1200	21	-Neurological
Hexanone, 2- [or Methyl butyl ketone]	591-78-6	24	130	1.4	NA	NA	14	-None Specified
Hexazinone	51235-04-2	2300	32000	1.1	120	120	11	-Body Weight
Hydroquinone	123-31-9	2600	35000	1.4	0.02	0.02	14	-Blood
Indeno(1,2,3-cd)pyrene	193-39-5	#	#	6.6	NA	NA	66	-Carcinogen
Iron	7439-89-6	53000	*	***	***	***	***	-Gastrointestinal
Isobutyl alcohol	78-83-1	6400	42000	8.9	200	200	89	-Neurological
Isophorone	78-59-1	540	1200	0.2	3.8	3.8	2	-Carcinogen -None Specified
Isopropyl benzene [see Cumene]								
Karate [see Cyhalothrin, lambda]								
Kelthane [see Dicofo]								
Lead	7439-92-1	400	1400	***	NA	***	***	-Neurological

**Table II**  
**Soil Cleanup Target Levels**

Contaminants	CAS#s	Direct Exposure		Leachability Based on Groundwater Criteria (mg/kg)	Leachability Based on Freshwater Surface Water Criteria (mg/kg)	Leachability Based on Marine Surface Water Criteria (mg/kg)	Leachability Based on Groundwater of Low Yield/Poor Quality (mg/kg)	Target Organs/Systems or Effects†
		Residential (mg/kg)	Commercial/Industrial (mg/kg)					
Limonene	138-86-3	640	3600	42	NA	NA	420	-Kidney -Liver
Lindane [see Hexachlorocyclohexane, gamma-]								
Linuron	330-55-2	160	3100	0.04	1.4	1.4	0.4	-Blood
Lithium	7439-93-2	1700	44000	***	NA	NA	***	-None Specified
Malathion	121-75-5	1500	24000	4.2	0.003	0.003	42	-Neurological
Maleic anhydride	108-31-6	3200	24000	2.8	NA	NA	28	-Kidney
Maleic hydrazide	123-33-1	1000	5400	16	3.4	3.4	160	-Kidney
Malonitrile	109-77-3	1.2	13	0.0006	NA	NA	0.0006	-Liver -Spleen
Maneb	12427-38-2	410	8400	2.9	0.5	0.5	29	-Thyroid
Manganese	7439-96-5	3500	43000	***	NA	NA	***	-Neurological
MCPA [see Methyl-4-chlorophenoxy acetic acid, 2- ]								
MCPP [see Propionic acid, 2-(2-methyl-4-chlorophenoxy)]								
Mercury (c)	7439-97-6	3	17	2.1	0.01	0.03	21	-Neurological
Mercury, methyl- [see Methylmercury]								
Merphos	150-50-5	2.5	52	0.5	NA	NA	5	-Neurological
Merphos oxide	78-48-8	2.5	56	0.3	0.3	0.3	3	-Neurological
Methacrylonitrile	126-98-7	1	5.9	0.003	NA	NA	0.03	-Liver
Methamidophos	10265-92-6	3.1	36	0.001	0	0	0.01	-Neurological

**Table II**  
**Soil Cleanup Target Levels**

Contaminants	CAS#s	Direct Exposure		Leachability Based on Groundwater Criteria (mg/kg)	Leachability Based on Freshwater Surface Water Criteria (mg/kg)	Leachability Based on Marine Surface Water Criteria (mg/kg)	Leachability Based on Groundwater of Low Yield/Poor Quality (mg/kg)	Target Organs/Systems or Effects†
		Residential (mg/kg)	Commercial/Industrial (mg/kg)					
Methanol	67-56-1	13000	90000	14	180	180	140	-Developmental -Eye -Neurological
Methidathion	950-37-8	68	950	0.003	0.0001	0.0001	0.03	-Liver
Methomyl	16752-77-5	38	200	1.2	0.007	0.007	12	-Kidney -Spleen
Methoxy-5-nitroaniline, 2-	99-59-2	19	71	0.006	NA	NA	0.06	-Carcinogen
Methoxychlor	72-43-5	420	8800	160	0.1	0.1	1600	-Developmental -Reproductive
Methyl acetate	79-20-9	6800	38000	16	NA	NA	160	-Liver
Methyl acrylate	96-33-3	260	1500	0.9	NA	NA	9	-None Specified
Methyl azinphos [see Guthion]								
Methyl bromide [see Bromomethane]								
Methyl butyl ketone [see Hexanone, 2-]								
Methyl chloride [or Chloromethane]	74-87-3	4	5.7	0.01	2.3	2.3	0.1	-Carcinogen -Neurological
Methyl chloroform [see Trichloroethane, 1,1,1-]								
Methyl ethyl ketone [or Butanone, 2-]	78-93-3	16000	110000	17	490	490	170	-Developmental
Methyl isobutyl ketone [or MIBK]	108-10-1	4300	44000	2.6	110	110	26	-Kidney -Liver
Methyl methacrylate	80-62-6	1900	10000	0.1	32	32	1	-Nasal
Methyl parathion [or Parathion, methyl]	298-00-0	20	370	0.06	0.0003	0.0003	0.6	-Blood -Neurological
Methyl styrene (mixed)	25013-15-4	120	770	0.8	NA	NA	8	-Nasal
Methyl styrene, alpha	98-83-9	1500	10000	11	NA	NA	110	-Kidney -Liver

**Table II**  
**Soil Cleanup Target Levels**

Contaminants	CAS#s	Direct Exposure		Leachability Based on Groundwater Criteria (mg/kg)	Leachability Based on Freshwater Surface Water Criteria (mg/kg)	Leachability Based on Marine Surface Water Criteria (mg/kg)	Leachability Based on Groundwater of Low Yield/Poor Quality (mg/kg)	Target Organs/Systems or Effects†
		Residential (mg/kg)	Commercial/Industrial (mg/kg)					
Methyl tert-butyl ether [or MTBE]	1634-04-4	4400	24000	0.09	150	150	0.9	-Eye -Kidney -Liver
Methyl-4-chlorophenoxy acetic acid, 2- [or MCPA]	94-74-6	35	500	0.02	0.4	0.4	0.2	-Kidney -Liver
Methylaniline, 2-	95-53-4	2.6	6.4	0.0009	0.2	0.2	0.009	-Carcinogen
Methylene bis(2-chloroaniline), 4,4-	101-14-4	6.4	23	0.001	NA	NA	0.01	-Carcinogen -Liver -Bladder
Methylene bromide	74-95-3	96	550	0.3	NA	NA	3	-Blood
Methylene chloride	75-09-2	17	26	0.02	7.3	7.3	0.2	-Carcinogen -Liver
Methylene diphenyl diisocyanate	101-68-8	400	2100	NA	NA	NA	NA	-Nasal
Methylmercury [or Mercury, methyl]	22967-92-6	1.1	6.1	0.002	NA	NA	0.02	-Neurological
Methylnaphthalene, 1-	90-12-0	200	1800	3.1	10	10	31	-Nasal
Methylnaphthalene, 2-	91-57-6	210	2100	8.5	9.1	9.1	85	-Nasal
Methylphenol, 2- [or Cresol, o-]	95-48-7	2900	31000	0.3	1.9	1.9	3	-Neurological
Methylphenol, 3- [or Cresol, m-]	108-39-4	2900	33000	0.3	3.3	3.3	3	-Neurological
Methylphenol, 4- [or Cresol, p-]	106-44-5	300	3400	0.03	0.5	0.5	0.3	-Neurological -Respiratory
Metolachlor	51218-45-2	12000	200000	1.2	0.01	0.01	12	-Body Weight
Metribuzin	21087-64-9	54	290	2.2	0.8	0.8	22	-Kidney -Liver
Metsulfuron, methyl [see Ally]								
Mevinphos	7786-34-7	18	270	0.01	0.0003	0.0003	0.1	-Neurological
MIBK [see Methyl isobutyl ketone]								

**Table II**  
**Soil Cleanup Target Levels**

Contaminants	CAS#s	Direct Exposure		Leachability Based on Groundwater Criteria (mg/kg)	Leachability Based on Freshwater Surface Water Criteria (mg/kg)	Leachability Based on Marine Surface Water Criteria (mg/kg)	Leachability Based on Groundwater of Low Yield/Poor Quality (mg/kg)	Target Organs/Systems or Effects†
		Residential (mg/kg)	Commercial/Industrial (mg/kg)					
Molinate	2212-67-1	120	1300	0.1	0.1	0.1	1	-Reproductive
Molybdenum	7439-98-7	440	11000	***	NA	NA	***	-Gout
MTBE [see Methyl tert-butyl ether]								
Naled	300-76-5	150	2400	0.1	0.0002	0.0002	1	-Neurological
Naphthalene	91-20-3	55	300	1.2	2.2	2.2	12	-Nasal
Nickel (b,c)	7440-02-0	340**	35000	130	NA	11	1300	-Body Weight
Nitrate	14797-55-8	140000	*	***	NA	NA	***	-Blood
Nitrite	14797-65-0	8700	220000	***	NA	NA	***	-Blood
Nitroaniline, m-	99-09-2	21	130	0.01	NA	NA	0.1	-Blood -Carcinogen
Nitroaniline, o-	88-74-4	24	130	0.1	NA	NA	1	-Blood
Nitroaniline, p-	100-01-6	17	96	0.008	5.9	5.9	0.08	-Blood -Carcinogen
Nitrobenzene	98-95-3	18	140	0.02	0.6	0.6	0.2	-Adrenals -Blood -Kidney -Liver
Nitroglycerin	55-63-0	27	54	0.03	NA	NA	0.3	-Carcinogen -Cardiovascular
Nitrophenol, 4-	100-02-7	560	7900	0.3	0.3	0.3	3	-None Specified
Nitroso-di-ethylamine, N-	55-18-5	0.003	0.005	0.000001	0.00003	0.00003	0.00001	-Carcinogen
Nitroso-dimethylamine, N-	62-75-9	0.009	0.02	0.000003	0.01	0.01	0.00003	-Carcinogen
Nitroso-di-n-butylamine, N-	924-16-3	0.05	0.08	0.00009	0.0005	0.0005	0.0009	-Carcinogen
Nitroso-di-n-propylamine, N-	621-64-7	0.08	0.2	0.00005	0.005	0.005	0.0005	-Carcinogen

**Table II**  
**Soil Cleanup Target Levels**

Contaminants	CAS#s	Direct Exposure		Leachability Based on Groundwater Criteria (mg/kg)	Leachability Based on Freshwater Surface Water Criteria (mg/kg)	Leachability Based on Marine Surface Water Criteria (mg/kg)	Leachability Based on Groundwater of Low Yield/Poor Quality (mg/kg)	Target Organs/Systems or Effects†
		Residential (mg/kg)	Commercial/Industrial (mg/kg)					
Nitroso-diphenylamine, N-	86-30-6	180	730	0.4	0.3	0.3	4	-Carcinogen
Nitroso-N-methylethylamine, N-	10595-95-6	0.02	0.04	0.000006	0.0002	0.0002	0.00006	-Carcinogen
Nitrotoluene, m-	99-08-1	640	4700	1.4	3.6	3.6	14	-Spleen
Nitrotoluene, o-	88-72-2	400	3300	0.9	7.3	7.3	9	-Spleen
Nitrotoluene, p-	99-99-0	750	12000	0.9	7.3	7.3	9	-Spleen
Nonylphenol	25154-52-3	100	2200	20	14	3.4	200	-Kidney
Octamethylpyrophosphoramide	152-16-9	130	1600	0.06	NA	NA	0.6	-Neurological
Oxamyl	23135-22-0	1700	22000	0.9	0.04	0.04	9	-Body Weight
Paraquat	1910-42-5	340	5500	16	230	230	160	-Respiratory
Parathion	56-38-2	500	11000	1	0.01	0.01	10	-Neurological
Parathion, methyl [see Methyl parathion]								
PCBs [or Aroclor mixture]	1336-36-3	0.5	2.6	17	0.002	0.002	170	-Carcinogen -Immunological
PCE [see Tetrachloroethene]								
Pebulate	1114-71-2	2000	17000	8.5	7.4	7.4	85	-Blood
Pendimethalin	40487-42-1	3200	58000	28	1	1	280	-Liver
Pentachlorobenzene	608-93-5	45	480	3.9	1.2	1.2	39	-Kidney -Liver
Pentachloronitrobenzene	82-68-8	3.3	12	0.2	0.03	0.03	2	-Carcinogen -Liver
Pentachlorophenol	87-86-5	7.2	28	0.03	0.2	0.2	0.3	-Carcinogen -Kidney -Liver

**Table II**  
**Soil Cleanup Target Levels**

Contaminants	CAS#s	Direct Exposure		Leachability Based on Groundwater Criteria (mg/kg)	Leachability Based on Freshwater Surface Water Criteria (mg/kg)	Leachability Based on Marine Surface Water Criteria (mg/kg)	Leachability Based on Groundwater of Low Yield/Poor Quality (mg/kg)	Target Organs/Systems or Effects†
		Residential (mg/kg)	Commercial/Industrial (mg/kg)					
Permethrin	52645-53-1	4200	96000	2500	0.007	0.007	25000	-Liver
Phenanthrene	85-01-8	2200	36000	250	NA	NA	2500	-Kidney
Phenmedipham [or Betanal]	13684-63-4	21000	450000	150	18	18	1500	-None Specified
Phenol	108-95-2	500**	220000	0.05	0.03	0.03	0.5	-Developmental
Phenylenediamine, m-	108-45-2	360	4000	0.2	NA	NA	2	-Liver
Phenylenediamine, o-	95-54-5	17	54	0.004	NA	NA	0.04	-Carcinogen
Phenylenediamine, p-	106-50-3	12000	160000	6.2	NA	NA	62	-Whole Body
Phenylphenol, 2-	90-43-7	490	2100	0.4	0.8	0.8	4	-Carcinogen
Phorate	298-02-2	16	320	0.3	0.001	0.001	3	-Neurological
Phosmet	732-11-6	1600	33000	5	0.004	0.004	50	-Liver -Neurological
Phthalic acid, p-	100-21-0	8000	45000	110	NA	NA	1100	-Bladder
Phthalic anhydride	85-44-9	11000	63000	76	NA	NA	760	-Kidney -Nasal -Respiratory
Polychlorinated dibenzo-p-dioxins [see Dioxins]								
Prometon	1610-18-0	1200	23000	2.4	14	14	24	-None Specified
Prometryn	7287-19-6	320	6100	0.7	0.5	0.5	7	-Bone Marrow -Kidney -Liver
Propachlor	1918-16-7	990	17000	1.1	0.1	0.1	11	-Liver
Propanil	709-98-8	390	6700	0.4	0.2	0.2	4	-Spleen
Propazine	139-40-2	1600	28000	0.2	2.7	2.7	2	-Body Weight

**Table II**  
**Soil Cleanup Target Levels**

Contaminants	CAS#s	Direct Exposure		Leachability Based on Groundwater Criteria (mg/kg)	Leachability Based on Freshwater Surface Water Criteria (mg/kg)	Leachability Based on Marine Surface Water Criteria (mg/kg)	Leachability Based on Groundwater of Low Yield/Poor Quality (mg/kg)	Target Organs/Systems or Effects†
		Residential (mg/kg)	Commercial/Industrial (mg/kg)					
Propionic acid, 2-(2-methyl-4-chlorophenoxy) [or MCPP]	93-65-2	64	800	0.03	NA	NA	0.3	-Kidney
Propoxur [see Baygon]								
Propylene glycol	57-55-6	*	*	560	140	140	5600	-Blood -Bone Marrow
Propylene glycol monomethyl ether	107-98-2	38000	390000	20	NA	NA	200	-Kidney -Liver -Neurological
Propylene oxide	75-56-9	3.1	9.3	0.0006	NA	NA	0.006	-Carcinogen -Nasal -Respiratory
Pydrin [or Fenvalerate]	51630-58-1	2100	46000	70	0.0001	0.0001	700	-Neurological
Pyrene	129-00-0	2400	45000	880	1.3	1.3	8800	-Kidney
Pyridine	110-86-1	20	130	0.03	5.4	5.4	0.3	-Liver
Quinoline	91-22-5	0.3	1.3	0.0009	NA	NA	0.009	-Carcinogen
RDX [see Hexahydro-1,3,5-trinitro-1,3,5-triazine]								
Resmethrin	10453-86-8	2500	56000	1200	0.01	0.01	12000	-Reproductive
Ronnel	299-84-3	4200	88000	1300	0.2	0.2	13000	-Liver
Roundup [see Glyphosate]								
Selenium	7782-49-2	440	11000	5.2	0.5	7.4	52	-Hair Loss -Neurological -Skin
Sevin [see Carbaryl]								
Silver	7440-22-4	410	8200	17	0.01	0.06	170	-Skin
Silvex [see Trichlorophenoxy propionic acid]								
Simazine	122-34-9	7.8	35	0.08	0.1	0.1	0.8	-Blood -Carcinogen

**Table II**  
**Soil Cleanup Target Levels**

Contaminants	CAS#s	Direct Exposure		Leachability Based on Groundwater Criteria (mg/kg)	Leachability Based on Freshwater Surface Water Criteria (mg/kg)	Leachability Based on Marine Surface Water Criteria (mg/kg)	Leachability Based on Groundwater of Low Yield/Poor Quality (mg/kg)	Target Organs/Systems or Effects†
		Residential (mg/kg)	Commercial/Industrial (mg/kg)					
Strontium	7440-24-6	52000	*	***	NA	NA	***	-Bone
Strychnine	57-24-9	23	380	0.02	0.3	0.3	0.2	-Mortality
Styrene	100-42-5	3600	23000	3.6	16	16	36	-Blood -Liver -Neurological
TCDD, 2,3,7,8- [see Dioxins, as total 2,3,7,8-TCDD equivalents]								
TCE [see Trichloroethene]								
Temik [see Aldicarb]								
Terbacil	5902-51-2	920	14000	0.5	14	14	5	-Liver -Thyroid
Terbufos	13071-79-9	1.9	29	0.02	0.001	0.001	0.2	-Neurological
Terbutryn	886-50-0	88	2200	0.2	0.09	0.09	2	-Blood
Tetrachlorobenzene, 1,2,4,5-	95-94-3	12	100	0.5	0.4	0.4	5	-Kidney
Tetrachloroethane, 1,1,1,2-	630-20-6	2.9	4.3	0.01	NA	NA	0.1	-Carcinogen -Kidney -Liver
Tetrachloroethane, 1,1,2,2-	79-34-5	0.7	1.2	0.001	0.08	0.08	0.01	-Carcinogen -Liver
Tetrachloroethene [or PCE]	127-18-4	8.8	18	0.03	0.1	0.1	0.3	-Carcinogen -Liver
Tetrachlorophenol, 2,3,4,6-	58-90-2	2100	30000	3.2	0.07	0.07	32	-Liver
Tetraethyl dithiopyrophosphate	3689-24-5	35	510	0.1	0.0004	0.0004	1	-Bone Marrow -Neurological
Thallium	7440-28-0	6.1	150	2.8	9	9	28	-Hair Loss -Liver
Thiobencarb	28249-77-6	810	16000	2.9	NA	NA	29	-Kidney
Thiram	137-26-8	400	7700	1.1	0.005	0.005	11	-Neurological

**Table II**  
**Soil Cleanup Target Levels**

Contaminants	CAS#s	Direct Exposure		Leachability Based on Groundwater Criteria (mg/kg)	Leachability Based on Freshwater Surface Water Criteria (mg/kg)	Leachability Based on Marine Surface Water Criteria (mg/kg)	Leachability Based on Groundwater of Low Yield/Poor Quality (mg/kg)	Target Organs/Systems or Effects†
		Residential (mg/kg)	Commercial/Industrial (mg/kg)					
Tin	7440-31-5	47000	880000	***	NA	NA	***	-Kidney -Liver
Toluene	108-88-3	7500	60000	0.5	5.6	5.6	5	-Kidney -Liver -Neurological
Toluene diisocyanate, 2,4/2,6- mixture	26471-62-5	1.3	15	NA	NA	NA	NA	-Respiratory
Toluidine, p-	106-49-0	2.2	4.5	0.0009	NA	NA	0.009	-Carcinogen
Toxaphene	8001-35-2	0.9	4.5	31	0.002	0.002	310	-Carcinogen -Developmental
Triallate	2303-17-5	980	16000	8.4	6	6	84	-Liver -Spleen
Tributyltin oxide	56-35-9	25	570	7.6	0.2	0.2	76	-Immunological
Trichloro-1,2,2-trifluoroethane, 1,1,2- [or CFC 113]	76-13-1	18000	96000	11000	NA	NA	110000	-Neurological
Trichloroacetic acid	76-03-9	770	8800	0.04	400	400	0.4	-None Specified
Trichlorobenzene, 1,2,3-	87-61-6	650	8200	4.6	5.6	5.6	46	-Adrenals
Trichlorobenzene, 1,2,4-	120-82-1	660	8500	5.3	1.7	1.7	53	-Adrenals
Trichlorobenzene, 1,3,5-	108-70-3	260	2300	16	NA	NA	160	-None Specified
Trichloroethane, 1,1,1- [or Methyl chloroform]	71-55-6	730	3900	1.9	2.6	2.6	19	-None Specified
Trichloroethane, 1,1,2-	79-00-5	1.4	2	0.03	0.09	0.09	0.3	-Carcinogen -Liver
Trichloroethene [or TCE]	79-01-6	6.4	9.3	0.03	0.9	0.9	0.3	-Carcinogen -None Specified
Trichlorofluoromethane	75-69-4	270	1500	33	NA	NA	330	-Cardiovascular -Kidney -Respiratory
Trichlorophenol, 2,4,5-	95-95-4	7700	130000	0.07	1.5	1.5	0.7	-Kidney -Liver
Trichlorophenol, 2,4,6-	88-06-2	70	230	0.06	0.1	0.1	0.6	-Carcinogen

**Table II**  
**Soil Cleanup Target Levels**

Contaminants	CAS#s	Direct Exposure		Leachability Based on Groundwater Criteria (mg/kg)	Leachability Based on Freshwater Surface Water Criteria (mg/kg)	Leachability Based on Marine Surface Water Criteria (mg/kg)	Leachability Based on Groundwater of Low Yield/Poor Quality (mg/kg)	Target Organs/Systems or Effects†
		Residential (mg/kg)	Commercial/Industrial (mg/kg)					
Trichlorophenoxy acetic acid, 2,4,5-	93-76-5	690	9500	0.4	0.8	0.8	4	-Kidney
Trichlorophenoxy propionic acid, 2, (2, 4, 5-) [or Silvex]	93-72-1	660	14000	5.4	NA	NA	54	-Liver
Trichloropropane, 1,1,2-	598-77-6	76	460	0.3	NA	NA	3	-Kidney -Liver -Thyroid
Trichloropropane, 1,2,3-	96-18-4	0.06	0.1	0.0001	0.001	0.001	0.001	-Carcinogen -Kidney -Liver
Trichloropropene, 1,2,3-	96-19-5	18	98	0.4	NA	NA	4	-Eye
Triethylamine	121-44-8	41	270	NA	NA	NA	NA	-Nasal
Trifluralin	1582-09-8	92	280	3.6	0.2	0.2	36	-Blood -Carcinogen -Liver
Trimethyl phosphate	512-56-1	19	57	0.004	NA	NA	0.04	-Carcinogen
Trimethylbenzene, 1,2,3-	526-73-8	18	96	0.3	NA	NA	3	-None Specified
Trimethylbenzene, 1,2,4-	95-63-6	18	95	0.3	7.2	7.2	3	-None Specified
Trimethylbenzene, 1,3,5-	108-67-8	15	80	0.3	6.7	6.7	3	-None Specified
Trinitrobenzene, 1,3,5-	99-35-4	2000	26000	1	0.09	0.09	10	-Blood -Spleen
Trinitrophenyl(methylnitramine	479-45-8	790	15000	1.4	NA	NA	14	-Kidney -Liver -Spleen
Trinitrotoluene, 2,4,6-	118-96-7	28	97	0.006	0.3	0.3	0.06	-Carcinogen -Liver
Trithion [see Carbophenothion]								
TRPH	NOCAS	460	2700	340	340	340	3400	-Multiple Endpoints Mixed Contaminants
Uranium, soluble salts	7440-61-1	110	820	***	NA	NA	***	-Kidney
Vanadium	7440-62-2	67**	10000	980	NA	NA	9800	-Hair Loss

**Table II**  
**Soil Cleanup Target Levels**

Contaminants	CAS#s	Direct Exposure (mg/kg)		Leachability Based on Groundwater Criteria (mg/kg)	Leachability Based on Freshwater Surface Water Criteria (mg/kg)	Leachability Based on Marine Surface Water Criteria (mg/kg)	Leachability Based on Groundwater of Low Yield/ Poor Quality (mg/kg)	Target Organs/Systems or Effects†
		Residential	Commercial/ Industrial					
Vernam	1929-77-7	51	510	0.1	0.2	0.2	1	-Body Weight
Vinyl acetate	108-05-4	320	1700	0.4	3	3	4	-Kidney -Nasal
Vinyl chloride (i)	75-01-4	0.2	0.8	0.007	0.02	0.02	0.07	-Carcinogen -Liver
Xylenes, total	1330-20-7	130	700	0.2	3.9	3.9	2	-Neurological
Zinc (b,c)	7440-66-6	26000	630000	***	NA	***	***	-Blood
Zinc phosphide	1314-84-7	26	660	***	NA	NA	***	-Body Weight
Zineb	12122-67-7	4100	82000	19	0.7	0.7	190	-Thyroid

**Table II**  
**Soil Cleanup Target Levels**

Contaminants	CAS#s	Direct Exposure		Leachability Based on Groundwater Criteria	Leachability Based on Freshwater Surface Water Criteria	Leachability Based on Marine Surface Water Criteria	Leachability Based on Groundwater of Low Yield/Poor Quality	Target Organs/Systems or Effects†
		Residential (mg/kg)	Commercial/ Industrial (mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	

Values expressed on a dry weight basis and rounded to two significant figures if >1 and to one significant figure if <1.

† = These default Target Organ(s)/Systems or Effects are those reported to occur at the doses used to derive the reference dose. Non-default Target Organ(s)/Systems or Effects may be justified through a detailed toxicological analysis of the chemicals present at a specific site.

\* Contaminant is not a health concern for this exposure scenario.

\*\* Direct exposure value based on acute toxicity considerations.

\*\*\* Leachability values may be derived using the SPLP Test to calculate site-specific SCTLs or may be determined using TCLP in the event oily wastes are present.

# = Site concentrations for carcinogenic polycyclic aromatic hydrocarbons must be converted to Benzo(a)pyrene equivalents before comparison with the appropriate direct exposure SCTL for Benzo(a)pyrene using the approach described in the February 2005 'Final Technical Report: Development of Cleanup Target Levels (CTLs) for Chapter 62-777, F.A.C.'

(a) = See discussion on the development of SCTLs for Ammonia in the February 2005 'Final Technical Report: Development of Cleanup Target Levels (CTLs) for Chapter 62-777, F.A.C.'

(b) = Leachability values derived from USEPA Soil Screening Guidance (1996). These values were derived assuming soil pH 6.8. These leachability values are dependent upon both the metal concentration in soil and soil characteristics. Thus, if site-specific soil characteristics are different than the defaults, these leachability values may not apply. If this is the case, site-specific leachability values should be derived using methods such as TCLP or SPLP.

(c) = Phytotoxicity must be considered.

(d) = Residential direct exposure value from USEPA Revised Interm Soil Guidance for CERCLA Sites and RCRA Corrective Action Facilities. OSWER Directive 9355.4-12 (1994). The industrial direct exposure value was derived using methodologies outlined in USEPA 'Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil', December 1996; and in 'Blood Lead Concentrations of U.S. Adult Females: Summary Statistics from Phases 1 and 2 of the NHANES III', March 2002.

(e) = The SCTL for Dioxins, as total 2,3,7,8-TCDD equivalents should be compared to the total dioxin equivalents for chlorinated dioxin and dibenzofuran congeners using the approach described in the February 2005 'Draft Technical Report: Development of Cleanup Target Levels (CTLs) for Chapter 62-777, F.A.C.'

(f) = The common name BHC is a misnomer for hexachlorocyclohexane.

(g) = Unless concentrations for both chromium III and VI are known, total chromium concentrations should be compared with direct exposure SCTLs for chromium VI.

(h) = Residential chronic SCTL for cadmium should be used as a not-to-exceed value because the residential chronic SCTL for cadmium is indistinguishable from the SCTL based on acute toxicity.

(i) = Residential chronic SCTL for vinyl chloride calculated by adding prorated and non-prorated risks, as discussed in the February 2005 'Final Technical Report: Development of Cleanup Target Levels (CTLs) for Chapter 62-777, F.A.C.'

(j) = 12789-03-6 or 57-74-9

Note: If more than one contaminant is present at a site, the direct exposure values are to be modified, if necessary, such that the sum of the hazard quotients for non-carcinogenic contaminants affecting the same organ(s) is 1 or less. For carcinogens, the direct exposure values shall be modified such that the cumulative lifetime risk level posed by the contaminants is 1.0E-06, as presented in Figure 10 of the February 2005 'Final Technical Report: Development of Cleanup Target Levels (CTLs) for Chapter 62-777, F.A.C.'

None Specified = Target organ(s) not determined at time of rule adoption.

NA = Not available at time of rule adoption.

**Table V  
Natural Attenuation Default Concentrations**

Contaminant	CAS#	Groundwater Criteria	Natural Attenuation Default Source
		(ug/L)	(ug/L)
Acenaphthene	83-32-9	20	200
Acenaphthylene	208-96-8	210	2100
Acephate	30560-19-1	4	400
Acetaldehyde	75-07-0		
Acetone	67-64-1	6300	63000
Acetonitrile	75-05-8	42	420
Acetophenone	98-86-2	700	7000
Acifluorfen, sodium [or Blazer]	62476-59-9	1	100
Acrolein	107-02-8	3.5	35
Acrylamide	79-06-1	0.008	0.8
Acrylic acid	79-10-7	3500	35000
Acrylonitrile	107-13-1	0.06	6
Alachlor	15972-60-8	*	***
Aldicarb [or Temik]	116-06-3	7	70
Aldicarb sulfone	1646-88-4	7	70
Aldicarb sulfoxide	1646-87-3	7	70
Aldrin	309-00-2	0.002	0.2
Aliphatic C 05-06	Ali-C5-6	5000	50000
Aliphatic >C 06-08	Ali-C6-8	5000	50000
Aliphatic >C 08-10	Ali-C8-10	5000	50000
Aliphatic >C 10-12	Ali-C10-12	5000	50000
Aliphatic >C 12-16	Ali-C12-16	5000	50000
Aliphatic >C16-21	Ali-C34+	5000	50000
Ally [or Metsulfuron, methyl]	74223-64-6	1800	18000
Allyl alcohol	107-18-6	35	350
Allyl chloride	107-05-1	35	350
Aluminum	7429-90-5	*	**
Aluminum phosphide	20859-73-8	2.8	28

**Table V  
Natural Attenuation Default Concentrations**

Contaminant	CAS#	Groundwater Criteria	Natural Attenuation Default Source
		(ug/L)	(ug/L)
Ametryn	834-12-8	63	630
Ammonia	7664-41-7	2800	28000
Ammonium sulfamate	7773-06-0	1400	14000
Anilazine [or Dyrene]	101-05-3	2.8	28
Aniline	62-53-3	6.1	610
Anthracene	120-12-7	2100	21000
Antimony	7440-36-0	*	**
Antimony pentoxide (as Antimony)	1314-60-9	3.5	35
Antimony potassium tartrate (as Antimony)	304-61-0	6.3	63
Antimony tetroxide (as Antimony)	1332-81-6	2.8	28
Antimony trioxide (as Antimony)	1309-64-4	2.8	28
Aramite	140-57-8	1.4	140
Aroclor mixture [see PCBs]			
Aromatic C 05-07	Aro-C5-6	5000	50000
Aromatic >C 07-08	Aro-C7-8	5000	50000
Aromatic >C 08-10	Aro-C8-10	5000	50000
Aromatic >C 10-12	Aro-C10-12	5000	50000
Aromatic >C 12-16	Aro-C12-16	5000	50000
Aromatic >C 16-21	Aro-C16-21	5000	50000
Aromatic >C 21-35	Aro-C21+	5000	50000
Arsenic	NOCAS	*	**
Atrazine	1912-24-9	*	***
Azinphos, methyl [see Guthion]			
Azobenzene	103-33-3	0.3	30
Barium (soluble salts)	7440-39-3	*	**
Baygon [or Propoxur]	114-26-1	28	280
Bayleton	43121-43-3	210	2100
Benomyl	17804-35-2	35	350

**Table V**  
**Natural Attenuation Default Concentrations**

Contaminant	CAS#	Groundwater Criteria	Natural Attenuation Default Source
		(ug/L)	(ug/L)
Bensulide	741-58-2	46	460
Bentazon	25057-89-0	210	2100
Benzaldehyde	100-52-7	700	7000
Benzene	71-43-2	*	***
Benzenethiol	108-98-5	0.07	0.7
Benzidine	92-87-5	0.0002	0.02
Benzo(a)anthracene	56-55-3	0.05	5
Benzo(a)pyrene	50-32-8	*	***
Benzo(b)fluoranthene	205-99-2	0.05	5
Benzo(g,h,i)perylene	191-24-2	210	2100
Benzo(k)fluoranthene	207-08-9	0.5	50
Benzoic acid	65-85-0	28000	280000
Benzotrichloride	98-07-7	0.003	0.3
Benzyl alcohol	100-51-6	2100	21000
Benzyl chloride	100-44-7	0.2	20
Beryllium	7440-41-7	*	**
Beta radiation	NOCAS	*	**
Betanal [see Phenmedipham]			
BHC, alpha- [see Hexachlorocyclohexane, alpha-]			
BHC, beta- [see Hexachlorocyclohexane, beta-]			
BHC, delta- [see Hexachlorocyclohexane, delta-]			
BHC, gamma- [see Hexachlorocyclohexane, gamma-]			
BHC, technical [see Hexachlorocyclohexane, technical]			
Bidrin [or Dicrotophos]	141-66-2	0.7	7
Bioallethrin	28057-48-9	35	350
Biphenyl, 1,1- [or Diphenyl]	92-52-4	0.5	5
Bis(2-chloro-1-methylethyl)ether [see Bis(2-chloroisopropyl)ether]			
Bis(2-chloroethoxy)methane	111-91-1	21	210

**Table V**  
**Natural Attenuation Default Concentrations**

Contaminant	CAS#	Groundwater Criteria	Natural Attenuation Default Source
		(ug/L)	(ug/L)
Bis(2-chloroethyl)ether	111-44-4	0.03	3
Bis(2-chloroisopropyl)ether [or Bis(2-chloro-1-methylethyl)ether]	39638-32-9	0.5	50
Bis(2-ethylhexyl)adipate	103-23-1	*	***
Bis(2-ethylhexyl)phthalate [or DEHP]	117-81-7	*	***
Bisphenol A	80-05-7	350	3500
Blazer [see Acifluorfen, sodium]			
Boron	7440-42-8	1400	14000
Bravo [see Chlorothalonil]			
Bromacil	314-40-9	70	700
Bromate	15541-45-4		
Bromochloromethane	74-97-5	91	910
Bromodichloromethane	75-27-4	0.6	60
Bromodiphenyl ether, p-	101-55-3	70	700
Bromoform	75-25-2	4.4	440
Bromomethane [or Methyl bromide]	74-83-9	9.8	98
Bromoxynil	1689-84-5	140	1400
Bromoxynil octanoate	1689-99-2	140	1400
Butane	106-97-8	9100	91000
Butanol, n-	71-36-3	700	7000
Butanol, tert- [see Butyl alcohol, tert-]			
Butanone, 2- [see Methyl ethyl ketone]			
Butyl acetate, n-	123-86-4	43	430
Butyl alcohol, tert- [or Butanol, tert-]	75-65-0	1400	14000
Butyl benzyl phthalate	85-68-7	140	1400
Butylate	2008-41-5	350	3500
Butylbenzene, sec	135-98-8	280	2800
Butylphthalyl butylglycolate	85-70-1	7000	70000
Cadmium	7440-43-9	*	**

**Table V  
Natural Attenuation Default Concentrations**

Contaminant	CAS#	Groundwater Criteria	Natural Attenuation Default Source
		(ug/L)	(ug/L)
Calcium cyanide	592-01-8	280	2800
Captafol	2425-06-1	4.1	410
Captan	133-06-2	10	1000
Carbaryl [or Sevin]	63-25-2	700	7000
Carbazole	86-74-8	1.8	180
Carbofuran	1563-66-2	*	**
Carbon disulfide	75-15-0	700	7000
Carbon tetrachloride	56-23-5	*	***
Carbophenothion [or Trithion]	786-19-6	0.9	9
Carboxin	5234-68-4	700	7000
CFC 113 [see Trichloro-1,2,2-trifluoroethane, 1,1,2-]			
Chloral hydrate	302-17-0	70	700
Chloramben	133-90-4	110	1100
Chlordane (total)	(a)	*	***
Chloride	16887-00-6	*	**
Chlorine	7782-50-5	700	7000
Chlorine cyanide [or Cyanogen chloride]	506-77-4	350	3500
Chlorite (sodium salt) [or Sodium chlorite]	7758-19-2	210	2100
Chloro-1,1-difluoroethane, 1-	75-68-3		
Chloro-1,3-butadiene [or Chloroprene]	126-99-8	140	1400
Chloro-3-methylphenol, 4- [see Chloro-m-cresol, p-]			
Chloroacetic acid	79-11-8	14	140
Chloroaniline, p-	106-47-8	28	280
Chlorobenzene	108-90-7	*	**
Chlorobenzilate	510-15-6	0.1	10
Chlorobenzoic acid, p-	74-11-3	1400	14000
Chlorobenzotrifluoride, 4-	98-56-6	140	1400
Chlorobutane, 1-	109-69-3	2800	28000

**Table V**  
**Natural Attenuation Default Concentrations**

Contaminant	CAS#	Groundwater Criteria	Natural Attenuation Default Source
		(ug/L)	(ug/L)
Chlorodifluoromethane	75-45-6		
Chlorodiphenyl ether, p-	7005-72-3	2.1	21
Chloroethane [see Ethyl chloride]			
Chloroethyl vinyl ether, 2-	110-75-8		
Chloroform	67-66-3	70	700
Chloro-m-cresol, p- [or Chloro-3-methylphenol, 4-]	59-50-7	63	630
Chloromethane [see Methyl chloride]			
Chloronaphthalene, beta-	91-58-7	560	5600
Chloronitrobenzene, o-	88-73-3	1.4	140
Chloronitrobenzene, p-	100-00-5	1.9	190
Chlorophenol, 2-	95-57-8	35	350
Chlorophenol, 3-	108-43-0	0.1	1
Chlorophenol, 4-	106-48-9	0.1	1
Chloropicrin	76-06-2	7.3	73
Chloroprene [see Chloro-1,3-butadiene]			
Chloropropane, 2-	75-29-6		
Chlorothalonil [or Bravo]	1897-45-6	3.2	320
Chlorotoluene, o-	95-49-8	140	1400
Chlorotoluene, p-	106-43-4	140	1400
Chlorpropham	101-21-3	1400	14000
Chlorpyrifos	2921-88-2	21	210
Chlorpyrifos, methyl	5598-13-0	70	700
Chlorsulfuron	64902-72-3	350	3500
Chromium (hexavalent)	18540-29-9		
Chromium (total)	NOCAS	*	**
Chromium (trivalent)	16065-83-1		
Chrysene	218-01-9	4.8	480
Cobalt	7440-48-4	140	1400

**Table V  
Natural Attenuation Default Concentrations**

Contaminant	CAS#	Groundwater Criteria	Natural Attenuation Default Source
		(ug/L)	(ug/L)
Copper	7440-50-8	*	**
Copper cyanide	544-92-3	35	350
Coumaphos	56-72-4	1.8	18
Cresol, m- [see Methylphenol, 3-]			
Cresol, o- [see Methylphenol, 2-]			
Cresol, p- [see Methylphenol, 4-]			
Crotonaldehyde	123-73-9	0.02	2
Cumene [or Isopropyl benzene]	98-82-8	0.8	8
Cyanazine	21725-46-2	0.04	4
Cyanide, free	57-12-5	*	**
Cyanogen	460-19-5	280	2800
Cyanogen chloride [see Chlorine cyanide]			
Cycloate	1134-23-2	35	350
Cyclohexanone	108-94-1	35000	350000
Cyclohexylamine	108-91-8	1400	14000
Cyhalothrin [or Karate]	68085-85-8	35	350
Cymene, p-	99-87-6		
Cypermethrin	52315-07-8	7	70
Dacthal [or DCPA]	1861-32-1	70	700
Dalapon	75-99-0	*	**
DB, 2,4- [see Dichlorophenoxy butyric acid, 2,4-]			
DBCP, 1,2- [see Dibromo-3-chloropropane, 1,2-]			
DCPA [see Dacthal]			
DDD, 4,4'- [see Dichlorodiphenyldichloroethane, p,p']			
DDE, 4,4'- [see Dichlorodiphenyldichloroethylene, p,p']			
DDT, 4,4'- [see Dichlorodiphenyltrichloroethane, p,p']			
Decabromodiphenyl ether	1163-19-5	7	70
DEET	134-62-3	6300	63000

**Table V  
Natural Attenuation Default Concentrations**

Contaminant	CAS#	Groundwater Criteria	Natural Attenuation Default Source
		(ug/L)	(ug/L)
DEHP [see Bis(2-ethylhexyl)phthalate]			
Demeton	8065-48-3	0.3	3
Diallate	2303-16-4	0.6	60
Diazinon	333-41-5	6.3	63
Dibenz(a,h)anthracene	53-70-3	0.005	0.5
Dibenzofuran	132-64-9	28	280
Dibromo-3-chloropropane, 1,2- [or DBCP, 1,2-]	96-12-8	*	***
Dibromoacetonitrile	3252-43-5		
Dibromobenzene, 1,4-	106-37-6	70	700
Dibromochloromethane	124-48-1	0.4	40
Dibromoethane, 1,2- [or EDB]	106-93-4	*	***
Dibutyl phthalate	84-74-2	700	7000
Dicamba	1918-00-9	210	2100
Dichloroacetic acid	79-43-6	0.7	70
Dichloroacetonitrile	3018-12-0	5.6	56
Dichlorobenzene, 1,2-	95-50-1	*	**
Dichlorobenzene, 1,3-	541-73-1	210	2100
Dichlorobenzene, 1,4-	106-46-7	*	***
Dichlorobenzidine, 3,3'-	91-94-1	0.08	8
Dichlorobenzophenone, 4,4'-	90-98-2	210	2100
Dichlorodifluoromethane	75-71-8	1400	14000
Dichlorodiphenyldichloroethane, p,p'- [or DDD, 4,4'-]	72-54-8	0.1	10
Dichlorodiphenyldichloroethylene, p,p'- [or DDE, 4,4'-]	72-55-9	0.1	10
Dichlorodiphenyltrichloroethane, p,p'- [or DDT, 4,4'-]	50-29-3	0.1	10
Dichloroethane, 1,1-	75-34-3	70	700
Dichloroethane, 1,2- [or EDC]	107-06-2	*	***
Dichloroethene, 1,1-	75-35-4	*	**
Dichloroethene, 1,2- (mixture)	540-59-0	63	630

**Table V  
Natural Attenuation Default Concentrations**

Contaminant	CAS#	Groundwater Criteria	Natural Attenuation Default Source
		(ug/L)	(ug/L)
Dichloroethene, cis-1,2-	156-59-2	*	**
Dichloroethene, trans-1,2-	156-60-5	*	**
Dichlorophenol, 2,3-	576-24-9	0.04	0.4
Dichlorophenol, 2,4-	120-83-2	0.3	3
Dichlorophenol, 2,5-	583-78-8	0.5	5
Dichlorophenol, 2,6-	87-65-0	0.2	2
Dichlorophenol, 3,4-	95-77-2	0.3	3
Dichlorophenoxy acetic acid, 2,4-	94-75-7	*	**
Dichlorophenoxy butyric acid, 2,4- [or DB, 2,4-]	94-82-6	56	560
Dichloropropane, 1,2-	78-87-5	*	***
Dichloropropene, 1,3-	542-75-6	0.4	40
Dichlorprop	120-36-5	35	350
Dichlorvos	62-73-7	0.1	10
Dicofol [or Kelthane]	115-32-2	0.08	8
Dicrotophos [see Bidrin]			
Dieldrin	60-57-1	0.002	0.2
Diethyl phthalate	84-66-2	5600	56000
Diethylene glycol, monoethyl ether	111-90-0	14000	140000
Diethylstilbestrol	56-53-1	0.000007	0.0007
Diisopropyl methylphosphonate	1445-75-6	560	5600
Dimethoate	60-51-5	1.4	14
Dimethoxybenzidine, 3,3'-	119-90-4	2.5	250
Dimethrin	70-38-2	2100	21000
Dimethylamine	124-40-3		
Dimethylaniline, 2,4-	95-68-1	0.05	5
Dimethylaniline, N,N-	121-69-7	14	140
Dimethylbenzidine, 3,3'-	119-93-7	0.004	0.4
Dimethylformamide, N,N-	68-12-2	700	7000

**Table V**  
**Natural Attenuation Default Concentrations**

Contaminant	CAS#	Groundwater Criteria	Natural Attenuation Default Source
		(ug/L)	(ug/L)
Dimethylphenol, 2,4-	105-67-9	140	1400
Dimethylphenol, 2,6-	576-26-1	4.2	42
Dimethylphenol, 3,4-	95-65-8	7	70
Dimethylphthalate	131-11-3	70000	700000
Dinitrobenzene, 1,2- (o)	528-29-0	2.8	28
Dinitrobenzene, 1,3- (m)	99-65-0	0.7	7
Dinitrobenzene, 1,4- (p)	100-25-4	2.8	28
Dinitro-o-cresol, 4,6-	534-52-1	0.7	7
Dinitro-o-cyclohexylphenol	131-89-5	14	140
Dinitrophenol, 2,4-	51-28-5	14	140
Dinitrotoluene, 2,4-	121-14-2	0.05	5
Dinitrotoluene, 2,6-	606-20-2	0.05	5
Di-n-octylphthalate	117-84-0	140	1400
Dinoseb	88-85-7	*	**
Dioxane, 1,4-	123-91-1	3.2	320
Dioxins, as total 2,3,7,8-TCDD equivalents	1746-01-6	*	***
Diphenamid	957-51-7	210	2100
Diphenyl [see Biphenyl, 1,1-]			
Diphenylamine, N,N-	122-39-4	180	1800
Diphenylhydrazine, 1,2-	122-66-7	0.04	4
Diquat	85-00-7	*	**
Disulfoton	298-04-4	0.3	3
Diuron	330-54-1	14	140
Dyrene [see Anilazine]			
EDB [see Dibromoethane, 1,2-]			
EDC [see Dichloroethane, 1,2-]			
Endosulfan (alpha+beta+sulfate)	115-29-7	42	420
Endothall	145-73-3	*	**

**Table V  
Natural Attenuation Default Concentrations**

Contaminant	CAS#	Groundwater Criteria	Natural Attenuation Default Source
		(ug/L)	(ug/L)
Endrin	72-20-8	*	**
EPEG [see Ethylphthalyl ethylglycolate]			
Epichlorohydrin	106-89-8	3.5	350
EPN [see Ethyl p-nitrophenyl phenylphosphorothioate]			
EPTC [see Ethyl dipropylthiocarbamate, S-]			
Ethanol	64-17-5	10000	100000
Ethion	563-12-2	3.5	35
Ethoprop	13194-48-4	0.7	7
Ethoxyethanol acetate, 2-	111-15-9	2100	21000
Ethoxyethanol, 2-	110-80-5	2800	28000
Ethyl acetate	141-78-6	6300	63000
Ethyl acrylate	140-88-5	0.4	40
Ethyl chloride [or Chloroethane]	75-00-3	12	1200
Ethyl dipropylthiocarbamate, S- [or EPTC]	759-94-4	180	1800
Ethyl ether	60-29-7	750	7500
Ethyl methacrylate	97-63-2	630	6300
Ethyl p-nitrophenyl phenylphosphorothioate [or EPN]	2104-64-5	0.07	0.7
Ethylbenzene	100-41-4	*	**
Ethylene diamine	107-15-3	140	1400
Ethylene glycol	107-21-1	14000	140000
Ethylene oxide	75-21-8	0.03	3
Ethylene thiourea [or ETU]	96-45-7	0.3	30
Ethylphthalyl ethylglycolate [or EPEG]	84-72-0	21000	210000
ETU [see Ethylene thiourea]			
Famphur	52-85-7	3.5	35
Fenamiphos	22224-92-6	1.8	18
Fenamiphos metabolites	NOCAS		
Fensulfothion	115-90-2	1.8	18

**Table V  
Natural Attenuation Default Concentrations**

Contaminant	CAS#	Groundwater Criteria	Natural Attenuation Default Source
		(ug/L)	(ug/L)
Fenvalerate [see Pydrin]			
Fluometuron	2164-17-2	91	910
Fluoranthene	206-44-0	280	2800
Fluorene	86-73-7	280	2800
Fluoride	7782-41-4	*	**
Fluoridone	59756-60-4	560	5600
Fonofos	944-22-9	14	140
Formaldehyde	50-00-0	600	6000
Formic acid	64-18-6	14000	140000
Furan	110-00-9	7	70
Furfural	98-01-1	21	210
Glycidaldehyde	765-34-4	2.8	28
Glyphosate [or Roundup]	1071-83-6	*	**
Gross alpha radiation	14127-62-9	*	**
Guthion [or Methyl azinphos]	86-50-0	11	110
Heptachlor	76-44-8	*	***
Heptachlor epoxide	1024-57-3	*	***
Hexachloro-1,3-butadiene	87-68-3	0.4	40
Hexachlorobenzene	118-74-1	*	***
Hexachlorocyclohexane, alpha- [or BHC, alpha-]	319-84-6	0.006	0.6
Hexachlorocyclohexane, beta- [BHC, beta-]	319-85-7	0.02	2
Hexachlorocyclohexane, delta- [or BHC, delta-]	319-86-8	2.1	21
Hexachlorocyclohexane, gamma- [or Lindane or BHC, gamma-]	58-89-9	*	***
Hexachlorocyclohexane, technical [ or BHC, technical]	608-73-1	0.02	2
Hexachlorocyclopentadiene	77-47-4	*	**
Hexachlorodibenzo-p-dioxin (mixture)	19408-74-3	0.000006	0.0006
Hexachloroethane	67-72-1	2.5	250
Hexachlorophene	70-30-4	2.1	21

**Table V  
Natural Attenuation Default Concentrations**

Contaminant	CAS#	Groundwater Criteria	Natural Attenuation Default Source
		(ug/L)	(ug/L)
Hexahydro-1,3,5-trinitro-1,3,5-triazine [or RDX]	121-82-4	0.3	30
Hexane, n-	110-54-3	6	60
Hexanone, 2- [or Methyl butyl ketone]	591-78-6	280	2800
Hexazinone	51235-04-2	230	2300
HMX [see Octahydro-1,3,5,7-tetranitro-tetrazocine]			
Hydrogen cyanide (as Cyanide)	74-90-8	140	1400
Hydrogen sulfide	7783-06-4	21	210
Hydroquinone	123-31-9	280	2800
Indeno(1,2,3-cd)pyrene	193-39-5	0.05	5
Iprodione	36734-19-7	280	2800
Iron	7439-89-6	*	**
Isobutyl alcohol	78-83-1	2100	21000
Isophorone	78-59-1	37	3700
Isopropanol	67-63-0		
Isopropyl benzene [see Cumene]			
Karate [see Cyhalothrin, lambda]			
Kelthane [see Dicofo]			
Kepone	143-50-0	0.004	0.4
Lead	7439-92-1	*	**
Limonene	138-86-3	700	7000
Lindane [see Hexachlorocyclohexane, gamma-]			
Linuron	330-55-2	1.4	14
Lithium	7439-93-2	140	1400
MADEP C11-C22 Aromatics	IA C11-C22 Ar	5000	50000
MADEP C19-C36 Aliphatics	IA C19-C36 A	5000	50000
MADEP C5-C8 Aliphatics	MA C5-C8 Ali	5000	50000
MADEP C9-C10 Aromatics	IA C9-C10 Arc	5000	50000
MADEP C9-C12 Aliphatics	MA C9-C12 Ali	5000	50000

**Table V**  
**Natural Attenuation Default Concentrations**

Contaminant	CAS#	Groundwater Criteria	Natural Attenuation Default Source
		(ug/L)	(ug/L)
MADEP C9-C18 Aliphatics	MA C9-C18 Ali	5000	50000
Malathion	121-75-5	140	1400
Maleic anhydride	108-31-6		
Maleic hydrazide	123-33-1	3500	35000
Malonitrile	109-77-3	0.1	1
Mancozeb	8018-01-7	210	2100
Maneb	12427-38-2	35	350
Manganese	7439-96-5	50	500
MCPA [see Methyl-4-chlorophenoxy acetic acid, 2- ]			
MCPP [see Propionic acid, 2-(2-methyl-4-chlorophenoxy)]			
Mercuric chloride (as Mercury)	7487-94-7	0.2	2
Mercury	7439-97-6	*	**
Mercury, methyl- [see Methylmercury]			
Merphos	150-50-5	0.2	2
Merphos oxide	78-48-8	0.2	2
Metalaxyl	57837-19-1	420	4200
Methacrylonitrile	126-98-7	0.7	7
Methamidophos	10265-92-6	0.4	4
Methanol	67-56-1	3500	35000
Methidathion	950-37-8	0.7	7
Methomyl	16752-77-5	180	1800
Methoxy-5-nitroaniline, 2-	99-59-2	0.8	80
Methoxychlor	72-43-5	*	**
Methoxyethanol, 2-	109-86-4	7	70
Methyl acetate	79-20-9	3000	30000
Methyl acrylate	96-33-3	210	2100
Methyl azinphos [see Guthion]			
Methyl bromide [see Bromomethane]			

**Table V  
Natural Attenuation Default Concentrations**

Contaminant	CAS#	Groundwater Criteria	Natural Attenuation Default Source
		(ug/L)	(ug/L)
Methyl butyl ketone [see Hexanone, 2-]			
Methyl chloride [or Chloromethane]	74-87-3	2.7	270
Methyl chloroform [see Trichloroethane, 1,1,1-]			
Methyl ethyl ketone [or Butanone, 2-]	78-93-3	4200	42000
Methyl isobutyl ketone [or MIBK]	108-10-1	560	5600
Methyl methacrylate	80-62-6	25	250
Methyl parathion [or Parathion, methyl]	298-00-0	1.8	18
Methyl styrene (mixed)	25013-15-4	42	420
Methyl styrene, alpha	98-83-9	490	4900
Methyl tert-butyl ether [or MTBE]	1634-04-4	20	200
Methyl(1,4-chlorophenoxy)propionic acid	7085-19-0		
Methyl-4-chlorophenoxy acetic acid, 2- [or MCPA]	94-74-6	3.5	35
Methyl-4-nitroaniline, 2-	99-52-5	1.1	110
Methyl-5-nitroaniline, 2-	99-55-8	1.1	110
Methylaniline, 2-	95-53-4	0.1	10
Methylene bis(2-chloroaniline), 4,4-	101-14-4	0.3	30
Methylene bromide	74-95-3	70	700
Methylene chloride	75-09-2	*	***
Methylene diphenyl diisocyanate	101-68-8		
Methylmercury [or Mercury, methyl]	22967-92-6	0.07	0.7
Methylnaphthalene, 1-	90-12-0	28	280
Methylnaphthalene, 2-	91-57-6	28	280
Methylphenol, 2- [or Cresol, o-]	95-48-7	35	350
Methylphenol, 3- [or Cresol, m-]	108-39-4	35	350
Methylphenol, 4- [or Cresol, p-]	106-44-5	3.5	35
Metolachlor	51218-45-2	110	1100
Metribuzin	21087-64-9	180	1800
Metsulfuron, methyl [see Ally]			

**Table V**  
**Natural Attenuation Default Concentrations**

Contaminant	CAS#	Groundwater Criteria	Natural Attenuation Default Source
		(ug/L)	(ug/L)
Mevinphos	7786-34-7	1.8	18
MIBK [see Methyl isobutyl ketone]			
Mirex	2385-85-5	1.4	14
Molinate	2212-67-1	14	140
Molybdenum	7439-98-7	35	350
MS Aliphatics	111-84-3	980	9800
MS Aromatics	111-84-4	1400	14000
MTBE [see Methyl tert-butyl ether]			
Naled	300-76-5	14	140
Naphthalene	91-20-3	14	140
Naphthylamine, 2-	91-59-8	0.0003	0.03
Napropamide	15299-99-7	700	7000
Nickel	7440-02-0	*	**
Nickel subsulfide	12035-72-2	*	**
Nitrate	14797-55-8	*	**
Nitrate+Nitrite	NOCAS	*	**
Nitrite	14797-65-0	*	**
Nitroaniline, m-	99-09-2	1.7	170
Nitroaniline, o-	88-74-4	21	210
Nitroaniline, p-	100-01-6	1.7	170
Nitrobenzene	98-95-3	3.5	35
Nitroglycerin	55-63-0	2.5	250
Nitrophenol, 2-	88-75-5	56	560
Nitrophenol, 4-	100-02-7	56	560
Nitroso-di-ethylamine, N-	55-18-5	0.0002	0.02
Nitroso-dimethylamine, N-	62-75-9	0.0007	0.07
Nitroso-di-n-butylamine, N-	924-16-3	0.006	0.6
Nitroso-di-n-propylamine, N-	621-64-7	0.005	0.5

**Table V  
Natural Attenuation Default Concentrations**

Contaminant	CAS#	Groundwater Criteria	Natural Attenuation Default Source
		(ug/L)	(ug/L)
Nitroso-diphenylamine, N-	86-30-6	7.1	710
Nitroso-N-methylethylamine, N-	10595-95-6	0.002	0.2
Nitrosopyrrolidine, N-	930-55-2	0.02	2
Nitrotoluene, m-	99-08-1	140	1400
Nitrotoluene, o-	88-72-2	70	700
Nitrotoluene, p-	99-99-0	70	700
Nonylphenol	25154-52-3	8.4	84
Norflurazon	27314-13-2	280	2800
Octahydro-1,3,5,7-tetranitro-tetrazocine [or HMX]	2691-41-0	350	3500
Octamethylpyrophosphoramidate	152-16-9	14	140
Oryzalin	19044-88-3	35	350
Oxadiazon	19666-30-9	35	350
Oxamyl	23135-22-0	*	**
Paraquat	1910-42-5	3.2	32
Parathion	56-38-2	4.2	42
Parathion, methyl [see Methyl parathion]			
PCBs [or Aroclor mixture]	1336-36-3	*	***
PCE [see Tetrachloroethene]			
Pebulate	1114-71-2	350	3500
Pendimethalin	40487-42-1	280	2800
Pentachlorobenzene	608-93-5	5.6	56
Pentachloronitrobenzene	82-68-8	0.1	10
Pentachlorophenol	87-86-5	*	***
Perchlorate	7601-90-3	4	40
Permethrin	52645-53-1	350	3500
Phenanthrene	85-01-8	210	2100
Phenmedipham [or Betanal]	13684-63-4	1800	18000
Phenol	108-95-2	10	100

**Table V  
Natural Attenuation Default Concentrations**

Contaminant	CAS#	Groundwater Criteria	Natural Attenuation Default Source
		(ug/L)	(ug/L)
Phenylenediamine, m-	108-45-2	42	420
Phenylenediamine, o-	95-54-5	0.7	70
Phenylenediamine, p-	106-50-3	1300	13000
Phenylphenol, 2-	90-43-7	18	1800
Phorate	298-02-2	1.4	14
Phosmet	732-11-6	140	1400
Phosphine	7803-51-2	2.1	21
Phthalic acid, p-	100-21-0	7000	70000
Phthalic anhydride	85-44-9	14000	140000
Picloram	1918-02-1	*	**
Polychlorinated dibenzo-p-dioxins [see Dioxins]			
Polycyclic Aromatic Hydrocarbons (PAHs)			
Polysorbate 80	9005-65-6	35000	350000
Potassium cyanide	151-50-8	350	3500
Profluralin	26399-36-0	42	420
Prometon	1610-18-0	110	1100
Prometryn	7287-19-6	28	280
Pronamide	23950-58-5	53	530
Propachlor	1918-16-7	91	910
Propanil	709-98-8	35	350
Propargite	2312-35-8	140	1400
Propazine	139-40-2	14	140
Propham	122-42-9	140	1400
Propiconazole	60207-90-1	91	910
Propionic acid, 2-(2-methyl-4- chlorophenoxy) [or MCPFP]	93-65-2	7	70
Propoxur [see Baygon]			
Propylene glycol	57-55-6	140000	1400000
Propylene glycol monoethyl ether	1569-02-4		

**Table V  
Natural Attenuation Default Concentrations**

Contaminant	CAS#	Groundwater Criteria	Natural Attenuation Default Source
		(ug/L)	(ug/L)
Propylene glycol monomethyl ether	107-98-2	4900	49000
Propylene oxide	75-56-9	0.1	10
Pydrin [or Fenvalerate]	51630-58-1	180	1800
Pyrene	129-00-0	210	2100
Pyridine	110-86-1	7	70
Quinoline	91-22-5	0.01	1
Radium, 226 and 228 (combined)	7440-14-4	*	**
RDX [see Hexahydro-1,3,5-trinitro-1,3,5-triazine]			
Resmethrin	10453-86-8	210	2100
Ronnel	299-84-3	350	3500
Rotenone	83-79-4	28	280
Roundup [see Glyphosate]			
Selenious acid (as Selenium)	7783-00-8	35	350
Selenium	7782-49-2	*	**
Sevin [see Carbaryl]			
Silver	7440-22-4	*	**
Silvex [see Trichlorophenoxy propionic acid]			
Simazine	122-34-9	*	***
Sodium	7440-23-5	*	**
Sodium chlorite [see Chlorite (sodium salt)]			
Sodium cyanide (as Cyanide)	143-33-9	280	2800
Strontium	7440-24-6	4200	42000
Strychnine	57-24-9	2.1	21
Styrene	100-42-5	*	**
Sulfate	14808-79-8	*	**
TCDD, 2,3,7,8- [see Dioxins, as total 2,3,7,8-TCDD equivalents]			
TCE [see Trichloroethene]			
TCMTB [see Thiocyanomethylthio-benzothiazole, 2-]			

**Table V  
Natural Attenuation Default Concentrations**

Contaminant	CAS#	Groundwater Criteria	Natural Attenuation Default Source
		(ug/L)	(ug/L)
TDS [see Total dissolved solids]			
Tebuthiuron	34014-18-1	490	4900
Temephos	3383-96-8	140	1400
Temik [see Aldicarb]			
Terbacil	5902-51-2	91	910
Terbufos	13071-79-9	0.2	2
Terbutryn	886-50-0	7	70
Tetrachlorobenzene, 1,2,4,5-	95-94-3	2.1	21
Tetrachlorodibenzofuran, 2,3,7,8-	51207-31-9		
Tetrachloroethane, 1,1,1,2-	630-20-6	1.3	130
Tetrachloroethane, 1,1,2,2-	79-34-5	0.2	20
Tetrachloroethene [or PCE]	127-18-4	*	***
Tetrachlorophenol, 2,3,4,6-	58-90-2	210	2100
Tetraethyl dithiopyrophosphate	3689-24-5	3.5	35
Thallium	7440-28-0	*	**
Thallium acetate (as Thallium)	563-68-8	0.6	6
Thallium carbonate (as Thallium)	6533-73-9	0.6	6
Thallium chloride (as Thallium)	7791-12-0	0.6	6
Thallium nitrate (as Thallium)	10102-45-0		
Thallium sulfate (as Thallium)	7446-18-6	0.6	6
Thiobencarb	28249-77-6	70	700
Thiocyanomethylthio-benzothiazole, 2- [or TCMTB]	21564-17-0	2.8	28
Thiram	137-26-8	35	350
Tin	7440-31-5	4200	42000
Titanium Dioxide	13463-67-7		
Toluene	108-88-3	*	**
Toluene diisocyanate, 2,4/2,6- mixture	26471-62-5		
Toluene-2,4-diamine	95-80-7	0.01	1

**Table V  
Natural Attenuation Default Concentrations**

Contaminant	CAS#	Groundwater Criteria	Natural Attenuation Default Source
		(ug/L)	(ug/L)
Toluidine, p-	106-49-0	0.2	20
Total dissolved solids [or TDS]	C-010	*	**
Toxaphene	8001-35-2	*	***
Triallate	2303-17-5	91	910
Tributyltin oxide	56-35-9	2.1	21
Trichloro-1,2,2-trifluoroethane, 1,1,2- [or CFC 113]	76-13-1	210000	2100000
Trichloroacetic acid	76-03-9	9.1	91
Trichlorobenzene, 1,2,3-	87-61-6	70	700
Trichlorobenzene, 1,2,4-	120-82-1	*	**
Trichlorobenzene, 1,3,5-	108-70-3	40	400
Trichloroethane, 1,1,1- [or Methyl chloroform]	71-55-6	*	**
Trichloroethane, 1,1,2-	79-00-5	*	***
Trichloroethene [or TCE]	79-01-6	*	***
Trichlorofluoromethane	75-69-4	2100	21000
Trichlorophenol, 2,4,5-	95-95-4	1	10
Trichlorophenol, 2,4,6-	88-06-2	3.2	320
Trichlorophenoxy acetic acid, 2,4,5-	93-76-5	70	700
Trichlorophenoxy propionic acid, 2, (2, 4, 5- ) [or Silvex]	93-72-1	*	**
Trichloropropane, 1,1,2-	598-77-6	35	350
Trichloropropane, 1,2,3-	96-18-4	0.02	2
Trichloropropene, 1,2,3-	96-19-5	35	350
Triethylamine	121-44-8		
Trifluralin	1582-09-8	4.5	450
Trimethyl phosphate	512-56-1	0.9	90
Trimethylbenzene, 1,2,3-	526-73-8	10	100
Trimethylbenzene, 1,2,4-	95-63-6	10	100
Trimethylbenzene, 1,3,5-	108-67-8	10	100
Trinitrobenzene, 1,3,5-	99-35-4	210	2100

**Table V  
Natural Attenuation Default Concentrations**

Contaminant	CAS#	Groundwater Criteria	Natural Attenuation Default Source
		(ug/L)	(ug/L)
Trinitrophenylmethylnitramine	479-45-8	70	700
Trinitrotoluene, 2,4,6-	118-96-7	1.2	120
Trithion [see Carbophenothion]			
TRPH	NOCAS	5000	50000
Uranium, soluble salts	7440-61-1	21	210
Vanadium	7440-62-2	49	490
Vanadium pentoxide (as Vanadium)	1314-62-1	63	630
Vanadium sulfate (as Vanadium)	36907-42-3		
Vernam	1929-77-7	7	70
Vinyl acetate	108-05-4	88	880
Vinyl chloride	75-01-4	*	***
White phosphorus	7723-14-0	0.1	1
Xylenes, total	1330-20-7	*	**
Zinc	7440-66-6	*	**
Zinc chloride	7646-85-7	2100	21000
Zinc phosphide	1314-84-7	2.1	21
Zineb	12122-67-7	350	3500

\* = As provided in Chapter 62-520, F.A.C.

\*\* = Groundwater criteria as provided in Chapter 62-520, F.A.C., multiplied by 10X.

\*\*\* = Groundwater criteria as provided in Chapter 62-520, F.A.C., multiplied by 100X.

(a) = 12789-03-6 or 57-74-9

Note: Natural Attenuation Default Source Concentrations are developed by multiplying the Groundwater Criteria by 10 for non-carcinogens and by 100 for carcinogens, except in the case of carcinogenic elements where the Groundwater Criteria are multiplied by 10. For those contaminants that have both primary and secondary groundwater standards, the Groundwater Criteria and Natural Attenuation Default Source Concentrations are based on the lower of the two standards.

**Attachment D**  
**Accutest**  
**Quality Assurance Manual(s)**

# Quality Systems Manual

Volume XIII, Revision I: February 2013

Effective Date: \_06/10/2013

Document Control Number: \_\_\_\_\_



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## **INTRODUCTION**

The Accutest Laboratories Southeast, Inc. (Accutest SE) Quality Assurance Program, detailed in this plan, has been designed to meet the quality program requirements of the National Environmental Laboratories Accreditation Conference (TNI), DoD QSM Ver 4.2, 2010 and ISO 17025. The plan establishes the framework for documenting the requirements of the quality processes regularly practiced by the Laboratory. The Quality Assurance Officer is responsible for changes to the Quality Assurance Program, which are appended to the LQSM as they occur. The plan is reviewed annually for compliance purposes by the Laboratory Director and Technical Director and edited if necessary. Changes that are incorporated into the plan are summarized in the plan introduction. Changes to the plan are communicated to the general staff in a meeting conducted by the Quality Assurance Officer following the plan's approval.

The Accutest SE plan is supported by standard operating procedures (SOPs), which provide specific operational instructions on the execution of each quality element and assure that compliance with the requirements of the plan are achieved. Accutest SE employees are responsible for knowing the requirements of the SOPs and applying them in the daily execution of their duties. These documents are updated as changes occur and the staff is trained to apply the changes.

At Accutest, we believe that satisfying client requirements and providing a product that meets or exceeds the standards of the industry is the key to a good business relationship. However, client satisfaction cannot be guaranteed unless there is a system that assures the product consistently meets its design requirements and is adequately documented to assure that all procedural steps are executed and are traceable.

This plan has been designed to assure that this goal is consistently achieved and the Accutest product withstands the rigors of scrutiny that are routinely applied to analytical data and the processes that support its generation.

Accutest Laboratories Southeast is a permanent location facility and is part of Accutest Laboratories, Inc.

**Summary of Changes**  
**Accutest SE Quality System Manual –October 2012**

<u>Section</u>	<u>Description</u>	<u>Page #</u>
Title Page	new revision number	Title
OrgChart	Lillian Torres replaced with Angel Rivera as WetChem supervisor; removed Paul Konnik from Sales.	8
1	Management commitment ro constant process improvement spelled out	5
16	Complete rewrite with detail and hierarchy of non-conforming products	63
App II	DoD certified methods specified in both TNI and non-TNI tables	80-83
App IV	Added Perchlorate, Nitrate/Nitrite, 1,4-Dioxane, Added 2 MS SOPs and 1 Sample Management SOP	99-101

**Table of Contents**

<b>Section</b>	<b>Title</b>	<b>Page</b>
1.0	Quality Policy .....	5
2.0	Organization .....	6
3.0	Quality Responsibilities of the Management Team .....	9
4.0	Job Descriptions Of Key Staff .....	16
5.0	Signatory Approvals .....	20
6.0	Documentation & Document Control .....	22
7.0	Reference Standard Traceability .....	27
8.0	Test Procedures, Method References, & Regulatory Programs .....	29
9.0	Sample Management, Login, Custody, Storage & Disposal .....	33
10.0	Laboratory Instrumentation and Measurement Standards .....	40
11.0	Instrument Maintenance .....	43
12.0	Quality Control Parameters, Procedures, and Corrective Action .....	44
13.0	Corrective Action System .....	53
14.0	Procedures For Executing Client Specifications .....	56
15.0	Client Complaint Resolution Procedure .....	60
16.0	Control of Non-Conforming Product .....	61
17.0	Confidentiality Protection Procedures .....	62
18.0	Quality Audits And Quality System Reviews .....	64
19.0	Health and Safety .....	66

**Appendices**

I	Glossary of Terms .....	69
II	Analytical Capabilities .....	77
III	Equipment List .....	85
IV	Certification Summary .....	89
V	Standard Operating Procedures (SOP) List .....	91

## 1.0 QUALITY POLICY

### 1.1 Accutest Mission:

***Accutest Laboratories provides analytical services to commercial and government clients in support of environmental monitoring and remedial activities as requested. The Laboratory's mission is dedicated to providing reliable data that satisfies clients requirements as explained in the following: "Provide easy access, high quality, analytical support to commercial and government clients which meet or exceeds data quality objectives and provides them with the data needed to satisfy regulatory requirements and/or make confident decisions on the effectiveness of remedial activities."***

These services are provided impartially and are not influenced by undue commercial or financial pressures, which might impact the staff's technical judgment. Coincidentally, Accutest does not engage in activities that endanger the trust in our independent judgment and integrity in relation to the testing activities performed.

### 1.2 Policy Statement:

*The management and staff of Accutest Laboratories share the responsibility for product quality and continually strive for its systematic improvement. Accordingly, Accutest's quality assurance program is designed to assure that all processes and procedures, which are components of environmental data production, meet established industry requirements, are adequately documented from a procedural and data traceability perspective, and are consistently executed by the staff. It also assures that analytical data of known quality, meeting the quality objectives of the analytical method in use and the data user's requirements, is consistently produced in the laboratory. This assurance enables the data user to make rational, confident, cost-effective decisions on the assessment and resolution of environmental issues.*

*The laboratory Quality System also provides the management staff with data quality and operational feedback information. This enables them to determine if the laboratory is achieving the established quality and operational standards, which are dictated by the client or established by regulation, such as TNI, ISO 17025 or DoD QSM. The information provided to management, through the QA program, is used to assess operational performance from a quality perspective and to perform corrective action as necessary.*

*All employees of Accutest Laboratories participating in environmental testing receive quality system training and are responsible for knowing and complying with the system requirements. The entire staff shares Accutest's commitment to good professional practice.*



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Harry Behzadi, Ph.D.  
VP Southeast Operations

## 2.0 ORGANIZATION

**2.1 Organizational Entity.** Accutest Laboratories, Inc. is a testing laboratory founded in 1956 and registered as a New Jersey Corporation. In 2007 the laboratory has changed ownership to Accutest Holdings, Inc. Operations, staff and physical locations were not affected by the change. The laboratory headquarters are located in Dayton, New Jersey where it has conducted business since 1987. Satellite laboratories are maintained in Marlborough, Massachusetts; Orlando, Florida; San Jose, California; Denver, Colorado; Lafayette, Louisiana; and Houston, Texas.

## 2.2 Management Responsibilities

**Requirement.** Each laboratory facility will have an established chain of command. The duties and responsibilities of the management staff are linked to the President/CEO of Accutest Laboratories who establishes the agenda for all company activities.

**President/CEO.** Primarily responsible for all operations and business activities. Delegates authority to laboratory directors, general managers, and quality assurance director to conduct day-to-day operations and execute quality assurance duties. Each of the individual operational entities (New Jersey, Massachusetts, Florida,, Texas, California, Colorado, and Louisiana) reports to the President/CEO.

**Corporate Quality Assurance Director.** Responsible for design, oversight, and facilitation of all quality assurance activities established by the Quality Program. Directly reports to the President/CEO.

**Vice President Operations/Laboratory Director.** There is a Laboratory Director assigned to each of the following operational entities: New Jersey, Massachusetts Florida, Louisiana, and West (Texas, California, and Colorado). The Laboratory Director executes day-to-day responsibility for laboratory operations including technical aspects of production activities and associated logistical procedures. Directly reports to the President/CEO.

**Quality Assurance Officer (on location).** Responsible for oversight, implementation and facilitation of all quality assurance activities established by the Quality Program. Directly reports to the Laboratory Director. Also exchanges information with and submits laboratory performance data (PE scores, audit reports, accreditation changes, etc.) to Corporate QA Director. Takes program directions from Corporate QA Director.

**Technical Director.** Responsible for oversight and implementation of technical aspects of production activities in the environmental testing laboratory. In the event that the technical director, quality assurance director, or laboratory manager is absent for a period of time that exceeds 15 consecutive calendar days, the designated appointees shall temporarily perform the technical director, quality assurance director, or laboratory manager's job function. If this absence exceeds 65 consecutive calendar days, the Accreditation Body(ies), including DoD ELAP, is to be notified in writing.

Current list of appointed deputies located in restricted access controlled document directory

**Department Managers.** Executes day-to-day responsibility for specific laboratory areas including technical aspects of production activities and associated logistical procedures. Directly report to the Laboratory Director.

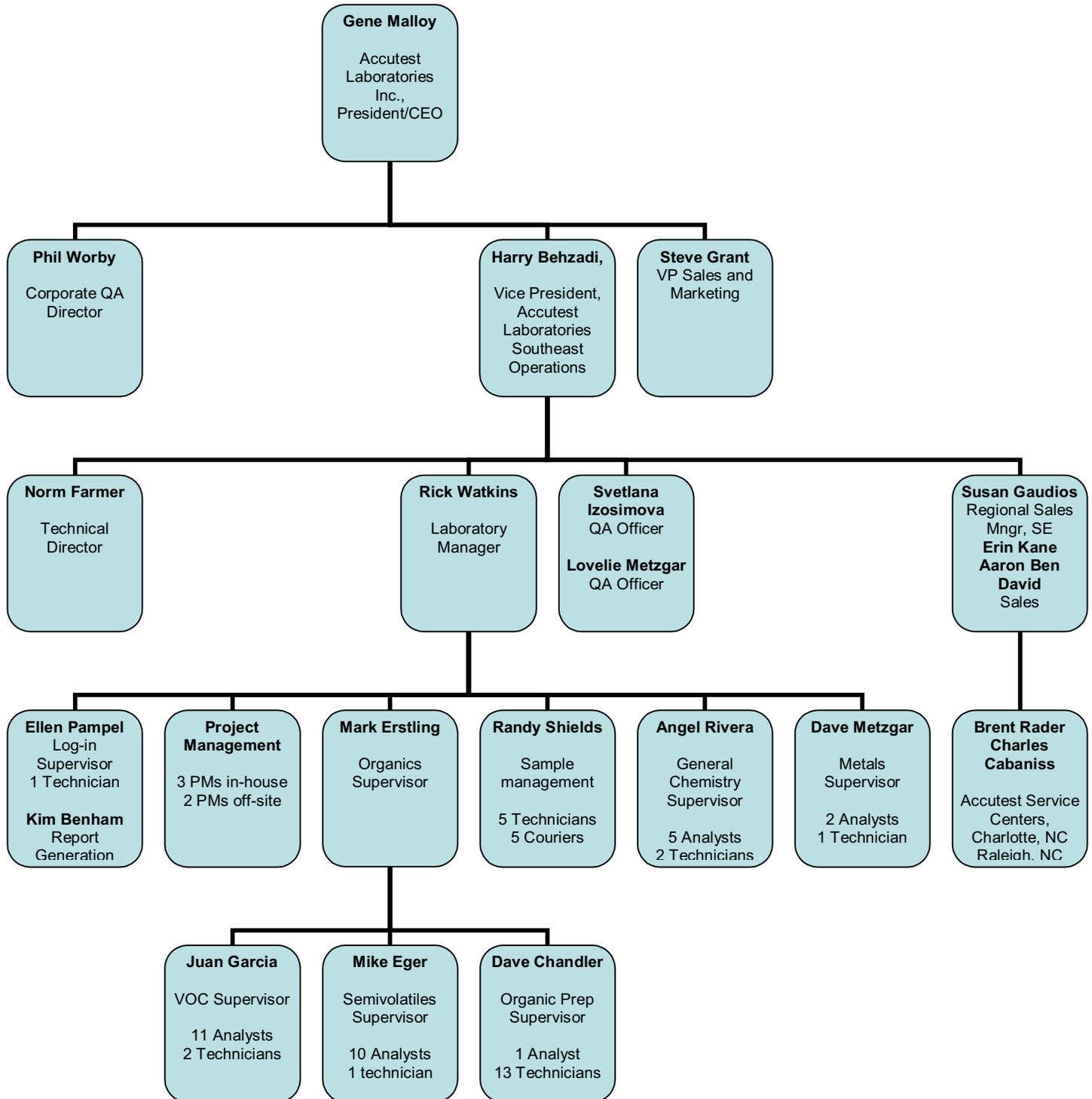
**Section Supervisors.** Executes day-to-day responsibility for specific laboratory units including technical aspects of production activities and associated logistical procedures. Directly report to the Department Manager.

### **2.3 Chain of Command**

The responsibility for managing all aspects of the Company's operation is delegated to specific individuals, who have been assigned the authority to act in the absence of the senior staff. These individuals are identified in the following Chain of Command:

Harry Behzadi, Ph.D., VP, Southeast Operations  
Norm Farmer, Technical Director (Operations and IT)  
Rick Watkins, Laboratory Manager (Operations)  
Heather Wandrey, Project Manager (Client Services)

## Accutest Laboratories Southeast Organizational Chart



### 3.0 QUALITY RESPONSIBILITIES OF THE MANAGEMENT TEAM

3.1 **Requirement:** Each member of the management team has a defined responsibility for the Quality Program. Program implementation and operation is designated as an operational management responsibility. Program design and implementation is designated as a Quality Assurance Responsibility.

**President/CEO:** Primary responsibility for all quality activities. Delegates program responsibility to the Quality Assurance Director. Serves as the primary alternate in the absence of the Quality Assurance Director. Has the ultimate responsibility for implementation of the Quality Program.

**Vice President Operations/Laboratory Director.** Responsible for implementing and operating the Quality Program in all laboratory areas. Responsible for the design and implementation of corrective action for defective processes. Has the authority to delegate Quality Program implementation responsibilities.

**Corporate Quality Assurance Director.** Responsible for design, implementation support, training, and monitoring of the quality system. Identifies product, process, or operational defects using statistical monitoring tools and processes audits for elimination via corrective action. Empowered with the authority to halt production if warranted by quality problems. Monitors implemented corrective actions for compliance.

**Quality Assurance Officer (on location).** Responsible for design support, implementation support, and monitoring support of the quality system. Training personnel in various aspects of quality system. Conducts audits and product reviews to identify product, process, or operational defects using statistical monitoring tools and processes audits for elimination via corrective action. Empowered with the authority to halt production if warranted by quality problems. Monitors implemented corrective actions for compliance.

**Technical Director.** Responsible for oversight and implementation of technical aspects of Quality System as they are integrated into method applications and employed to assess analytical controls on daily basis. The Technical Director reviews and acknowledges the technical feasibility of proposed quality system involving technical applications.

**Department Managers.** Responsible for applying the requirements of the Quality Program in their section and assuring subordinate supervisors and staff apply all program requirements. Initiates, designs, documents, and implements corrective action for quality deficiencies.

**Group Leaders.** Responsible for applying the requirements of the Quality Program to their operation and assuring the staff applies all program requirements. Initiates, designs, documents, and implements corrective action for quality deficiencies.

**Bench Analysts.** Responsible for applying the requirements of the Quality Program to the analyses they perform, evaluating QC data and initiating corrective action for quality control deficiencies within their control. Implements global corrective action as directed by superiors.

### 3.2 **Program Authority:**

Authority for program implementation on corporate level originates with the President/CEO who bears ultimate responsibility for program design, implementation, and enforcement of requirements. This authority and responsibility is delegated to the Director of Quality Assurance who performs quality functions independently without the encumbrances or biases created by operational or production responsibilities to ensure an honest, independent assessment of quality issues.

Laboratory Director and Quality Assurance Officer mirror this authority on location.

### 3.3 **Data Integrity Policy:**

The Accutest Data Integrity Policy reflects a comprehensive, systematic approach for assuring that data produced by the laboratory accurately reflects the outcome of the tests performed on field samples and has been produced in a bias free environment by ethical professionals. The policy includes a commitment to technical ethics, staff training in ethics and data integrity, an individual attestation to data integrity and procedures for evaluating data integrity. Senior management assumes the responsibility for assuring compliance with all technical ethics elements and operation of all data integrity procedures. The staff is responsible for compliance with the ethical code of conduct and for practicing data integrity procedures.

The Accutest Data Integrity Policy is as follows:

***“Accutest Laboratories is committed to producing data that meets the data integrity requirements of the environmental regulatory community. This commitment is demonstrated through the application of a comprehensive data integrity program that includes ethics and data integrity training, data integrity evaluation procedures, staff participation and management oversight. Adherence to the specifications of the program assures that data provided to our clients is of the highest possible integrity and can be used for decision making processes with high confidence.”***

## **Data Integrity Responsibilities**

**Management.** Senior management retains oversight responsibility for the data integrity program and retains ultimate responsibility for execution of the data integrity program elements. Senior management is responsible for providing the resources required to conduct ethics training and operate data integrity evaluation procedures. They also include responsibility for creating an environment of trust among the staff and being the lead advocate for promoting the data integrity policy and the importance of technical ethics.

**Staff.** The staff is responsible for adhering to the company ethics policy as they perform their duties and responsibilities associated with sample analysis and reporting. By executing this responsibility, data produced by Accutest Laboratories retains its high integrity characteristics and withstands the rigors of all data integrity checks.

The staff is also responsible for adhering to all laboratory requirements pertaining to manual data edits, data transcription and data traceability. These include the application of approved manual peak integration and documentation procedures. It also includes establishing traceability for all manual results calculations and data edits.

**Ethics Statement.** The Accutest ethics statement reflects the standards that are expected for businesses that provide environmental services to regulated entities and regulatory agencies on a commercial basis. The Ethics Policy is comprised of key elements that are essential to organizations that perform chemical analysis for a fee. As such, it focuses on elements related to personal, technical and business activities.

Accutest Laboratories provides analytical chemistry services on environmental matters to the regulated community. The data the company produces provides the foundation for determining the risk presented by a chemical pollutant to human health and the environment. The environmental industry is dependent upon the accurate portrayal of environmental chemistry data. This process is reliant upon a high level of scientific and personal ethics.

It is essential to the Company that each employee understands the ethical and quality standards required to work in this industry. Accordingly, Accutest has adopted a code of ethics, which each employee is expected to adhere to as follows:

- Perform chemical and microbiological analysis using accepted scientific practices and principles.
- Perform tasks in an honest, principled and incorruptible manner inspiring peers & subordinates.
- Maintain professional integrity as an individual.
- Provide services in a confidential, honest, and forthright manner.
- Produce results that are accurate and defensible.

- Report data without any considerations of self-interest.
- Comply with all pertinent laws and regulations associated with assigned tasks and responsibilities.

### **Data Integrity Procedures.**

Four key elements comprise the Accutest data integrity system:

- 1) data integrity training,
- 2) signed data integrity documentation for all laboratory employees,
- 3) in-depth, periodic monitoring of data integrity, and
- 4) data integrity procedure documentation.

Procedures have been implemented for conducting data integrity training and for documenting that employees conform to the Accutest Data Integrity and Ethics policy.

The data integrity program consists of routine data integrity evaluation and documentation procedures to periodically monitor and document data integrity. These procedures are documented in SOPs. SOPs are approved and reviewed annually following the procedures employed for all Accutest SOPs. Documentation associated with data integrity evaluations is maintained on file and is available for review.

**Data Integrity Training.** Accutest employees receive technical ethics training during new employee orientation. Employees are also required to attend annual ethics refreshment training and sign an ethical conduct agreement annually, which verifies their understanding of Accutest's technical ethics policy and their ethical responsibilities. The agreement is refreshed annually and appended to each individual's training file.

The training focuses on the reasons for technical ethic training, explains the impact of data fraud on human health and the environment, and illustrates the consequences of criminal fraud on businesses and individual careers. Multiple examples of prohibited practices are reviewed and discussed. Accutest's ethics policy and code of ethics are reviewed and explained for each new employee. Employees receive Accutest's technical ethics brochure for further review.

Training on department-specific data integrity procedures are conducted by individual departments for groups involved in data operations. These include procedures for manual chromatographic peak integration, standards traceability, etc.

**Data Integrity Training Documentation.** Records of all data integrity training are maintained in individual training folders. Attendance at all training sessions is documented and appended to the training file.

**Accutest Data Integrity and Ethical Conduct Agreement.** All employees are required to sign a Data Integrity and Ethical Conduct Agreement annually. This document is archived in individual training files, which are retained for duration of employment.

The Data Integrity and Ethical Conduct Agreement is as follows:

- I. I understand the high ethical standards required of me with regard to the duties I perform and the data I report in connection with my employment at Accutest Laboratories.*
- II. I have received formal instruction on the code of ethics that has been adapted by Accutest Laboratories and agree to comply with these requirements.*
- III. I have received formal instruction on the elements of Accutest Laboratories' Data Integrity Policy and have been informed of the following specific procedures:*
  - a. Routine data integrity monitoring is conducted on sample data, which may include an evaluation of the data I produce,*
  - b. Formal procedures for the confidential reporting of data integrity issues are available, which can be used by any employee,*
  - c. A data integrity investigation is conducted when data issues are identified that may negatively impact data integrity.*
- IV. I am aware that data fraud is a punishable crime that may include fines and/or imprisonment upon conviction.*
- V. I also agree to the following:*
  - a. I shall not intentionally report data values, which are not the actual values observed or measured.*
  - b. I shall not intentionally modify data values unless the modification can be technically justified through a measurable analytical process.*
  - c. I shall not intentionally report dates and times of data analysis that are not the true and actual times the data analysis was conducted.*
  - d. I shall not condone any accidental or intentional reporting of inauthentic data by other employees and immediately report it's occurrence to my superiors.*
  - e. I shall immediately report any accidental reporting of inauthentic data by myself to my superiors.*

**Data Integrity Monitoring.** Several documented procedures are employed for performing data integrity monitoring. These include regular data review procedures by supervisory and management staff (Section 12.7), supervisory review and approval of manual integrations and periodic reviews of data audit trails from the LIMS and all computer controlled analysis.

*Data Review.* All data produced by the laboratory undergoes several levels of review, which includes two levels of management review. Detected data anomalies that appear to be related to data integrity issues are isolated for further investigation. The investigation is conducted following the procedures described in this section.

*Manual Peak Integration Review and Approval.* Routine data review procedures for all chromatographic processes includes a review of all manual chromatographic peak integrations. This review is performed by the management staff and consists of a review of the machine integration compared to the manual integration. Manual integrations, which have been performed in accordance with Accutest's manual peak integration procedures are approved for further processing and release. Manual integrations which are not performed to Accutest's specifications are set aside for corrective action, which may include analyst retraining or further investigation as necessary.

*Data Audit Trail Review.* Data integrity audits are comprehensive data package audits that include a review of raw data, process logbooks, processed data reports and data audit trails from individual instruments and LIMS. Data audit trails, which record all electronic data activities, are available for the majority of computerized methodology and the laboratory information management system (LIMS). These audit trails are periodically reviewed to determine if interventions performed by technical staff constitute an appropriate action. The review is performed on a recently completed job and includes interviews with the staff that performed the analysis. Findings indicative of inappropriate interventions or data integrity issues are investigated to determine the cause and the extent of the anomaly.

**Confidential Reporting Of Data Integrity Issues.** Data integrity concerns may be raised by any individual to their supervisor. Employees with data integrity concerns should always discuss those concerns with their immediate supervisors as a first step unless the employee is concerned with the confidentiality of disclosing data integrity issues or is uncomfortable discussing the issue with their immediate supervisors. The supervisor makes an initial assessment of the situation to determine if the concern is related to a data integrity violation. Those issues that appear to be violations are documented by the supervisor and referred to the QA Officer (local) for investigation.

Documented procedures for the confidential reporting of data integrity issues in the laboratory are part of the data integrity policy. These procedures assure that laboratory staff can privately discuss ethical issues or report items of ethical concern without fears of repercussions with senior staff.

Employees with data integrity concerns that they consider to be confidential are directed to the Corporate Human Resources Manager in Dayton, New Jersey. The HR Manager acts as a conduit to arrange a private discussion between the employee and the Corporate QA Director or a local QA Officer.

During the employee - QA discussion, the QA representative evaluates the situation presented by the employee to determine if the issue is a data integrity concern or a legitimate practice. If the practice is legitimate, the QA representative clarifies the

process for the employee to assure understanding. If the situation appears to be a data integrity concern, the QA representative initiates a Data Integrity Investigation following the procedures specified in SOPs QA038-QA041.

**Data Integrity Investigations.** Follow-up investigations are conducted for all reported instances of ethical concern related to data integrity. Investigations are performed in a confidential manner by senior management according to a documented procedure. The outcome of the investigation is documented and reported to the company president who has the ultimate responsibility for determining the final course of action in the matter. Investigation documentation includes corrective action records, client notification information and disciplinary action outcomes, which is archived for a period of five years.

The investigations are conducted by the senior staff and supervisory personnel from the affected area. The investigation team includes the Laboratory Director and the Quality Assurance Officer. Investigations are conducted in a confidential manner until it is completed and resolved.

The investigation includes a review of the primary information in question by the investigations team. The team performs a review of associated data and similar historical data to determine if patterns exist. Interviews are conducted with key staff to determine the reasons for the observed practices.

Following data compilation, the investigations team reviews all information to formulate a consensus conclusion. The investigation results are documented along with the recommended course of action.

**Corrective Action, Client Notification & Discipline.** Investigations that reveal systematic data integrity issues will go through corrective action for resolution and disposition (Section 13). If the investigation indicates that an impact to data has occurred and the defective data has been released to clients, client notification procedures will be initiated following the steps in Section 17.6.

In all cases of data integrity violations, some level of disciplinary action will be conducted on the responsible individual. The level of discipline will be consistent with the violation and may range from retraining and/or verbal reprimand to termination.

## 4.0 JOB DESCRIPTIONS OF KEY STAFF

4.1 **Requirement:** Descriptions of key positions within the organization must be defined to ensure that clients and staff understand duties and the responsibilities of the management staff and the reporting relationships between positions.

**President/Chief Executive Officer.** Responsible for all laboratory operations and business activities. Establishes the company mission and objectives in response to business needs. Direct supervision of the Vice President of Operations, each laboratory director, client services, management information systems, and quality assurance.

**Vice President, Operations/Laboratory Director.** Reports to the company president. Establishes regional laboratory operations strategy and business development. Authorized to enter into contractual agreements on Company's behalf.

**Director, Quality Assurance.** Reports to the company president. Establishes the company quality agenda, develops quality procedures, provides assistance to operations on quality procedure implementation, coordinates all quality control activities monitors the quality system and provides quality system feedback to management to be used for process improvement.

**Vice President, Information Technologies** Reports to the company president. Develops the MIS software and hardware agenda. Provides system strategies to compliment company objectives. Maintains all software and hardware used for data handling.

**Client Services, Sales, Account Manager(s).** Reports to the company president. Establishes and maintains communications between clients and the laboratory pertaining to client requirements which are related to sample analysis and data deliverables. Initiates client orders and supervises sample login operations.

**Quality Assurance Officer (on location).** Reports to the Laboratory Director. Develops quality procedures, provides assistance to operations on quality procedure implementation, coordinates all quality control activities, monitors the quality system, and provides quality system feedback to management to be used for process improvement. In the event of prolonged absence QAO also designated a Deputy Technical Director, unless otherwise specified by internal memo from Laboratory Director.

**Manager Client Services (on location).** Reports to the Laboratory Director. Establishes and maintains communications between clients and the laboratory pertaining to client requirements which are related to sample analysis and data deliverables. Initiates client orders and supervises sample login operations.

**Technical Director (On Location).** Reports to the laboratory director. Establishes laboratory operations strategy. Direct supervision of organic chemistry and inorganic

chemistry. Directs the operations, preparation and instrumental analysis. Responsible for following Quality Program requirements. Assumes operational responsibilities of Lab Director in his absence.

**Laboratory Manager.** Reports to the Laboratory Director. Directs the day-to day operations of entire laboratory, direct supervision of organic chemistry, inorganic chemistry, field services, and sample management. Oversees daily work schedule as developed by respective departments. Supervises method implementation. Responsible for following Quality Program requirements. Maintains laboratory instrumentation in an operable condition.

**Supervisors, Shipping and Receiving Departments.** Reports to the Laboratory Manager. Develops, maintains and executes all procedures required for transport and receipt of samples, verification of preservation, and chain of custody documentation. Responsible for maintaining and documenting secure storage, delivery of samples to laboratory units on request, and disposal following completion of all analytical procedures.

**Supervisor, Wet Chemistry.** Reports to the Laboratory Manager. Directs the operations of the wet chemistry group. Establishes and executes daily work schedule. Supervises method implementation, application, and data production. Supervises the analysis of samples for wet chemistry parameters using valid, documented methodology. Maintains instrumentation in an operable condition. Reviews data for compliance to quality and methodological requirements. Responsible for following Quality Program requirements.

**Supervisor, Metals.** Reports to the Laboratory Manager. Directs the operations of the metals group. Establishes and executes daily work schedule. Supervises method implementation, application, and data production. Supervises the analysis of samples for metallic elements using valid, documented methodology. Documents all procedures and data production activities. Maintains instrumentation in an operable condition. Reviews data for compliance to quality and methodological requirements. Responsible for following Quality Program requirements

**Supervisor, Organic Preparation.** Reports to the Laboratory Manager. Directs the operations of the sample preparation group. Establishes and executes daily work schedule. Supervises method implementation, and application. Supervises the preparation of samples for organic compounds using valid, documented methodology. Documents all procedures and data production activities. Maintains laboratory equipment in an operable condition. Reviews records for compliance to quality and methodological requirements. Responsible for following Quality Program requirements.

**Volatile and Semivolatile Supervisors, Organics.** Reports to the Laboratory Manager. Directs the operations of the respective organics group. Establishes and executes daily work schedule. Supervises method implementation, application, and data production. Supervises the analysis of samples for organic compounds using valid, documented methodology. Documents all procedures and data production

activities. Maintains instrumentation in an operable condition. Reviews data for compliance to quality and methodological requirements. Responsible for following Quality Program requirements

**Report Generation Supervisor.** Reports to Laboratory Manager. Oversees report generation and fulfillment of client specifications as applied to data deliverables. Responsible for data delivery in timely manner.

Detailed Job descriptions of lab personnel are found in training folders

#### **4.2 Employee Screening, Orientation, and Training.**

All potential laboratory employees are screened and interviewed by human resources and technical staff prior to their hire. The pre-screen process includes a review of their qualifications including education, training and work experience to verify that they have adequate skills to perform the tasks of the job. Minimum qualifications for non-technical personnel require High School diploma (couriers also shall possess clean driving record), technical personnel must also demonstrate basic laboratory experience, such as balance and syringe use, aseptic practices, etc. College-level science coursework is favored.

Newly hired employees receive orientation training beginning the first day of employment by the Company. Orientation training consists of initial health and safety training and a detailed review of the personal protection policies, technical ethics training and data integrity procedures and quality assurance program training (including Company's goals, objectives, mission, and vision).

All technical staff receives training to develop and demonstrate proficiency for the methods they perform. New analysts work under supervision until the supervisory staff is satisfied that a thorough understanding of the method is apparent. Organics/Inorganics analysts are required to demonstrate method proficiency through a precision and accuracy study. Data from the study is compared to method acceptance limits. If the data is unacceptable, additional training is required. The analyst must also demonstrate the ability to produce acceptable data through the analysis of an independently prepared proficiency sample.

Proficiency is demonstrated annually. Data from initial and continuing proficiency demonstration is archived in the individual's training folder. In the instance where analyte can not be spiked in the clean matrix, such as TSS or pH, the results of an external Performance Evaluation (PE) sample may be used to document analyst's proficiency.

Minimum training required for administrative staff consists of laboratory safety and ethical conduct.

#### **4.3 Training Documentation.** The QA Officer prepares a training file for every new employee. All information related to qualifications, experience, external training courses, and education are placed into the file. Verification documentation for

orientation, health & safety, quality assurance, and ethics training is also included in the file.

Additional training documentation is added to the file as it occurs. This includes data for initial and continuing demonstrations of proficiency, performance evaluation study data and notes and attendance lists from group training sessions.

The Quality Assurance Department maintains the employee training database. This database is a comprehensive inventory of training documentation for each individual employee. The database enables supervisors to obtain current status information on training data for individual employees on a job specific basis. It also enables the management staff to identify training documentation in need of completion.

Employee specific database records are created by human resources on the date of hire. Data base fields for job specific requirements such as SOP documentation of understanding and annual demonstration of analytical capability are automatically generated when the supervisor assigns a job responsibility. Employees acknowledge that their SOP responsibilities have been satisfied using a secure electronic process, which updates the database record. Reports are produced which summarize the qualifications of individual employees or departments.

## 5.0 SIGNATORY APPROVALS

**Requirement:** Procedures are required for establishing the traceability of data and documents. The procedure consists of a signature hierarchy, indicating levels of authorization for signature approvals of data and information within the organization. Signature authority is granted for approval of specific actions based on positional hierarchy within the organization and knowledge of the operation that requires signature approval. A log of signatures and initials of all employees is maintained for cross-referencing purposes.

### 5.1 Signature Hierarchy.

**President/Chief Executive Officer.** Authorization for contracts and binding agreements with outside parties. Approval of final reports, quality assurance policy, SOPs, project specific QAPs, data review and approval in lieu of technical managers. Contract signature authority resides with Company Officers only, which include the President/CEO, CFO and VP Administration.

**Vice President, Operations/Laboratory Director.** Approval of final reports and quality assurance policy in the absence of the President. Approval of SOPs, project specific QAPs, data review and approval in lieu of technical managers. Technical policy.

**Technical Director (on location):** Approval of final reports and quality assurance policy in the absence of the Laboratory Director. Approval of SOPs, project specific QAPs, data review and approval in lieu of technical managers. Technical policy review. In the event of prolonged absence refer to list of approved deputies – sec 2.2.

**Director, Quality Assurance.** Approval of final reports and quality assurance policy in the absence of the President. Approval of SOPs, project specific QAPs, data review and approval in lieu of technical managers.

**Quality Assurance Officer (on location).** Approval of final reports and quality assurance policy in the absence of the Laboratory Director. Approval of SOPs, project specific QAPs, data review and approval in lieu of technical managers. In the event of prolonged absence refer to list or appointed deputies – see sec. 2.2.

**Manager, Sample Management.** Initiation of laboratory sample custody and acceptance of all samples. Approval of department policies and procedures. Department specific supplies purchase. Waste manifesting and disposal.

**Project Manager, Client Services.** QAP and sampling and analysis plan approval. Project specific contracts, pricing, and price modification agreements. Approval and acceptance of incoming work, Client services policy.

**Supervisors, Technical Departments.** Methodology and department specific QAPs. Data review and approval, department specific supplies purchase. Technical approval of SOPs.

**Supervisors, Technical Departments.** Data review approval, purchasing of expendable supplies.

**5.2 Signature Requirements.** All laboratory activities related to sample custody and generation or release of data must be approved using either initials or signatures. The individual, who applies his signature or initial to an activity or document, is authorized to do so within the limits assigned to them by their supervisor. All signatures and initials must be applied in a readable format that can be cross-referenced to the signatures and initials log if necessary.

**5.3 Signature and Initials Log.** The QA Officer maintains a signature and initials log. New Employee signatures and initials are appended to the log on the first day of employment. Signature of individuals no longer employed by the company are retained.

## 6.0 DOCUMENTATION and DOCUMENT CONTROL

**Requirement:** Document control policies have been established which specify that any document used as an information source or for recording analytical or quality control information must be managed using defined document control procedures. Accordingly, policies and procedures required for the control, protection, and storage of any information related to the production of analytical data and the operation of the quality system to assure its integrity and traceability have been established and implemented in the laboratory. The system contains sufficient controls for managing, archiving and reconstructing all process steps, which contributed to the generation of an analytical test result. Using this system, an audit trail for reported data can be produced, establishing complete traceability for the result.

**6.1 Administrative Records.** The Quality Assurance Officer manages Administrative (non-analytical) records. These records consist of electronic documents that are retained in a limited access electronic directory, which are released to the technical staff upon specific request.

**Form Generation & Control.** The Quality Assurance Officer approves all forms used as either stand-alone documents or in logbooks to ensure their traceability. Forms are generated as computer files only and maintained in a limited access master directory. Access to the electronic forms and applications is granted to QA Officer, Laboratory Manager and Technical Director(s) (local and regional). Approved forms must display the date of current revision and initials of person who revised the form. Modifications to existing forms are approved by QA, obsolete forms moved to archive directory and retained for minimum of five years.

New forms must include Accutest SE identification and appropriate spaces for signatures of approvals and dates. Further design specifications are the responsibility of the originating department.

Technical staff is required to complete all forms to the maximum extent possible. If information for a specific item is unavailable, the analyst is required to cross out the information block. The staff is also required to cross out the uncompleted portions of a logbook or logbook form if the day's analysis does not fill the entire page of the form.

**Logbook Control.** All laboratory logbooks are controlled documents that are comprised of approved forms used to document specific processes. Logbook control is maintained by QA staff.

New logs are numbered and issued to a specific individual who is assigned responsibility for the log. Supervisor performs periodical review of the logbooks. Old logs are returned to QA for entry into the document archive system where they are retained for minimum of five (5) years. Laboratory staff may hold a maximum of two consecutively dated logbooks of the same type in the laboratory, not including the most recently issued book to simplify review of recently completed analysis.

**Controlled Documents.** Key laboratory documents are designated for controlled document status to assure that identities of individuals receiving copies and the number of copies that have been distributed are known. Controlled status simplifies document updates and **retrieval** of outdated documents. Control is maintained through a document numbering procedure and document control logbook designating the individual receiving the controlled document. Document control is also maintained by pre-designating the numbers of official copies of documents that are placed into circulation within the laboratory.

**Quality Systems Manual (QSM).** All QSMs are assigned a number prior to distribution. The QSMs are distributed as controlled documents i.e. ones that will be collected back and replaced with next version (documents distributed to the Accutest Inc. staff). QSMs distributed to outside entities are considered tracked documents – since there is no possibility of collecting them back and ensuring that current revision is in use. These situation include bid submissions, client requests, etc. These copies are watermarked as “Uncontrolled Documents” The control/tracking number, date of distribution, and identity of the individual receiving the document are recorded in the document control spreadsheet. QA staff maintains tracking spreadsheet. The numbering system is continuous.

**Standard Operating Procedures (SOPs).** SOPs are maintained by pre-designating the numbers of official copies of documents that are placed into circulation within the laboratory. Official documents are printed and placed into the appropriate laboratory section as follows:

Sample Management: One copy for the sample receiving file  
Bottle preparation area – One copy for shipping area  
Organics Laboratories: One for the affected laboratory area.  
Inorganics Laboratories: One for the affected laboratory area.

The original, signed copy of the SOP is maintained in the master SOP binder by the QA staff.

Documents are controlled using an “Official Copy” stamp in red ink. Additional copies could be issued to individuals for training purposes. Distribution is documented on SOP cover page. Superseded copies collection is conducted accordingly to cover page distribution list.

SOPs distributed to clients as part of bid submission, pre-audit evaluation, etc. are watermarked as “Proprietary Information”.

**Quick reference cards:** These documents are compiled for lab staff convenience and are based on current SOP revision and/or recent regulatory updates. These one- or two-sided documents are footnoted with reference to SOP/regulatory standard, stamped with “Official Copy” stamp in red ink and laminated for durability. *Use of these quick references does not substitute reading and acknowledging the parent SOP.*

Operators' Manuals are considered controlled documents and stored in appropriate departments.

- 6.2 Technical Records.** All records related to the analysis of samples and the production of analytical results are archived in secure document storage or on electronic media and contain sufficient detail to produce an audit trail, which re-creates the analytical result. These records include information related to the original client request, bottle order, sample login and custody, storage, sample preparation, analysis, data review and data reporting.

Records that can not be maintained on electronic media are considered irretrievable records, segregated into separate secured storage and access controlled with access log maintained by QA Staff. Examples of such records are employee training files, obsolete SOPs and acknowledgement form originals, training files, logbooks, etc.

Each department involved in this process maintains controlled documents, which enable them to maintain records of critical information relevant to their department's process.

- 6.3 Quality Assurance Directory.** All Quality Assurance documentation and quality control limit data is stored in a restricted QA directory on the network server. The directory has been designated as read only. The QA staff, technical director and the laboratory manager have write capability in this directory. Information on this directory is backed-up daily.

This directory contains all current and archived Quality System Manuals, SOPs, control limits, MDL studies, precision and accuracy data, internal and external audit reports, official forms, Health and Safety materials, PT scores, State Certifications and metrics calibration information.

- 6.4 Analytical Records.** All data related to the analysis of field samples are retained as either paper or electronic records that can be retrieved to compile a traceable audit trail for any reported result. All information is linked to the client job and sample number, which serves as a reference for all sample related information tracking.

Critical times in the life of the sample from collection through analysis to disposal are documented. This includes date and time of collection, receipt by the laboratory, preparation times and dates, analysis times and dates and data reporting information. Analysis times are calculated in hours for methods where holding time is specified in hours ( $\leq 72$  hours).

Sample preparation information is recorded in a separate controlled logbook or on controlled forms in three-ring binder. It includes sample identification numbers, types of analysis, preparation and cleanup methods, sample weights and volumes, reagent lot numbers and volumes and any other information pertinent to the preparation procedure.

Information related to the identification of the instrument used for analysis is permanently attached to the electronic record. The record includes an electronic data file that indicates all instrument conditions employed for the analysis, including the type of analysis conducted. The analyst's identification is electronically attached to the record. The instrument tuning and calibration data is electronically linked to the sample or linked through paper logs, which were used in the documentation of the analysis. Quality control and performance criteria are permanently linked to the paper archive or electronic file.

Paper records for the identity, receipt, preparation and evaluation of all standards and reagents used in the analysis are documented in prepared records and maintained in controlled documents or files. Lot number information linking these materials to the analysis performed is recorded in the logbooks associated with the samples in which they were used.

Manual calculations or peak integrations that were performed during the data review are retained as paper or electronically generated PDF documents and included as part of the electronic archive. Signatures for data review are retained on paper or as electronic stamps on PDF versions of the paper record for the permanent electronic file.

- 6.5 Confidential Business Information (CBI).** Operational documents including SOPs, Quality Manuals, personnel information, internal operations statistics, and laboratory audit reports are considered confidential business information. Strict controls are placed on the release of this information to outside parties.

Release of CBI to outside parties or organizations may be authorized upon execution of a confidentiality agreement between Accutest and the receiving organization or individual. CBI information release is authorized for third party auditors and commercial clients in electronic mode as Adobe Acrobat .PDF format only.

- 6.6 Software Change Documentation & Control.** Changes to software are documented as text within the code of the program undergoing change. Documentation includes a description of the change, reason for change and the date the change was placed into effect. Documentation indicating the adequacy of the change is prepared following the evaluation by the user who requested the change.

- 6.7 Report and Data Archiving.** Accutest Laboratories maintains electronic image file copies of original reports in archive for a minimum period of five (5) years. After five years, the files are automatically discarded unless contractual arrangements exist which dictate different requirements. Client specific data retention practices are employed for government organizations such as the Department of Defense Agencies and MA DEP that require a retention period of ten (10) years, as well as commercial clients upon contractual requirements agreement.

Complete date and time stamped client reports are generated from LIMS using the source documents archived on Document server. These source documents are maintained on document server and backed up to primary and clone tapes. Accutest

archives the original report (organized by job number) and the organic and inorganic support data. Organic support data is archived according to instrument batch numbers. All organics data is backed up to the tape or archive drive via Networker Backup software and/or AccuBack backup software. Data from the archive drive is then written to tape at periodic intervals.

Wet chemistry support data is archived by analytical batch (GN...). Metals support data is archived by instrument batch (MA...). Metals digestion data is archived as digestion logbooks.

The reports generation group electronically scans completed reports and stores them by job number on the document server. The document server is backed up daily to a digital tape. Copies of these files remain active on the document server for easy review access. The digital tapes remain in secure storage for the remainder of the archive period.

- 6.8 Training.** Ongoing training ensures competence of all relevant personnel. At the minimum personnel should possess knowledge of the technology used in the testing, general requirements expressed in legislature and industry standards, and understand the significance of deviations with regard to approved procedures. The company maintains a training record for all employees that documents that they have received instruction on administrative and technical tasks that are required for the job they perform. Training records for individuals employed by the company are retained for a period of five years following their termination of employment.

**Training File Origination.** The Quality Assurance Officer (QAO) initiates training files. Quality Assurance officer retains the responsibility for the maintenance and tracking of all training related documentation in the file. The file is begun on the first day of employment. Information required for the file includes a copy of the individual's most current resume, detailing work experience and a copy of any college diplomas or transcript(s). Information added on the first day includes documentation of health and safety training and a signed Ethics and Data Integrity agreement. These two constitute minimal necessary training for Project Management and Administrative staff. Training documentation, training requirements, analyst proficiency information and other training related support documentation is tracked using a customized database application. Database extracts provide an itemized listing of specific training requirements by job function. Training status summaries for individual analysts portray dates of completion for job specific training requirements.

**Technical Training.** The supervisor of each new employee is responsible for developing a training plan for each new employee. The supervisor updates the outline, adding signatures and dates as training elements are completed at regular frequency. Supporting documentation, such as precision and accuracy studies, which demonstrate analyst capability for a specific test, are added as completed. When analyte can not be spiked, such as pH or TSS, external PE sample is purchased and analyzed. Where no external PE sample is available, sample duplicates must be successfully analyzed. Method review records are retained where analysis of duplicates is not possible. Employees and supervisors verify documentation of

understanding (DOU) for all assigned standard operating procedures in the training database. Certificates or diplomas for any off-site training are added to the file.

## 7.0 REFERENCE STANDARD TRACEABILITY

**Requirement:** Documented procedures, which establish traceability between any measured value and a national reference standard, must be in place in the laboratory. All metric measurements must be traceable to NIST reference weights or thermometers that are calibrated on a regular schedule. All chemicals used for calibration of a quantitative process must be traceable to an NIST reference that is documented by the vendor using a certificate of traceability. The laboratory maintains a documentation system that establishes the traceability links. The procedures for verifying and documenting traceability must be documented in standard operating procedures.

**7.1 Traceability of Metric Measurements - Thermometers.** Accutest uses NIST-traceable thermometers to calibrate commercially purchased working laboratory thermometers prior to their use in the laboratory and annually thereafter for liquid in glass thermometers or quarterly for electronic temperature measuring devices. If necessary, these working thermometers are assigned correction factors that are determined during their calibration using an NIST-traceable thermometer as the standard. The correction factor is documented in a thermometer log and on a tag attached to the working thermometer. Both original observation and corrected measurement are recorded in the temperature log. The NIST-traceable reference thermometer is checked for accuracy by an outside vendor minimum every five (5) years following the specifications for NIST-traceable thermometer calibration verification detailed in the United States Environmental Protection Agency's "Manual for the Certification of Laboratories Analyzing Drinking Water", Fifth Edition, January 2005. Currently the NIST thermometer is verified by outside vendor on triennial basis due to contract-specific requirements. Calibration log and Certificate(s) of calibration are maintained on file with QAO.

**7.2 Traceability of Metric Measurements – Calibration Weights.** Accutest uses calibrated weights, which are traceable to NIST standard weights to calibrate all balances used in the laboratory. Balances must be calibrated to specific tolerances within the intended use range of the balance. Calibration checks are required on each day of use. If the tolerance criteria are not achieved, corrective action specified in the balance calibration SOP must be applied before the balance can be used for laboratory measurements. All weights are recalibrated by outside vendor every five years following the specifications for weight calibration verification detailed in the United States Environmental Protection Agency's "Manual for the Certification of Laboratories Analyzing Drinking Water", Fifth Edition, January 2005. Certificate(s) of calibration are maintained on file with QAO. Balances are inspected and maintained by professional service technicians annually. Certificate(s) of inspection are maintained with QAO.

**7.3 Traceability of Chemical Standards and Reagents.** All chemicals and reagents, with the exception of bulk dry  $\text{Na}_2\text{SO}_4$  and solvents purchased as reference standards for use in method calibration must establish traceability to NIST referenced material through a traceability certificate (Certificate of Analysis, CoA). Process links are

established that enable a calibration standard solution to be traced to its NIST reference certificate. Solvents, acids and other supplies are being tested to verify their suitability for the analytical process.

**7.4 Assignment Of Reagent and Standard Expiration Dates.** Expiration date information for all purchased standards and reagents is provided to Accutest with all prepared standard solutions and unstable reagents as a condition of purchase. Neat materials and inorganic reagents are not required to be purchased with expiration dates. Certified prepared solutions are labeled with the expiration date provided by the manufacturer. In-house prepared solutions are assigned expiration dates that are consistent with the method that employs their use unless documented experience indicates that an alternate date can be applied. If alternate expiration dates are employed, their use is documented in the method SOP. Expiration dates for prepared inorganic reagents, which have not exhibited instability, are established at two years from the date of preparation for tracking purposes. All containers shall be labeled with the date of preparation and expiration date clearly indicated.

The earliest expiration date is always the limiting date for assigning expiration dates to prepared solutions. Expiration dates that are later than the expiration date of any derivative solution or material are prohibited.

**7.5 Documentation of Traceability.** Traceability information is documented in individual logbooks designated for the measurement process in use. The QA Officer maintains calibration documentation for metric references in pertinent folders and logbooks.

Balance calibration verification is documented in logbooks that are assigned to each balance. The individual conducting the verification is required to initial and date all calibration activities. Any defects that occur during verification are also documented along with the corrective action applied and a demonstration of return to control. Annual service and calibration reports and certificates retained on file with QA staff.

Temperature control is documented in logbooks assigned to the equipment being monitored. A verified (see 7.1) thermometer is assigned to each individual item. Measurements are recorded along with date and initials of the individual conducting the measurement on a daily or as used basis. Corrective action, if required, is also documented including the demonstration of return to control.

Initial traceability of chemical standards and reagents is documented via a vendor-supplied certificate (see also 7.3) that includes lot number and expiration date information. Solutions prepared using the vendor supplied chemical standard are documented in logbooks assigned to specific analytical processes. Alternatively, documentation may be entered into the electronic standards and reagent tracking log. The documentation includes links to the vendors lot number, an internal lot number, dates of preparation, and the preparer's initials. Standards received without certificate of analysis can not be used for calibration or calibration verification and are rejected.

Supervisors conduct regular reviews of logbooks, which are verified using a word rev'd", signature and date. QA Staff monitors the process and documents it in the same manner.

## 8.0 TEST PROCEDURES, METHOD REFERENCES, AND REGULATORY PROGRAMS

**Requirements:** The laboratory must use client specified or regulatory agency approved methods for the analysis of environmental samples. The laboratory maintains a list of active methods, which specifies the type of analysis performed, and cross-references the methods to applicable environmental regulation. Routine procedures used by the laboratory for the execution of a method must be documented in a standard operating procedure. Method performance and sensitivity must be demonstrated annually where required. Defined procedures for the use of method sensitivity for data reporting purposes must be established by the Director of Quality Assurance and used consistently for all data reporting purposes.

- 8.1 **Method Selection.** Accutest employs methods for environmental sample analysis that are consistent with the client's application, which are appropriate and applicable to the project objectives. Accutest informs the client if the method proposed is inappropriate or outdated and suggests alternative approaches.

Accutest employs documented, validated regulatory methods in the absence of a client specification and informs the client of the method selected. These methods are available to the client and other parties as determined by the client. Documented and validated in-house methods may be applied if they are appropriate to the project. The client is informed of the method selection.

- 8.2 **Method Validation.** Standard methods from regulatory sources are primarily used for all analysis. Standard methods do not require validation by the laboratory. Non-standard, in-house methods are validated prior to use. Validation is also performed for standard methods applied outside their intended scope of use. Validation is dependent upon the method application and may include analysis of quality control samples to develop precision and accuracy information for the intended use. A final method validation report is generated, which includes all data in the validation study. A statement of adequacy and/or equivalency is included in the report. A copy of the report is archived in the quality assurance directory of the company server.

Non-standard methods are validated prior to use. This includes the validation of modified standard methods to demonstrate comparability with existing methods. Demonstrations and validations are performed and documented prior to incorporating technological enhancements and non-standard methods into existing laboratory methods used for general applications. The demonstration includes method specific requirements for assuring that significant performance differences do not occur when the enhancement is incorporated into the method. Validation is dependent upon method application and may include the analysis of quality control samples to develop precision and accuracy information for intended use.

The study procedures and specifications for demonstrating validation include comparable method sensitivity, calibration response, method precision, method accuracy and field sample consistency for several classes of analytical methods are

detailed in this document. These procedures and specifications may vary depending upon the method and the modification.

**8.3 Standard Operating Procedures.** Standard operating procedures (SOP) are prepared for routine methods executed by the laboratory and processes related to sample or data handling. The procedures describe the process steps in sufficient detail to enable an individual, who is unfamiliar with the procedure to execute it successfully. SOPs are reviewed annually and edited if necessary. SOPs can be edited on a more frequent basis if systematic errors dictate a need for process change or the originating regulatory agency promulgates a new version of the method. Procedural modifications are indicated using a revision number. SOPs are available for client review at the Accutest facility upon request.

**8.4 Method Detection Limit Determination and verification.** Annual method detection limit (MDL) studies are performed as appropriate for routine methods used in the laboratory. MDL studies are also performed when there is a change to the method that affects how the method is performed or when an instrumentation change that impacts sensitivity occurs. The procedure used for determining MDLs is described in 40 CFR, Part 136, Appendix B. Studies are performed for each method on water, soil and air matrices for every instrument that is used to perform the method. MDLs are established at the instrument level. The highest MDL of the pooled instrument data is used to establish a laboratory MDL. MDLs are experimentally verified through the analysis of spiked quality control samples at 2-3 times the concentration of the experimental MDL, or 1-4 times for multicomponent methods. The verification is performed on every instrument used to perform the analysis. The quality assurance staff manages the annual MDL determination process and is responsible for retaining MDL data on file. Approved MDLs are appended to the LIMS and used for data reporting purposes. MDL values are used as DL values for DOD projects and verification spiking concentrations are listed as LOD values.

Methods certified under DOD ELAP requirements must undergo verification procedure on quarterly basis – see DOD QSM 4.2, Gray Box D-13.

**8.5 Method Reporting Limit.** The method reporting limit is established at the lowest concentration calibration standard in the calibration curve. The low calibration standard is selected by department managers as the lowest concentration standard that can be used while continuing to meet the calibration linearity criteria of the method being used. The validity of the Method Reporting Limits is confirmed via analysis of a spiked quality control sample at 1 – 2x Method reporting limit concentration. RL values are referred to as LOQ for DOD projects.

By definition, detected analytes at concentrations below the low calibration standard cannot be accurately quantitated and must be qualified accordingly.

Methods certified under DOD ELAP requirements must undergo verification procedure on quarterly basis – see DOD QSM 4.2, Gray Box D-14.

**8.6 Reporting of Quantitative Data.** Analytical data for all methods is reported without qualification to the reporting limit established for each method. Data may be reported to MDL depending upon the client's requirements provided that all qualitative identification criteria for the parameter have been satisfied. All parameters reported at concentrations between the reporting limit and MDL are qualified as an estimated concentration.

Measured concentrations of detected analytes that exceed the upper limit of the calibration range are either diluted into the range and reanalyzed or qualified as an estimated value. The only exception to this applies to ICP and ICP/MS analysis, which can be reported to the upper limit of the experimentally determined linear range without qualification.

**8.7 Estimated Uncertainty.** A statement of the estimated uncertainty of an analytical measurement accompanies the test result when required. Estimated uncertainty is derived from the performance limits established for spiked samples of similar matrices. The degree of uncertainty is derived from the negative or positive bias for spiked samples accompanying a specific parameter. When the uncertainty estimate is applied to a measured value, the possible quantitative range for that specific parameter at that measured concentration is defined. Well recognized regulatory methods that specify values for the major sources of uncertainty and specify the data reporting format do not require a further estimate of uncertainty.

**8.8 Precision and Accuracy Studies.** Annual precision and accuracy (P&A) studies, which demonstrate the laboratories ability to generate acceptable data, are performed for all routine methods used in the laboratory. The procedure used for generating P&A data is referenced in the majority of the regulatory methodology in use. The procedure requires quadruplicate analysis of a sample spiked with target analytes at a concentration in the working range of the method. This data may be compiled from a series of existing blank spikes or laboratory control samples. Accuracy (percent recovery) of the replicate analysis is averaged and compared to established method performance limits. Values within method limits indicate an acceptable performance demonstration. (See also Sec 4, Training, Demonstration of capability)

**8.9 Method Sources, References and Update Mechanism.** The Quality Assurance Staff maintains a list of active methods used for the analysis of samples. This list includes valid method references such as EPA, American Society of Testing and Materials (ASTM) or Standard Methods designations and the current version and version date.

Updated versions of approved reference methodology are placed into use as changes occur. The Quality Assurance Director informs operations management of changes in method versions as they occur. The operations management staff selects an implementation date. The operations staff is responsible for completing all method requirements prior to the implementation date. This includes modification to SOPs, completion of MDL and precision and accuracy studies and staff training. Documentation of these activities is provided to the QA staff who retains this information on file. The updated method is placed into service on the implementation date and the old version is de-activated.

Multiple versions of selected methods may remain in use to satisfy client specific needs. In these situations, the default method version becomes the most recent version. Client specific needs are communicated to the laboratory staff using method specific analytical codes method, which clearly depict the version to be used. The old method version is maintained as an active method until the specified client no longer requires the use of the older version.

Accutest will not use methodology that represents significant departures from the reference method unless specifically directed by the client. In cases where clients direct the laboratory to use a method modification that represents a significant departure from the reference method, the request will be documented in the project file. The LQSM lists active methods used for the analysis of samples in Table 8.1. This list includes valid method references from sources such as USEPA, ASTM or Standard Methods designations and the current version and version date.

**8.10 Analytical Capabilities.** Appendix II provides a detailed listing of the methodology employed for the analysis of test samples.

## 9.0 SAMPLE MANAGEMENT, LOGIN, CUSTODY, STORAGE AND DISPOSAL

**Requirement:** A system to ensure that client supplied product is adequately evaluated, acknowledged, and secured upon delivery to the laboratory must be practiced by the laboratory. The system must assure that chain of custody is maintained and that sample receipt conditions and preservation status are documented and communicated to the client and internal staff. The login procedure must assign, document, and map the specifications for the analysis of each unique sample to assure that the requested analysis is performed on the correct sample and enables the sample to be tracked throughout the laboratory analytical cycle. The system must include procedures for reconciling defects in sample condition or client provided data, which occur at sample arrival. The system must specify the procedures for proper sample storage, transfer to the laboratory, and disposal after analysis. The system must be documented in a standard operating procedure.

**9.1 Order Receipt and Entry.** New orders are initiated and processed by the client services group (See Chapter 14, Procedures for Executing Client Specifications). The new order procedure includes mechanisms for providing sampling containers to clients. These containers must meet the size, cleanliness, and preservation specifications for the analysis to be performed.

For new orders, the project manager prepares a bottle request form, which is submitted to sample management department. This form provides critical project details to the sample management staff, which are used to prepare and assemble the sample bottles for shipment to the client prior to sampling.

The bottle order is assembled using bottles that meet USEPA specifications for contaminant-free sample containers. Accutest-SE checks all sample containers for cleanliness. Data are reviewed by both the analyst and sample management technician. Results of bottle analyses are retained for minimum of 5 years.

All preservative solutions are prepared in the laboratory and are checked to assure that they are free of contamination from analytes of interest before being released for use. Sample management department retains a copy of the documentation of in-house contamination checks.

Reagent water for trip and field blanks is poured into appropriately labeled containers. Sample bottleware is labeled with durable labels printed on waterproof printing medium with indelible laser or heat transfer printer ink. All bottles are packed into ice chests with blank chain of custody forms and the original bottle order form. Completed bottle orders are delivered to clients using Accutest couriers or commercial carriers for use in field sample collection.

**9.2 Sample Receipt and Custody.** Samples are delivered to the laboratory using a variety of mechanisms including Accutest couriers, commercial shippers, and client self-delivery. Documented procedures are followed for arriving samples to assure that

custody and integrity are maintained and that handling and preservation requirements are documented and continued.

Sample custody documentation is initiated when the individual collecting the sample collects field samples. Custody documentation includes all information necessary to provide an unambiguous record of sample collection, sample identification, and sample collection chronology. Initial custody documentation employs either Accutest or client generated custody forms.

Accutest generates a Sample Receipt Confirmation form in situations where the individuals who collected the sample did not generate custody documentation in the field. Accutest SE Project Manager then contacts the client for the CoC information to be faxed or e-mailed from the client to the lab.

Accutest defines sample custody as follows:

- The sample is in the actual custody or possession of the assigned responsible person,
- The sample is in a secure area.

The Accutest facility is defined as a secure facility. Perimeter security has been established, which limits access to authorized individuals only. Visitors enter the facility through the building lobby and must register with the receptionist prior to entering controlled areas. While in the facility, visitors must be accompanied by their hosts at all times. After hours, building access is controlled using a computerized pass-key reader system. This system limits building access to individuals with a pre-assigned authorization status. After hours visitors are not authorized to be in the building. Clients delivering samples after hours must make advanced arrangements through client services and sample management to assure that staff is available to take delivery and maintain custody.

Upon arrival at Accutest, the sample custodian reviews the chain of custody and generates Sample Receipt Confirmation form for the samples received to verify that the information on the form corresponds with the samples delivered. This includes verification that all listed samples are present and properly labeled, checks to verify that samples were transported and received at the required temperature, verification that the sample was received in proper containers, verification that sufficient volume is available to conduct the requested analysis, and a check of individual sample containers to verify test specific preservation requirements including the absence of headspace for volatile compound analysis.

- 9.3** Sample conditions and other observations are documented on the Sample Receipt Confirmation form by the sample custodian prior to completing acceptance of custody. The sample custodian accepts sample custody upon verification that the custody document is correct. Discrepancies or non-compliant situations are documented, flagged and communicated to the Accutest project manager, who contacts the client

for resolution. The resolution is documented and communicated to sample management for execution.

- 9.4 Laboratory preservation of Improperly preserved field samples.** Accutest extends every effort to preserve samples which were received without proper field preservation.

Field/Equipment negative controls also receive the same amount of preservation as incorrectly preserved samples, and record made in the preservation logbook.

- 9.5 Sample Tracking Via Status Change.** An automated, electronic LIMS procedure records sample exchange transactions between departments and changes in analytical status. This system tracks all preparation, analytical, and data reporting procedures to which a sample is subjected while in the possession of the laboratory. Each individual receiving samples must acknowledge the change in custody and operational status in the LIMS. This step is required to maintain an accurate electronic record of sample status, dates of analytical activity, and custody throughout the laboratory.

Sample tracking is initiated at login where all chronological information related to sample collection dates and holding times are entered into the LIMS. This information is entered on an individual sample basis

- 9.6 Sample Acceptance Policy.** Incoming samples must satisfy Accutest's sample acceptance criteria before being logged into the system. Sample acceptance is based on the premise that clients have exercised proper protocols for sample collection. This includes sufficient volume, proper chemical preservation, temperature preservation, sample container sealing and labeling, and appropriate shipping container packing.

The sample management staff will make every attempt to preserve improperly preserved samples upon arrival. However, if preservation is not possible, the samples may be refused unless the client authorizes analysis. No samples will be accepted if holding times have been exceeded or will be exceeded before analysis can take place unless the client authorizes analysis.

Sample acceptance criteria include proper custody and sample labeling documentation. Proper custody documentation includes an entry for all physical samples delivered to the laboratory with an identification code that matches the sample bottle and a date and signature of the individual who collected the sample and delivered them to the laboratory. Labeling is done using durable waterproof labels printed with indelible heat-transfer ink.

Accutest reserves the right to refuse any sample which in its sole and absolute discretion and judgement is hazardous, toxic and poses or may pose a health, safety or environmental risk during handling or processing. The company will not accept samples for analysis using methodology that is not performed by the laboratory or for methods that lab does not hold valid accreditation unless arrangements have been made to have the analysis conducted by a qualified subcontractor.

**9.7 Assignment of Unique Sample Identification Codes.** Unique identification codes must be assigned to each sample bottle to assure traceability and unambiguously identify the tests to be performed in the laboratory.

The sample identification coding process begins with the assignment of a unique alphanumeric job number. A job is defined as a group of samples received on the same day, from a specific client pertaining to a specific project. A job may consist of groups of samples received over multi-day period. The first character of the job number is an alpha-character that identifies the laboratory facility. The next characters are numeric and sequence by one number with each new job.

Unique sample numbers are assigned to each bottle collected as a discrete entity from a designated sample point. This number begins with the job number and incorporates a second series of numbers beginning at one and continuing chronologically for each point of collection. The test to be performed is clearly identified on the bottle label.

Alpha suffixes may be added to the sample number to identify special designations such as subcontracted tests, in-house QC checks, or re-logs. Multiple sample bottles for a specific analysis are labeled Bottle 1, Bottle 2, etc.

**9.8 Subcontracted Analysis.** Subcontract laboratories are employed to perform analysis not performed by Accutest. The quality assurance staff evaluates subcontract laboratories to assure their quality processes meet the standards of the environmental laboratory industry prior to engagement. Throughout the subcontract process, Accutest follows established procedures to assure that sample custody is maintained and the data produced by the subcontractor meets established quality criteria.

Accutest network laboratories are considered primary subcontractors.

*Subcontracting Procedure.* Subcontracting procedures are initiated through several mechanisms, which originate with sample management. Samples for analysis by a subcontractor are logged into the Accutest system using regular login procedures. If subcontract parameters are part of the project or sample management has received subcontracting instructions for a specific project, a copy of the chain of custody is given to the appropriate project manager with the subcontracted parameters highlighted. This procedure triggers the subcontract process at the project management level. The Sample Management supervisor contacts an approved subcontractor to place the subcontract order. Subcontract chain of custody is processed in Sample Management Department and copy is filed with the original CoC. Sample management signs the subcontract chain of custody and ships the sample(s) to the subcontractor. The subcontract COC is filed with the original COC and the request for subcontract. Copies are distributed to the login department, the project manager, and sample management.

Client is verbally notified by Project Manager of the requirement to subcontract to the outside laboratory as soon as need is identified by the Accutest staff. Client notification

must be verified in writing, i.e. by e-mail. Client notification may take place during the initial project set-up, or at the time of sample receipt and login.

Subcontractor data packages are reviewed by the QA Staff to assess completeness and quality compliance. If completeness defects are detected, the subcontractor is asked to immediately upgrade the data package. If data quality defects are detected, the package is forwarded to the QA staff for further review. The QA staff will pursue a corrective action solution before releasing data to the client.

Approved subcontract data is entered into the laboratory information management system (LIMS) if possible and incorporated into the final report. All subcontract data is footnoted to provide the client with a clear indication of its source. Copies of original subcontract data are always included in the data report whether in hardcopy or PDF file, depending on the data submission requirements.

*Subcontract Laboratory Evaluation.* The QA staff evaluates subcontract laboratories prior to engagement. As a minimum, the subcontract laboratory must provide Accutest with proof of a valid certification to perform the requested analysis for the venue where they were collected, QC criteria summary (LOD/LOQ, LCS, MS/MSD, %RPD, etc.), copy of the most recent regulatory agency audit report, and a copy of the laboratory's Summary of Qualifications (SOQ). Other beneficial materials are QSM, copies of SOPs used for the subcontracted analysis, a copy of the most recent performance evaluation study for the subcontracted parameter, and copies of the most recent third party accreditor's audit report.

Certification verification must be submitted to Accutest annually. If possible, the QA staff may conduct a site visit to the laboratory to inspect the quality system. Accutest Laboratories Southeast assumes the responsibility for the performance of all subcontractors who have successfully demonstrated their qualifications. When selecting a subcontractor for analysis not performed by Accutest, assure qualifications of the subcontractor through local QA officer.

Qualification process of a subcontract laboratory may be bypassed if the primary client directs Accutest to employ a specific subcontractor

*Subcontract Laboratory Database.* Accutest Laboratories Inc. maintains centralized database of preferred contractors in order to optimize sample handling and data submission process, as well as obtain competitive priced services of uniform quality throughout the network. Individual Accutest laboratories are assigned "Center of Expertise" status according to unique capabilities.

**9.9 Sample Storage.** Following sample custody transfer, samples are assigned to various refrigerated storage areas by the sample management staff depending upon the test to be performed and the matrix of the samples. The location (refrigerator and shelf) of each sample is entered into sample location database on the line corresponding to each sample number. Samples remain in storage until the laboratory technician retrieves them into the laboratory for analysis.

Samples for volatile organics analysis are placed in storage in designated refrigerators by the sample management staff and immediately transferred to the organics group control. Sample custody is transferred to the VOC department staff. These samples are segregated according to matrix to limit opportunities for cross contamination to occur.

Organics staff is authorized to retrieve samples from these storage areas for analysis. When analysis is complete, the samples are placed back into storage.

- 9.10 Sample Login.** Following sample custody transfer to the laboratory, the documentation that describes the clients analytical requirements are delivered to the sample login group for coding and entry to the Laboratory Information management System (LIMS). This process translates all information related to collection time, turnaround time, sample analysis, and deliverables into a code which enables client requirements to be electronically distributed to the various departments within the laboratory for scheduling and execution.

The technical staff is alerted to client or project specific requirements through the use of a unique project code that is electronically attached to the job during login. The unique project code directs the technical staff to controlled specifications documents detailing the unique requirements.

- 9.11 Sample Retrieval for Analysis.** It is a responsibility of individual analyst to retrieve samples for analysis. Sample Management employs a program to facilitate sample placement and retrieval. Sample is traced around the laboratory using Status feature of LIMS.

After sample analysis has been completed, the analyst places the sample back into the storage and updates sample status.

- 9.12 Sample Disposal.** Accutest retains all samples under proper storage for a minimum of 30 days following completion of the analysis report. Longer storage periods are accommodated on a client specific basis if required. Samples may also be returned to the client for disposal.

Accutest disposes of all laboratory wastes following the requirements of the Resource Conservation and Recovery Act (RCRA). The Company has obtained and maintains a waste generator identification number, FLR00001263309002 (FLR designates State of Florida).

Sample management generates a sample disposal dump sheet from the LIMS tracking system each week, which lists all samples whose holding period has expired. Data from each sample is compared to the hazardous waste criteria established by the Florida Department of Environmental Protection (FDEP).

Samples containing constituents at concentrations above the criteria are labeled as hazardous and segregated into the following waste categories for disposal as follows:

Chlorinated Waste (Closed Top Steel Drum)- Methylene Chloride

Non-Chlorinated Waste (Closed Top Steel Drum)- Hexane, Methanol, and mixed solvents

Sodium Sulfate/Used Charcoal (Open Top Steel Drum)- Charcoal and paper filters used in the filtering of samples.

Hazardous Flammable Vials (Open Top Polypropylene Drum)- Methylene Chloride, Hexane.

Hazardous Aqueous waste (Closed Top Polypropylene Drum)- High Odor Samples, Lachat Waste.

Non Hazardous Soil (Open Top Steel Drum)- Soils.

Hazardous Solid Waste- (Open Top Steel Drum).

Non-Aqueous/Oil Samples- (Closed Top Steel Drum)

Difference between Open and Closed type of drums is whether it is possible to remove entire lid or just threaded stopper. Drums are closed at all times while in storage.

Non-hazardous aqueous samples are neutralized and collected in HDPP 500 Gal holding tank to be removed by waste company.

Non-hazardous solids are drummed and disposed of by contract waste company. Sample bottles are disposed of as recyclable waste in order to crush the bottles and destroy the labels. VOC vials are crushed on site using PRODEVA glass crusher. Supernatant liquid is siphoned off into the HDPP holding tank and solid residue drummed separately.

Laboratory wastes are collected by waste stream in designated areas throughout the laboratory. Waste streams are consolidated twice a week by the waste custodian and transferred to stream specific drums for disposal through a permitted waste management contractor. Filled, consolidated drums are tested for hazardous characteristics and scheduled for removal from the facility for appropriate disposal based on the laboratory data.

## 10.0 LABORATORY INSTRUMENTATION AND MEASUREMENT STANDARDS

**Requirement:** Procedures, which assure that instrumentation is performing to a pre-determined operational standard prior to the analysis of any samples, must be established by the laboratory. In general, these procedures will follow the regulatory agency requirements established in promulgated methodology. The instrumentation selected to perform specified analysis is capable of providing the method-specified uncertainty and sufficient sensitivity of measurement needed. These procedures must be documented and incorporated into the standard operating procedures for the method being executed. ALSE Equipment List attached as Appendix III.

**10.1 Mass Tuning – Mass Spectrometers.** The mass spectrometer tune and sensitivity must be monitored to assure that the instrument is assigning masses and mass abundances correctly and that the instrument has sufficient sensitivity to detect compounds at low concentrations. This is accomplished by analyzing a specific mass tuning compound at a fixed concentration. If the sensitivity is insufficient to detect the tuning compound, corrective action must be performed prior to the analysis of standards or samples. If the mass assignments or mass abundances do not meet criteria, corrective action must be performed prior to the analysis of standards or samples.

**10.2 Wavelength Verification – Spectrophotometers.** Spectrophotometer detectors are checked on a regular schedule to verify proper response to the wavelength of light needed for the test in use. If the detector response does not meet specifications, corrective action (detector adjustment or replacement) is performed prior to the analysis of standards or samples.

**10.3 Inter-element Interference Checks (Metals).** Inductively Coupled Plasma Emission Spectrophotometers (ICP) are subject to a variety of spectral interferences, which can be minimized or eliminated by applying interfering element correction factors and background correction points. Interfering element correction factors are checked on a specified frequency through the analysis of check samples containing high levels of interfering elements. Analysis of single element interferent solutions is also conducted at a specified frequency.

If the check indicates that the method criteria has not been achieved for any element in the check standard, the analysis is halted and data from the affected samples are not reported. Sample analysis is resumed after corrective action has been performed and the correction factors have been re-calculated.

New interfering element correction factors are calculated and applied whenever the checks indicate that the correction factors are no longer meeting criteria. At a minimum, correction factors are replaced once a year.

- 10.4 Calibration and Calibration Verification.** Many tests require calibration using a series of reference standards to establish the concentration range for performing quantitative analysis. Method specific procedures for calibration are followed prior to any sample analysis.

Calibration is performed using a linear or quadratic regression calculation or calibration factors calculated from the curve. The calibration must meet method specific criteria for linearity or precision. If the criteria are not achieved, corrective action (instrument maintenance or re-calibration) is performed. The instrument must be successfully calibrated before analysis of samples can be conducted.

Initial calibration for metals analysis performed using inductively coupled plasma (ICP) employs the use of two standards and a calibration blank to establish linearity. The calibration blank contains all reagents that are placed into the calibration standard with the exception of the target elements. Valid calibration blanks must not contain any target elements.

Initial calibrations must be initially verified using a single concentration calibration standard from a second source (i.e. separate lot or different provider). The continuing validity of an existing calibration must be regularly verified using a single concentration calibration standard. The response to the standard must meet pre-established criteria that indicate the initial calibration curve remains valid. If the criteria are not achieved corrective action (re-calibration) is performed before any additional samples may be analyzed.

- 10.5 Linear Range Verification and Calibration** Linear range verification is performed for all ICP instrumentation and select General Chemistry methods. The regulatory program or analytical method specifies the verification frequency. A series of calibration standards are analyzed over a broad concentration range. The data from these analyses are used to determine the valid analytical range for the instrument.

Some methods or analytical programs require a low concentration calibration check to verify that instrument is sufficient to detect target elements at the reporting limit. The analytical method or regulatory program defines the criteria used to evaluate the low concentration calibration check. If the low calibration check fails criteria, corrective action is performed and verified through reanalysis of the low concentration calibration check before continuing with the field sample analysis.

In accordance with TNI standards minimum number of calibration points in the absence of method-specific requirements is two calibration points and a blank.

- 10.6 Retention Time Verification (GC/HPLC/IC).** Chromatographic retention time windows are developed for all analysis performed using gas chromatographs with conventional detectors. An initial experimental study is performed, which establishes the width of the retention window for each compound. The retention time range of the window defines the time ranges for elution of specified target analytes on the primary and

confirmation columns. Retention time windows are established upon initial calibration, applying the retention time range from the initial study to each target compound. Retention times are regularly confirmed through the analysis of an authentic standard during calibration verification. If the target analytes do not elute within the defined range during calibration verification, the instrument must be recalibrated and new windows defined. New studies are performed when major changes, such as column replacement are made to the chromatographic system.

## 11.0 INSTRUMENT MAINTENANCE

**Requirement.** Procedures must be established for equipment maintenance. The procedure may include a maintenance schedule if required or documentation of daily maintenance related activities. All instrument maintenance activities must be documented in instrument specific logbooks. All equipment out of service (both analytical and auxiliary) must be clearly marked “Out of Order”.

**11.1 Routine, Daily Maintenance.** Routine, daily maintenance is required on an instrument specific basis. It is performed each time the instrument is used. Daily maintenance traditionally includes activities to insure a continuation of good analytical performance. In some cases, they include performance checks that indicate whether non-routine maintenance is required. If the performance check indicates a need for higher level maintenance, the equipment is taken out of service until maintenance is performed. Analysis cannot be continued until the performance checks meet established criteria. Document return to control. Daily maintenance is the responsibility of the individual assigned to the instrument used for the analysis he is performing.

**11.2 Non-routine Maintenance.** Non-routine maintenance is reserved for catastrophic occurrences such as instrument failure. The need for non-routine maintenance is indicated by failures in general operating systems that result in an inability to conduct required performance checks or calibration. Equipment in this category are taken out of service and repaired before attempting further analysis. Analysis cannot continue until the instrument meets all performance check criteria and is capable of being calibrated. Section supervisors are responsible for identifying non-routine maintenance episodes and initiating repair activities to bring the equipment on-line. This may include initiating telephone calls to maintenance contractors if necessary. They are also responsible for documenting all details related to the occurrence and the repair.

**11.3 Scheduled Maintenance.** Modern laboratory instrumentation rarely requires regular preventative maintenance. Where required, the equipment is placed on a schedule, which dictates when maintenance is required. Examples include annual balance calibration by an independent provider and optical alignment of the ICP. Section supervisors are responsible for initiating scheduled maintenance on equipment that requires scheduled preventative attention. Scheduled maintenance is documented using routine documentation practices.

**11.4 Maintenance Documentation.** Routine and non-routine maintenance activities are documented in logbooks assigned to instruments and equipment used for analytical measurements. The logbooks contain preprinted forms, which specify the maintenance activities required with each use. Accutest Laboratories Southeast has adopted a problem – action – follow-up format to conduct instrument maintenance. The analyst or supervisor who performs or initiates the maintenance activity is required to check the activity upon its completion, verify complete statement of return to normal conditions and initial the form. Non-routine maintenance (i.e. repairs, upgrades, etc.) is documented as well either electronically via e-mail from the service provider or receipt attached to the maintenance log.

## 12.0 QUALITY CONTROL PARAMETERS, PROCEDURES, AND CORRECTIVE ACTION

**Requirement:** All procedures used for test methods must incorporate quality control parameters to monitor elements that are critical to method performance. Each quality parameter includes acceptance criteria that have been established by regulatory agencies for the methods in use. Criteria may also be established through client dictates or through the accumulation and statistical evaluation of internal performance data. Data obtained from these parameters must be evaluated by the analyst, and compared to established method criteria. If the criteria are not achieved, the procedures must specify corrective action and conformation of control before proceeding with sample analysis. QC parameters, procedures, and corrective action must be documented within the standard operating procedures for each method. In the absence of client specific objectives the laboratory must define qualitative objectives for completeness and representativeness of data.

**12.1 Procedure.** Bench analysts are responsible for methodological quality control and sample specific quality control. Each method specifies the control parameters to be employed for the method in use and the specific procedures for incorporating them into the analysis. These control parameters are analyzed and evaluated with every designated sample group (batch).

The data from each parameter provides the analyst with critical decision making information on method performance. The information is used to determine if corrective action is needed to bring the method or the analysis of a specific sample into compliance. These evaluations are conducted throughout the course of the analysis. Each parameter being indicative of a critical control feature. Failure of a methodological control parameter is indicative of either instrument or batch failure. Failure of a sample control parameter is indicative of control difficulties with a specific sample or samples.

**Sample Batch.** All samples analyzed in the laboratory are assigned to a designated sample batch, which contains all required quality control samples and a defined maximum number of field samples that are prepared and/or analyzed over a defined time period. The maximum number of investigative and field QC samples in the batch is 20. Accutest has incorporated the NELAP batching policy as the sample-batching standard. This policy incorporates the requirement for blanks and spiked blanks as a time based function as defined by NELAP. The typical batch contains a blank, laboratory control sample (LCS or spiked blank), matrix spike and matrix spike duplicate. Batch documentation includes lot specifications for all reagents and standards used during preparation of the batch.

**12.2 Methodological Control Parameters and Corrective Action.** Prior to the analysis of field sample the analyst must determine that the method is functioning properly. Specific control parameters indicate whether critical processes meet specified requirements before continuing with the analysis. Method specific control parameters must meet criteria before sample analysis can be conducted. Each of these

parameters is related to processes that are under the control of the laboratory and can be adjusted if out of control.

**Method Blank.** A method blank is analyzed during the analysis of any field sample. The method blank is defined as a sample. It contains the same standards (internal standards, surrogates, matrix modifiers, etc.) and reagents that are added to the field sample during analysis, with the exception of the sample itself. If the method blank contains target analyte(s) at concentrations that exceed method or client requirements (typically defined as 1/2 RL concentrations), the source of contamination is eliminated before proceeding with sample analysis. Systematic contamination is documented for corrective action and resolved following the established corrective action procedures. In specific cases, contamination detected in the method blank may be acceptable if the concentrations do not exceed regulatory limits or client defined reporting limits.

**Laboratory Control Samples (LCS or Spiked Blanks).** A laboratory control sample (spiked blank or commercially prepared performance evaluation sample) is analyzed along with field samples to demonstrate that the method accuracy is within acceptable limits. These spike solutions are derived from different sources than the solutions used for method calibration. The performance limits are derived from published method specifications or from statistical controls generated from laboratory method performance data. Spiked blanks are blank matrices (reagent water or clean sand) spiked with the targeted parameters and analyzed using the same method used for samples. Accuracy data is compared to laboratory experimentally derived limits to determine if the method is in control. Laboratory control samples (LCS) are commercially prepared spiked samples in an inert material. Performance criteria for recovery of spiked analytes is pre-established by the commercial entity preparing the sample. This sample is analyzed in the laboratory as an external reference.

Accuracy data is compared to the applicable performance limits. If the spike accuracy exceeds the performance limits, corrective action, as specified in the SOP for the method is performed and verified before continuing with a field sample analysis. In some cases, decisions are made to continue with sample analysis if performance limits are exceeded; provided the unacceptable result has no negative impact on the sample data.

Marginal exceedance (ME) values are calculated for methods containing more than eleven (11) targeted analytes. The ME is calculated as  $\pm 4$  standard deviations about the mean. MEs are considered for multi-analyte methods because of the increased likelihood of LCS failure as the number of analytes in the method increase. The number of allowable MEs is based on the number of target analytes in the method. Analytes that regularly fall into the ME category are treated as systematic problems, which are resolved using established trend monitoring and corrective action procedures. Marginal Exceedances are not applied to parameters that are detected in field samples. Routine corrective action is initiated for all cases where LCS spike accuracy criteria is beyond the established control limits and the parameter is detected in field samples corresponding to the unacceptable LCS.

Blanks and spikes are routinely evaluated before samples are analyzed. However, in situations where sample analysis is performed using an autosampler, they may be evaluated after sample analysis has occurred. If the blanks and spikes do not meet criteria, sample analysis is repeated.

**Proficiency Testing.** Performance Evaluation (Proficiency Testing) samples (PEs, PTs) are single or double blind samples spiked with know amount of analytes on interest and introduced to the laboratory to assess method performance. PEs may be introduced as double blinds submitted by commercial clients, single or double blinds from regulatory agencies, or internal blinds submitted by the QA group.

A minimum of two single blind studies must be performed each year for every parameter in aqueous and solid matrices for each field of proficiency testing (FOPT) for which the laboratory maintains accreditation. Proficiency Testing samples must be purchased as blinds from an accredited vendor. Data from these studies are provided to the laboratory by the vendor and reported to accrediting agencies. If unsatisfactory performance is noted, corrective action is performed to identify and eliminate any sources of error. A new PT must be analyzed to demonstrate continuing proficiency.

PE samples performed for accrediting agencies or clients, which do not meet performance specifications, require a written summary that documents the corrective action investigation, findings, and corrective action implementation.

Single or double blind PT samples are employed for self-evaluation purposes. Data from these analyses are compared to established performance limits. If the data does not meet performance specifications, the system is evaluated for sources of acute or systematic error. If required, corrective action is performed and verified before initiating or continuing sample analysis.

**Trend Analysis for Control Parameters.** Accuracy data for selected spiked parameters from the laboratory control sample (LCS) is statistically evaluated daily for trends. Data from selected LCS parameters and surrogates are pooled on a method, matrix, and instrument basis. This data is evaluated by comparison to existing control and warning limits. Trend analysis is performed automatically as follows:

- Any point outside the control limit
- Any three consecutive points between the warning and control limits
- Any eight consecutive points on the same side of the mean
- Any six consecutive points increasing or decreasing

The results of the trend analysis are printed for supervisory evaluation prior to sample analysis. Trends that indicate the potential loss of statistical control are further evaluated to determine the impact on data quality and to determine if corrective action is necessary. If corrective action is indicated, the supervisor informs the analysts of

the corrective actions to be performed. Return to control is demonstrated before analysis resumes.

**12.3 Sample Control Parameters and Corrective Action.** The analysis of samples can be initiated following a successful demonstration that the method is operating within established controls. Additional controls are incorporated into the analysis of each sample to determine if the method is functioning within established specifications for each individual sample. Sample QC data is evaluated and compared to established performance criteria. If the criteria are not achieved the method or the SOP specifies the corrective action required to continue sample analysis. In many cases, failure to meet QC criteria is a function of sample matrix and cannot be remedied. Each parameter is designed to provide quality feedback on a defined aspect of the sampling and analysis episode.

**Duplicates.** Duplicate sample analysis is used to measure analytical precision. This can also be equated to laboratory precision for homogenous samples. Precision criteria are method dependent. If precision criteria are not achieved, corrective action or additional action may be required. Recommended action must be completed before sample data can be reported.

**Laboratory Control Duplicate, Spikes & Spiked Duplicates.** Spikes and spiked duplicates are used to measure analytical precision and accuracy for the sample matrix selected. Precision and accuracy criteria are method dependent. If precision and accuracy criteria are not achieved, corrective action or additional action may be required. Recommended action must be completed before sample data can be reported.

**Serial Dilution (Metals).** Serial dilutions of metals samples are analyzed to determine if analytical matrix effects may have impacted the reported data. If the value of the serially diluted samples does not agree with the undiluted value within a method-specified range, the sample matrix may be causing interference, which may lead to either a high or low bias. If the serial dilution criterion is not achieved, it must be flagged to indicate possible bias from matrix effects. *Accutest-SE uses this procedure as opposed to post-digestion spike unless contractual obligations absolutely require latter*

**Post Digestion Spikes.** Digested samples are spiked and analyzed to determine if matrix interferences are creating biases in the results. It may also be used to determine potential interferences per client's specification. Spike concentration is determined as per analytical method. No action is necessary if the post digestion spike is outside of the method criteria, unless a preparation problem is suspected with the spike, in which case the post digestion spike should remade and reanalyzed.

**Surrogate Spikes (Organics).** Surrogate spikes are organic compounds that are similar in behavior to the target analytes but unlikely to be found in nature. They are added to all quality control and field samples to measure method performance for each individual sample. Surrogate accuracy limits are derived from published method

specifications or by statistical evaluation of laboratory generated surrogate accuracy data. Accuracy data is compared to the applicable performance limits. If the surrogate accuracy exceeds performance limits, corrective action, as specified in the method or SOP is performed before sample data can be reported.

**Internal Standards (Organic Methods).** Internal standards are retention time and instrument response markers added to every sample to be used as references for quantitation. Their response is compared to reference standards and used to evaluate instrument sensitivity on a sample specific basis. Internal standard retention time is also compared to reference standards to assure that target analytes are capable of being located by their individual relative retention time.

If internal standard response criteria are not achieved, corrective action or additional action may be required. The recommended action must be completed before sample data can be reported.

If the internal standard retention time criteria are not achieved corrective action or additional action may be required. This may include re-calibration and re-analysis. Additional action must be completed before sample data is reported.

**Internal Standards (ICP Metals).** Internal standards are used on ICP instruments to compensate for variations in response caused by differences in sample matrices. This adjustment is performed automatically during sample analysis. The internal standard response of replicated sample analysis is monitored to detect potential analytical problems. If analytical problems are suspected, then the field samples are reanalyzed.

- 12.4 Laboratory Derived Quality Control Criteria.** Control criteria for in-house methods and client specific modifications that exceed the scope of published methodology are defined and documented prior to the use of the method. The Quality Assurance staff identifies the responsibility for control criteria needs. Control parameters and criteria, based on best technical judgement are established using input provided by the operations staff. These control parameters and criteria are documented and incorporated into the method.

The laboratory derived criteria are evaluated for technical soundness on spiked samples prior to the use of the method on field samples. The technical evaluation is documented and archived by the Quality Assurance staff.

When sufficient data from the laboratory developed control parameter is accumulated, the data is statistically processed and the experimentally derived control limits are incorporated into the method.

- 12.5 Bench Review & Corrective Action.** The bench chemists are responsible for all QC parameters. Before proceeding with sample analysis, they are required to successfully meet all instrumental QC criteria. They have the authority to perform any necessary corrective action before proceeding with sample analysis. Their authority

includes the responsibility for assuring that departures from documented policies and procedures do not occur.

The bench chemists are also responsible for all sample QC parameters. If the sample QC criteria are not achieved, they are authorized and required to perform the method specified corrective action before reporting sample data.

**Data Qualifiers.** An alpha character coding system is employed for defining use limitations for reported data. These limitations are applied to analytical data by the analyst to clarify the usefulness of the reported data for data user. Accutest Laboratories Southeast qualifies data in accordance with program-specific requirements, such as State of Florida DEP, AFCEE, etc., and these qualifiers are hard-coded in the LIMS on project level. Definitions of common qualifiers could be found at the bottom of the sample report form.

**12.6 QA Monitoring.** The QA staff prior to client release conducts a spot review of completed data packages. This review includes an examination of QC data for compliance and trends indicative of systematic difficulties. If non-conformances are detected, the QA staff places an immediate stop on the release of the data and initiates corrective action to rectify the situation. The data package is released when the package becomes compliant with all quality requirements.

If the review reveals trends indicative of systematic problems, QA initiates an investigation to determine the cause. If process defects are detected, a corrective action is implemented and monitored for effectiveness.

**Performance Limits.** The Technical Director is responsible for compilation and maintenance of all precision and accuracy data used for performance limits. Quality control data for all test methods are accumulated and stored in the laboratory information management system (LIMS). Parameter specific QC data is extracted annually and statically processed to eliminate outliers and develop laboratory specific warning limits and confidence limits. The new limits are reviewed and approved by the supervisory staff prior to their use for data assessment. The new limits are used to evaluate QC data for compliance with method requirements for a period of one year. Laboratory generated limits appear on all data reports unless method specifies hard-coded limits (mostly General Chemistry and Metals)

**12.7 Data Package Review.** Accutest employs multiple levels of data review to assure that reported data has satisfied all quality control criteria and that client specifications and requirements have been met. Production departments have developed data review procedures which must be conducted before data is released to the client.

**Analytical Review.** The analyst conducts the primary review of all data. This review begins with a check of all instrument and method quality control and progresses through sample quality control concluding with a check to assure that the client's requirements have been executed. Analyst checks focuses on a review of qualitative

determinations and checks of precision and accuracy data to verify that existing laboratory criteria have been achieved. Checks at this level may include comparisons with project specific criteria if applicable. The analyst has the authority and responsibility to perform corrective action for any out-of-control parameter or nonconformance at this stage of review.

Secondary data reviews are performed at the peer level by analysts who have met the qualification criteria for the method in use. Qualification requirements include a valid demonstration of capability and demonstrated understanding of the method SOP. Section supervisors may perform secondary review in-lieu of a peer review. Secondary review is performed on 100% of the data produced by their department. It includes a check of all manual calculations; an accuracy check of manually transcribed data from bench sheets to the LIMS, a check of all method and instrument QC criteria, baseline manipulations (if applicable) and a comparison of the data package to client specified requirements. Also included are checks to assure the appropriate methodology was applied and that all anomalous information was properly flagged for communication in the case narrative. Supervisors have the authority to reject data and initiate re-analysis, corrective action, or reprocessing.

All laboratory data requiring manual entry into LIMS system is double-checked by the analysts performing initial data entry and the section supervisor. Verification of supervisory review is indicated on the raw data summary by the supervisor's initials and date.

Electronic data that is manually edited at the bench by the primary analysts is automatically flagged by the instrument data system indicating an override by the analyst. All manual overrides must be verified and approved by a supervisor who initials and dates all manual changes.

Hard copies of manually integrated chromatographic peaks are printed that clearly depict the manually drawn baseline. The hard copy is reviewed and approved by the reviewer (initialed and dated) and included in the data package of all full tier reports or the archived batch records of commercial report packages.

Electronic data that has been committed to the LIMS can only be edited by a manager or supervisor. These edits may be required if needs for corrections are indicated during the final review. An audit record for all electronic changes in the LIMS is automatically appended to the record.

The group manager performs a tertiary review on a spot check basis. This review includes an evaluation of QC data against acceptance criteria and a check of the data package contents to assure that all analytical requirements and specifications were executed.

**Report Generation Review.** The report generation group reviews all data and supporting information delivered by the laboratory for completeness and compliance

with client specifications. Missing deliverables are identified and obtained from the laboratory. The group also reviews the completed package to verify that the delivered product complies with all client specifications. Non-analytical defects are corrected before the package is sent to the client.

**Project Management/Quality Assurance Review.** Spot-check data package reviews are performed by the project manager. Project management reviews focus on project specifications. If the project manager identifies defects in the product prior to release, he initiates immediate corrective action to rectify the situation.

The QA Staff reviews approximately 10% of the data produced. The QA review focuses on all elements of the deliverable including the client's specifications and requirements, analytical quality control, sample custody documentation and sample identification. QA reviews at this step in the production process are geared towards systematic process defects, which require procedural changes to effect a corrective action. However, if defects are identified that can be corrected prior to data release, the QA staff returns the package to the laboratory for corrective action. QA data review cannot be used in lieu of a peer level review or a supervisory review.

**Data Reporting.** Analytical data is released to clients following secondary departmental review. Data release at this stage of the process is limited to electronic information, which is released to clients through a secure, encrypted, password protected, Internet connection.

Hard copy support data is compiled by the report generation group and assembled into the final report. The report is sent to the client following reviews by report generation, and spot-check by QA staff.

All data reports include specified information, which is required to identify the report and its contents. This information includes a title, name and address of the laboratory, a unique report number, total number of pages in the report, clients name and address, analytical method identification, arriving sample condition, sample and analysis dates, test results with units of measurement, authorized signature of data release, statement of applicability, report reproduction restrictions and TNI requirements certification. Subcontracted data is clearly identified.

In the event of report revision date of the revision, nature of revision and identity of the person revising the report must be clearly stated in the body of the report. Depending on the level of the deliverables it could be either stated in the Case Narrative or Case Narrative generated specifically for this purpose. Case Narrative must state "supercedes all previous reports".

**12.8 Electronic Data Reduction.** Raw data from sample analysis is entered into the laboratory information management system (LIMS) using automated processes or manual entry. Final data processing is performed by the LIMS using procedures developed by the Company.

All LIMS programs and internally developed software (including Excel spreadsheets) are tested and validated prior to use to assure that they consistently produce correct results. Validation testing is performed by the Information Technology Staff. The testing procedures are documented in an SOP. Programs are not approved for use until they have demonstrated that they are capable of performing the required calculations.

- 12.9 Representativeness.** Data representativeness is based on the premise that qualitative and quantitative information developed for field samples is characteristic of the sample that was collected by the client and analyzed in the laboratory. The laboratory objective for representativeness defines data as representative if the criteria for all quality parameters associated with the analysis of the sample are achieved.
- 12.10 Comparability.** Analytical data is defined as comparable when data from a sample set analyzed by the laboratory is representatively equivalent to other sample sets analyzed separately regardless of the analytical logistics. The laboratory will achieve 100% comparability for all sample data which meets the criteria for the quality parameters associated with its analysis using the method requested by the client.

## 13.0 CORRECTIVE ACTION SYSTEM

**Requirement.** The laboratory must have policies and procedures for correcting defective processes, systematic errors, and quality defects, which enables the staff to systematically improve product quality. The system must include procedures for communicating items requiring corrective action, corrective action tracking procedures, corrective action documentation, monitoring of effectiveness, and reports to management. The system must be documented in a standard operating procedure.

**13.1 Procedure.** Corrective action is the step that follows the identification of a process defect. The type of defect determines the level of documentation, communication, and training necessary to prevent re-occurrence of the defect or non-conformance.

**Routine Corrective Action.** Routine corrective action is defined as the procedures used to return out of control analytical systems back to control. This level of corrective action applies to all analytical quality control parameters or analytical system specifications.

Bench analysts have full responsibility and authority for performing routine corrective action. The resolution of defects at this level does not require a procedural change or staff re-training. The analyst is free to continue work once corrective action is complete and the analytical system has been returned to control. Documentation of routine corrective action is limited to bench logbook or maintenance logbook comment.

**Process Changes.** Corrective actions in this category require procedural modifications. They may be the result of systematic defects identified during audits, the investigation of client inquiries, failed proficiency tests, product defects identified during data review, or method updates. Resolution of defects of this magnitude requires formal identification of the defect, development and documentation of a corrective action plan, and staff training to communicate the procedural change.

**Technical Corrective Action.** Technical corrective action encompasses routine corrective action performed by bench analysts for out of control systems and corrective actions performed for data produced using out of control systems. Technical corrective action for routine situations is conducted using the procedures detailed above.

Non-routine corrective actions apply to situations where the bench analysts failed to perform routine corrective action before continuing analysis. Supervisors and Department Managers perform corrective action in these situations. Documentation of all non-routine corrective actions is performed using the corrective action system.

Sample re-analysis is conducted if sufficient sample and holding time remain to repeat the analysis using an in-control system. If insufficient sample or holding time remains, the data is processed and qualifiers applied that describe the out of control situation. The occurrence is further documented in the case narrative and in the corrective

action response. The corrective action must include provisions for retraining the analysts who failed to perform routine corrective action.

**13.2 Documentation & Communication.** Routine corrective actions are documented as part of the analytical record. Notations are made in the comments section of the analytical chronicle or data sheet detailing the nonconformance. Continuation of the analysis indicates that return to control was successful.

Corrective actions for process changes are documented, tracked and monitored for effectiveness. Corrective actions may be initiated by any supervisor or senior staff member by completing the corrective action form in Corrective Action database

The corrective action database is an Access application. The initiator generates the corrective action investigation form, which is documented, tracked, distributed to responsible parties and archived through the application. The application assigns a tracking number initiation data and due date to each corrective action initiated and copies the corrective action form to the corrective action database. The application also distributes an E-mail message containing the form to the responsible parties for resolution.

Corrective Action system employs Deficiency – Root Cause – Immediate Fix – Corrective action approach, further divided into categories of Analytical Error, Omission Error, Random Error, Systemic Error and Training Issue.

The responsible party develops and implements the procedural change. Existing documentation such as SOPs are edited to reflect the change. The affected staff is informed of the procedural change through a formal training session. The training is documented and copies are placed into individual training files. The corrective action form is completed and closed in CA database.

Initial and completed corrective action forms are maintained in the Corrective Action directory. This information is archived daily. Copies of training records describing corrective actions are appended to the involved individuals training files.

**Monitoring.** The QA Staff monitors the implemented corrective action until it is evident that the corrective action has been effective and the systematic deficiency has been eliminated. The corrective action database is updated by QA to reflect closure of the corrective action. The QA staff also assigns an error code to the corrective action for classification of the type of errors being committed.

If QA determines that the corrective action procedure has not effectively remedied the deficiency, the process continues with a re-initiation of the corrective action. Corrective action continues until the defective process is eliminated. If another procedural change is required, it is treated as a new corrective action, which is documented and monitored using established procedures.

**Client Notification.** Defective processes, systematic errors, and quality defects, detected during routine audits may have negative impacts on data quality. In some cases, data that has been released to clients may be affected. If defective data has been released for use, Accutest will notify the affected clients of the defect and provide specific details regarding the magnitude of the impact to their data.

## 14.0 PROCEDURES FOR EXECUTING CLIENT SPECIFICATIONS

**Requirement.** Systems must be established for evaluating and processing client specifications for routine and non-routine analytical services. The systems must enable the client services staff to identify, evaluate, and document the requested specifications to determine if adequate resources are available to perform the analysis. The system must include procedures for communicating the specifications to the laboratory staff for execution and procedures for verifying the specifications have been executed.

- 14.1 Client Specific Requirements.** The project manager is the primary contact for clients requesting laboratory services. Client specifications are communicated using several mechanisms. The primary source of information is the client's quality assurance project plan (QAPP) which details analytical and quality control specifications for the project. In the absence of a QAPP, projects specifications can also be communicated using contracts, letters of authorization, or letters of agreement, which may be limited to a brief discussion of the analytical requirements and the terms and conditions for the work. These documents may also include pricing information, liabilities, scope of work, in addition to the analytical requirements. QAPPs include detailed analytical requirements and data quality objectives, which supersede those found in the referenced methods. This information is essential to successful project completion.

Laboratory also reviews its Accreditation status to evaluate whether it is possible to accept proposed project. Discrepancies must be resolved before the work commences.

The client services staff provides additional assistance to clients who are unsure of the specifications they need to execute the sampling and analysis requirements of their project. They provide additional support to clients who require assistance in results interpretation as needed, provided they possess the expertise required to render an opinion.

The project manager is responsibility for obtaining project documents, which specify the analytical requirements. Following project management review, copies are distributed to the QA staff and the appropriate departmental managers for review and comment. The original QAPP is numbered with a document control number and filed in a secure location.

- 14.2 Requirements for Non-Standard Analytical Specifications.** Client requirements that specify departures from documented policies, procedures, or standard specifications must be submitted to Accutest in writing. These requirements are reviewed and approved by the technical staff before the project is accepted. Once accepted, the non-standard requirements become analytical specifications, which follow the routine procedure for communicating client specifications. Departures from documented policies, procedures, or standard specifications that do not follow this procedure are not permitted.

*Exception Policy:* With respect to the quality system, incoming non-conforming product refers to received samples that do not meet requirements of custody documentation, are improperly packaged or stored or are contaminated. An internal non-conformance refers to a problem, caused internally due to improper handling of samples, improper sampling methods, and equipment malfunction or data management errors. The individual who identifies the incoming non-conformance is responsible for notifying the project manager. The project manager resolves the issue with the client. The individual who recognizes an internal non-conformance is responsible for initiating corrective action

Departures from standard practices, policies and specifications are reviewed and approved by Technical Director, QA Officer and by Project Manager of the project affected.

*Corrective & Preventative Action:* Once a quality problem has been identified, the analytical or review process stops, until the reason is identified. Primary responsibility for identifying the cause of the problem rests with the instrument operator. Other staff may be called on to assist in reaching the root cause. The problem prevention tracking system, using Corrective Action Tracking Records, provides a method to track systemic problems until resolved/removed. The QA Officer is responsible for the record management with respect to the disposition of problems.

Deviations that do not limit themselves to a single department and/or client are cited on Corrective Action Record. This may include but not limited to: sample arrival outside of EPA specified holding time, analysis completion outside of EPA specified holding time (with explanation of the reason), inconsistencies between chain of custody and cooler contents, including labeling errors, improper preservation, etc.

Deviations from analytical methods' SOP's are reported by the Analyst to the Section Leader. Single occurrences warrant completion of Corrective Action Tracking record, repetitive occurrences may indicate that either an additional training session is in order, or the SOP does not reflect proper laboratory practice. Training session is conducted by the Technical Director or by QA Officer. In case where SOP does not reflect current laboratory practice, SOP review and correction process may be initiated.

- 14.3 Evaluation of Resources.** A resource evaluation is completed prior to accepting projects submitted by clients. The evaluation is initiated by the client services staff receives project requirements (usually in the form of QAPjP) and distributes these requirements to the laboratory departments affected. The specifications are evaluated by the department managers from a scheduling and hardware resources perspective. The project is not accepted unless the department managers have the necessary resources to execute the project according to client specifications.

- 14.4 Documentation.** New projects are initiated using a project set up form, which is completed prior to the start of the project. This form details all of the information needed to correctly enter the specifications for each client sample into the laboratory information management system (LIMS, see example). The form includes data reporting requirements, billing information, data turnaround times, QA level, state of origin, and comments for detailing project specific requirements. The project manager is responsible for obtaining this information from the client and completing the form prior to sample arrival and login.

Sample receipt triggers project creation and the login process. The information on the set-up form is entered into the LIMS immediately prior to logging in the first sample. The set up form may be accompanied by a quotation, which details the analytical product codes and sample matrices. These details are also entered into the LIMS during login.

Special information is distributed to the laboratory supervisors and login department in electronic or hardcopy format upon project setup. All project specific information is retained by the project manager in a secure file. The project manager maintains a personal telephone log, which details conversations with the client regarding the project.

- 14.5 Communication.** A pre-project meeting is held between client services and the operations managers to discuss the specifications described in the QAPjP and/or related documents. Project logistics are discussed and finalized and procedures are developed to assure proper execution of the client's analytical specifications and requirements. Questions, raised in the review meeting, are discussed with the client for resolution. Exceptions to any requirements, if accepted by the client, are documented and incorporated into the QAPjP or project documentation records.

Non-standard specifications for individual clients are documented in the LIMS at the client account level. Once entered into the LIMS, these specifications become memorialized for all projects related to the client account. Upon sample arrival, these specifications are accessed through a terminal or printed as a hard copy and stored in a binder for individuals who require access to the specification. Specifications that are not entered into the LIMS are prohibited unless documented in an interdepartmental memo, which clearly identifies the project, client and effective duration of the specification.

- 14.6 Operational Execution.** A work schedule is prepared for each analytical department on a daily basis. Analytical specifications from recently arrived samples have now been entered into the LIMS database. The database is sorted by analytical due date and holding time, into product specific groups. Samples are scheduled for analysis by due date and holding time. The completed schedule, which is now defined as a work list, is printed. The list contains the client requested product codes and specifications required for the selected sample(s). Special requirements are communicated to the analyst using the comments section or relayed through verbal instructions provided by

the supervisor. The bench analyst assumes full responsibility for performing the analysis according to the specifications printed on the work sheet.

- 14.7 Verification.** Prior to the release of data to the client, laboratory section managers and the report generation staff review the report and compare the completed product to the client specifications documentation to assure that all requirements have been met. Project managers perform a spot check of projects with unique requirements to assure that the work was executed according to specifications.

## 15.0 CLIENT COMPLAINT RESOLUTION PROCEDURE

**Requirement.** A system for managing and reconciling client complaints must be implemented in the laboratory. The system must include procedures for documenting client complaints and communicating the complaint to the appropriate department for resolution. The system must also include a quality assurance evaluation to determine if the complaint is related to systematic defects requiring process changes.

**15.1 Procedure.** Client complaints are communicated to client services representatives, quality assurance staff, or senior management staff for resolution. The individual receiving the complaint retains the responsibility for documentation and communicating the nature of the complaint to the responsible department(s) for resolution. The responsible party addresses the complaint. The resolution is communicated to quality assurance (QA) and the originator for communication to the client. QA reviews the complaint and resolution to determine if systematic defects exist. If systematic defects are present, QA works with the responsible party to develop a corrective action that eliminates the defect.

**Documentation.** Client's complaints are documented by the client service representative receiving the complaint. A record of the telephone conversation is maintained by client services. Client service staff enters the complaint into Data Challenge database or Client Complaint database, depending on the nature of complaint. These databases are cross-linked with corrective action database – see sec. 13. Complaint is communicated to the production departments concerned via auto e-mail. The complaint resolution is documented in the database by the responsible party and resultant e-mail returned to the originator. QA staff is copied on the correspondence.

**15.2 Corrective Action.** Responses to Data Challenges/Client Complaints are required from the responsible party. At a minimum, the response addresses the query and provides an explanation to the complaint. Corrective action may focus on the single issue expressed in the complaint. Corrective action may include job case narrative generation, reprocessing of data, editing of the initial report, and re-issue to the client. If the QA review indicates a systematic error, process modification is required. The defective process at the root of the complaint is changed. SOPs are either created or modified to reflect the change. The party responsible for the process implements process changes.

**15.3 QA Monitoring.** Process changes, implemented to resolve systematic defects, are monitored for effectiveness by QA. If monitoring indicates that the process change has not resolved the defect, QA works with the department management to develop and implement an effective process. If monitoring indicates that the defect has been resolved, monitoring is slowly discontinued. Continued monitoring is incorporated as an element of the annual system audit and annual Management Report (see 18.8).

## 16.0 CONTROL OF NONCONFORMING PRODUCT

**Requirement:** Policies and procedures have been developed and implemented that describe the procedures employed by the laboratory when any aspect of sample analysis or data reporting do not conform to established procedures or client specifications. These procedures include steps to ensure that process defects are corrected and affected work is evaluated to assess its impact to the client.

**Procedure.** Nonconforming product is identified through multiple channels, such as second level analytical data review, routine internal review and audit practices, external auditing or through client inquiry. Responsibility and authority for the management of the non-conforming product directly defined by a nature of a non-conformance. For example, non-conformances resulting from internal and external reviews are evaluated and managed by QA Staff. Corrective Action items are issued and followed to completion and verification that defect is prevented from reoccurring. Non-conformances stemming from client inquiry are managed by Project Management staff with QA staff oversight.

Data associated with out-of compliance QC are evaluated by bench personnel and section supervisors. The analyst has the authority and responsibility to perform corrective action for any out-of-control parameter or nonconformance at this stage of review.

If non-conformances are detected, the QA staff places an immediate stop on the release of the data and initiates corrective action to rectify the situation

Non-conformances and their significance are communicated in case narrative and sample report footnotes. Case narrative comments and sample report footnotes must state the impact on data quality.

**Corrective Action.** The outcome of the evaluation dictates the course of action. The type of defect determines the level of documentation, communication, and training necessary to prevent re-occurrence of the defect or non-conformance. This may include at a minimum client notification, but may also include corrective action. Immediate corrective action is performed using the SOP-specified procedures. However, additional action may be required including cessation of analysis and withholding and/or recalling data reports. If the evaluation indicates that nonconforming data may have been issued to clients, the client is immediately notified and data may be recalled following the procedures specified in respective SOPs. If work has been stopped because of a nonconformance, the Laboratory Director is the only individual authorized to direct a resumption of analysis.

Nonconformances caused by systematic process defects require retraining of the personnel involved as an element of the corrective action solution. Routine corrective actions are documented as part of the analytical record.

## 17.0 CONFIDENTIALITY PROTECTION PROCEDURES

**Requirements:** Policies and procedures are required to protect client data from release to unauthorized parties or accidental release of database information through accidental electronic transmission or illegal intrusion. These policies must be communicated to clients and staff. Electronic systems must be regularly evaluated for effectiveness.

- 17.1 Client Anonymity.** Information related to the Company's clients is granted to employees on a "need to know" basis. An individual's position within the organization defines his "need to know". Individuals with "need to know" status are given password access to systems that contain client identity information and access to documents and document storage areas containing client reports and information. Access to client information by individuals outside of the Company is limited to the client and individuals authorized by the client.

Individuals outside of the Company may obtain client information through subpoena issued by a court of valid jurisdiction. Clients are informed when subpoenas are received ordering the release of their information.

- 17.2 Documents.** Access to client documents is restricted to employees in need to know positions. Copies of all client reports are stored in secure archive with restricted access. Reports and report copies are distributed to individuals who have been authorized by the client to receive them. Documents are not released to third parties without verbally expressed or written permission from the client.

- 17.3 Confidential Business Information (CBI).** Operational documents including SOPs, Quality Manuals, personnel information, internal operations statistics, and laboratory audit reports are considered confidential business information. Strict controls are placed on the release of this information to outside parties.

Release of CBI to outside parties or organizations may be authorized upon execution of a confidentiality agreement between Accutest and the receiving organization or individual. CBI information release is authorized for third party auditors and commercial clients in electronic mode as Adobe Acrobat .PDF format only. See also Sec. 6.5.

- 17.4 Electronic Data.**

**Database Intrusion.** Direct database entry is authorized for employees of Accutest only on a need to know basis. Entry to the database is restricted through a user specific multiple password entry system. Direct access to the database outside of the facility is possible through a VPN connection. A unique password is required for access to the local area network. A second unique password is required to gain access to the database. The staff receives read or write level authorization on a hierarchical privilege basis.

**Internet Access.** Access to client information is through an HTTP Web application only. It does not contain a mechanism that allows direct access to the database. Clients can gain access to their data only using a series of Accutest assigned accounts, and client specific passwords. The viewable data, which is encrypted during transmission, consists of an extraction of database information only.

**Client Accessibility.** Accessibility to client data delivered via electronic means follows strict protocols to insure confidentiality. Clients accessing electronic data are assigned a company account. The account profile, which is established by the MIS staff, grants explicit access to explicit information pertaining to the clients project activity. Passwords are assigned on an individual basis within a client account. These accounts can be activated or deactivated by the MIS staff only.

**17.5 Information Requests.** Client specific data or information is not released to third parties without verbally expressed or written permission from the client. Written permission is required from third parties, who contact the Company directly for the release of information. Verbal requests will be honored only if they are received directly from the client. These requests must be documented in a record of communication maintained by authorized recipient.

**17.6 Transfer of Records.** Archived data, which has previously been reported and transmitted to clients, is the exclusive property of Accutest Laboratories. In the event of a cessation of business activities due to business failure or sale, The Company's legal staff will be directed to arrange for the final disposition of archived data.

The final disposition of archived data will be accomplished using the approach detailed in the following sequence:

1. All data will be transferred to the new owners for the duration of the required archive period as a condition of sale.
2. If the new owners will not accept the data or the business has failed, letters will be sent to clients listed on the most recent active account roster offering them the option to obtain specific reports (identified by Accutest Job Number) at their own expense.
3. A letter will be sent to the TNI accrediting authority with organizational jurisdiction over the company offering them the option to obtain all unclaimed reports at their own expense.
4. All remaining archived data will be recycled using the most expedient means possible.

## 18.0 QUALITY AUDITS AND SYSTEM REVIEWS

**Requirement:** The quality assurance group will conduct regularly scheduled audits of the laboratory to assess compliance with quality system requirements, technical requirements of applied methodology, and adherence to documentation procedures. The information gathered during these audits will be used to provide feedback to senior management and perform corrective action where needed for quality improvement purposes.

- 18.1 Quality Systems Review.** Quality system audits are performed annually by the Quality Assurance Director for the Company President. In this audit, the laboratory is evaluated for compliance with the Laboratory Quality Systems Manual (LQSM) and the quality system standards of the National Environmental Laboratory Accreditation Conference. Findings, which indicate non-compliance or deviation from the LQSM, are flagged for corrective action. Corrective actions require either a return to compliance or a plan change to reflect an improved quality process. The QA Officer is responsible for making and documenting changes to the LQSM. These changes are reviewed by the Laboratory Director and Technical Director prior to the approval of the revised system.
- 18.2 Quality System Audits.** Quality system audits are conducted to evaluate the effectiveness and laboratory compliance with individual quality system elements. These audits are conducted on an established schedule. Audit findings are documented and communicated to the management staff and entered into the corrective action system for resolution. If necessary, retraining is conducted to assure complete understanding of the system requirements.
- 18.3 Technical Compliance Audits.** Technical compliance audits are performed throughout the year following the established schedule. Selected analytical procedures are evaluated for compliance with standard operating procedures (SOPs) and method requirements. If non-conformances exist, the published method serves as the standard for compliance. SOPs are edited for compliance if the document does not reflect method requirements. Analysts are trained to the new requirements and the process is monitored by quality assurance. Analysts are retrained in method procedures if an evaluation of bench practices indicates non-compliance with SOP requirements.
- 18.4 Documentation Audits.** Documentation audits are conducted periodically. This audit includes a check of measurement processes that require manual documentation and non-analytical logbook review. It also includes checks of data archiving systems and a search to find and remove any inactive versions of SOPs that may still be present in the laboratory and being accessed by the analysts. Non-conformances are corrected on the spot. Procedural modifications are implemented if the evaluation indicates a systematic defect.
- 18.5 Corrective Action Monitoring.** Defects or non-conformances that are identified during client or internal audits are shared with management and entered into CA

database for attention by the responsible party. Audit findings are corrected through process modifications and/or retraining. Once a corrective action has been designed and implemented, it is monitored for compliance on a regular basis by the QA staff. Monitoring of the corrective action continues until satisfactory implementation has been verified.

- 18.6 Preventive Action.** Laboratory systems or processes, which may be faulty and pose the potential for nonconformances, errors, confusing reports or difficulties establishing traceability may be identified during internal audits. These items are highlighted for systematic change using the corrective action system and managed to resolution using appropriate procedures for corrective action.
- 18.7 Client Notification.** Defective processes, systematic errors, and quality defects detected during routine audits may have negative impact on data quality. In some cases, data that has been released to the client may be affected. If defective data has been released for use, Accutest will immediately notify the affected clients of the defect and provide specific details regarding the magnitude of the impact to their data.
- 18.8 Management Reports.** Formal reports of all audit activities are prepared for the management staff. These reports are prepared annually. The report details the status of the Quality System

The formal report also addresses the following topics:

- *the suitability of policies and procedures;*
- *reports from managerial and supervisory personnel;*
- *the outcome of recent internal audits;*
- *corrective and preventive actions;*
- *assessments by external bodies;*
- *the results of interlaboratory comparisons or proficiency tests;*
- *changes in the volume and type of the work;*
- *customer feedback;*
- *complaints;*
- *recommendations for improvement;*
- *other relevant factors, such as quality control activities, resources, and staff training.*

## 19.0 HEALTH AND SAFETY

**Requirement.** The company operates a formal health and safety program that complies with the requirements of the Occupational Health and Safety Administration. The program consists of key policies and practices that are essential to safe laboratory operation. All employees are required to receive training on the program elements. Job specific training is conducted to assure safe practices for specific tasks. All employees are required to participate in the program, receive initial and annual training, and comply with the program requirements. All plan and program requirements are detailed in the Health and Safety Program Manual.

- 19.1 Policy.** Accutest Laboratories will provide a safe and healthy working environment for its employees and clients while protecting the public and preserving the Company's assets and property. The company will comply with all applicable government regulations pertaining to safety and health in the laboratory and the workplace.

The objective of the Accutest Health and Safety Program is to promote safe work practices that minimize the occurrence of injuries and illness to the staff through proper health and safety training, correct laboratory technique application and the use of engineering controls.

- 19.2 Responsibilities.** The Health and Safety Program assists managers, supervisors and non-supervisory employees in control of hazards and risks to minimize the potential for employee and client injuries, damage to client's property and damage or destruction to Accutest's facility.

The Health and Safety Officer is responsible for implementing the Program's elements and updating its contents as necessary. He also conducts periodic audits to monitor compliance and assess the program's effectiveness and is also responsible for creating and administering safety training for all new and existing employees.

The employee is responsible for following all safety rules established for their protection, the protection of others and the proper use of protective devices provided by the Company. The employee is also expected to comply with the requirements of the program at all times. Department Managers and Supervisors are responsible for ensuring the requirements of the Safety Program are practiced daily. The Company President retains the ultimate responsibility for the program design and implementation.

- 19.3 Program Elements.** The Accutest Health and Safety Program consists of key program elements that compliment the company's health and safety objective. These elements form the essence of the health and safety policy and assure that the objectives of the program are achieved.

***Safety Education and Training and Communication.*** Training is conducted to increase the staff's awareness of laboratory hazards and their knowledge of the safety

practices and procedures required to protect them from those hazards. It is also used to communicate general safety procedures required for safe operation in a chemical laboratory.

Initial health and safety training for new employees is conducted during orientation. The training focuses on the Accutest Safety and Health Program and includes specific training for the hazards that may be associated with the employees' duties. Training is also conducted for all program elements focusing on general, acceptable, laboratory safety procedures. Targeted training is conducted to address hazards or safety procedures that are specific to individual employee's work assignments. All training activities are documented and archived in individual training folders. A health and safety training inventory is maintained in the training database.

Accutest Laboratories Southeast maintains personnel trained in HAZWOPER, DOT and HazMat operations, as well as respirator certified.

**Safety Officer.** The safety officer provides the employees with an opportunity to express their views and concerns on safety issues in an environment where those concerns will be addressed to ensure that the interests of the company and the well being of the employee are protected. Safety Officer is entrusted with elevating the level of safety awareness among their peers.

**Hazard Identification and Communication.** The hazard communication program enables employees to readily identify laboratory hazards and the procedures to protect themselves from those hazards. This program complies with OSHA's Hazard Communication Standard, Title 29 Code of Federal Regulations 1910.1200 that requires the company to adopt and adhere to the following key elements:

- ◆ Material Safety Data Sheets (MSDS) and/or Safety Data Sheets (SDS) must be available to any employee wishing to view them,
- ◆ The Company must maintain a Hazardous Chemicals Inventory (by location), which is updated on an annual basis,
- ◆ Containers are properly labeled,
- ◆ All employees must be provided with annual Personal Protection, Hazard Communication and Right to Know training,

**Chemical Hygiene Plan.** The Chemical Hygiene Plan complies with the requirements of the Occupational Safety and Health Administration's Occupational Exposure to Hazardous Chemicals in the Laboratory Standard, 29 CFR 1910.1450. This plan establishes procedures, identifies safety equipment, personal protective equipment, and work practices that protect employees from the potential health hazards presented by hazardous chemicals in the laboratory if properly used and/or applied.

**Emergency Action & Evacuation Plan.** The Emergency Action and Evacuation Plan details the procedures used to protect and safeguard Accutest's employees and property during emergencies. Emergencies are defined as fires or explosions, gas leaks, building collapse, hazardous material spills, emergencies that immediately threaten life and health, bomb threats and natural disasters such as floods, hurricanes or tornadoes. The plan identifies and assigns responsibility for executing specific roles in situations requiring emergency action.

**Lockout/Tagout Plan.** Lockout/tagout procedures have been established to assure that laboratory employees and outside contractors take steps to render equipment inoperable and/or safe before conducting maintenance activities. The plan details the procedures for conducting maintenance on equipment that has the potential to unexpectedly energize, start up, or release energy or can be operated unexpectedly or accidentally resulting in serious injury to employees. The plan ensures that employees performing maintenance render the equipment safe through lock out or tag out procedures.

**Personal Protection Policy.** Policies have been implemented which detail the personal protection requirements for employees. The policy includes specifications regarding engineering controls, personal protective equipment (PPE), hazardous waste, chemical exposures, working with chemicals and safe work practices. Safety requirements specific to processes or equipment are reviewed with the department supervisor or the Health and Safety Officer before beginning operations.

**Emergency Preparedness Plan.** This plan identifies the actions to be taken by Accutest Laboratory's staff in the event of terrorism or terrorist actions, to ensure the safety of the employees and the facility. The plan describes the building security actions coinciding with the "Alert Condition", designated by the Department of Homeland Security.

# **Appendix I**

## **Glossary of Terms**

## GLOSSARY OF TERMS

**Acceptance Criteria:** specified limits placed on characteristics of an item, process, or service defined in requirement documents.

**Accreditation:** the process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory. In the context of the National Environmental Laboratory Accreditation Program (NELAP), this process is a voluntary one.

**Accuracy:** the degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator.

**Analyst:** the designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.

**Analytical Uncertainty:** A subset of Measurement Uncertainty that includes all laboratory activities performed as part of the analysis.

**Audit:** a systematic evaluation to determine the conformance to quantitative *and qualitative* specifications of some operational function or activity.

**Batch:** environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A **preparation batch** is composed of one to 20 environmental samples of the same quality-system matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours. An **analytical batch** is composed of prepared environmental samples (extracts, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples.

**Blank:** a sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results.

**Blind Sample:** a sub-sample for analysis with a composition known to the submitter. The analyst/laboratory may know the identity of the sample but not its composition. It is used to test the analyst's or laboratory's proficiency in the execution of the measurement process.

**Case Narrative:** a statement of non-conformances associated with particular data report

**Calibration:** to determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter, instrument, or other device. The levels of the applied calibration standard should bracket the range of planned or expected sample measurements.

**Calibration Curve:** the mathematical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response.

**Calibration Method:** a defined technical procedure for performing a calibration.

**Calibration Standard:** a substance or reference material used to calibrate an instrument.

**Certified Reference Material (CRM):** a reference material one or more of whose property values are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation which is issued by a certifying body.

**Chain of Custody:** an unbroken trail of accountability that ensures the physical security of samples and includes the signatures of all who handle the samples.

**Clean Air Act:** the enabling legislation in 42 U.S.C. 7401 *et seq.*, Public Law 91-604, 84 Stat. 1676 Pub. L. 95-95, 91 Stat., 685 and Pub. L. 95-190, 91 Stat., 1399, as amended, empowering EPA to promulgate air quality standards, monitor and to enforce them.

**Comprehensive Environmental Response, Compensation and Liability Act (CERCLA/Superfund):** the enabling legislation in 42 U.S.C. 9601-9675 *et seq.*, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), 42 U.S.C. 9601 *et seq.*, to eliminate the health and environmental threats posed by hazardous waste sites.

**Confirmation:** verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to second column confirmation, alternate wavelength, derivatization, mass spectral interpretation, alternative detectors or, additional cleanup procedures.

**Conformance:** an affirmative indication or judgement that a product or service has met the requirements of the relevant specifications, contract, or regulation; also the state of meeting the requirements.

**Corrective Action:** the action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence.

**Data Audit:** a qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data are of acceptable quality (i.e., that they meet specified acceptance criteria).

**Data Reduction:** the process of transforming raw data by arithmetic or statistical calculations, standard curves, concentration factors, etc., and collation into a more useable form.

**Demonstration of Capability:** a procedure to establish the ability of the analyst to generate acceptable accuracy.

**Document Control:** the act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly and controlled to ensure use of the correct version at the location where the prescribed activity is performed.

**Duplicate Analyses:** the analyses or measurements of the variable of interest performed identically on two sub-samples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory.

**Federal Water Pollution Control Act (Clean Water Act, CWA):** the enabling legislation under 33 U.S.C. 1251 *et seq.*, Public Law 92-50086 Stat. 816, that empowers EPA to set discharge limitations, write discharge permits, monitor, and bring enforcement action for non-compliance.

**Field of Testing:** TNI's approach to accrediting laboratories by program, method and analyte. Laboratories requesting accreditation for a program-method-analyte combination or for an up-dated/improved method are required submit to only that portion of the accreditation process not previously addressed (see TNI, section 1.9ff).

**Holding Times (Maximum Allowable Holding Times)** the maximum times that samples may be held prior to analysis and still be considered valid or not compromised.

**Laboratory Control Sample (however named, such as laboratory fortified blank, spiked blank, or QC check sample ):** a sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes from a source independent of the calibration standards or a material containing known and verified amounts of analytes. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.

**Matrix (or Quality System Matrix):** the component or substrate that contains the analyte of interest. For purposes of batch and QC requirement determinations, the following matrix distinctions shall be used:

**Aqueous:** any aqueous sample excluded from the definition of Drinking Water matrix or Saline/Estuarine source. Includes surface water, groundwater, effluents, and TCLP or other extracts.

**Drinking Water:** any aqueous sample that has been designated a potable or potential potable water source. **Saline/Estuarine:** any aqueous sample from an ocean or estuary, or other salt-water source such as the Great Salt Lake. **Non-aqueous Liquid:** any organic liquid with <15% settleable solids.

**Biological Tissue, Biota:** any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples shall be grouped according to origin.

**Solids:** includes soils, sediments, sludges and other matrices with >15% settleable solids.

**Chemical Waste:** a product or by-product of an industrial process that results in a matrix not previously defined.

**Air:** whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbent tube, impinger solution, filter, or other device.

**Matrix Spike (spiked sample or fortified sample):** a sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of Target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

**Matrix Spike Duplicate (spiked sample or fortified sample duplicate):** a second replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte.

**Method Blank:** a sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest, which is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.

**Method Detection Limit:** the minimum concentration of a substance (an analyte) that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.

**National Institute of Standards and Technology (NIST):** an agency of the US Department of Commerce's Technology Administration that is working with EPA, States, TNI, and other public and commercial entities to establish a system under which private sector companies and interested States can be accredited by NIST to provide NIST-traceable proficiency testing (PT) to those laboratories testing drinking water and wastewater.

**The NELAC institute (TNI):** a voluntary organization of State and Federal environmental officials and interest groups purposed primarily to establish mutually acceptable standards for accrediting environmental laboratories.

**TNI Standards:** the plan of procedures for consistently evaluating and documenting the ability of laboratories performing environmental measurements to meet nationally defined standards established by the The NELAC Institute.

**Performance Audit:** the routine comparison of independently obtained *qualitative and quantitative* measurement system data with routinely obtained data in order to evaluate the proficiency of an analyst or laboratory.

**Precision:** the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms.

**Preservation:** refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical and/or biological integrity of the sample.

**PT Fields of Testing:** TNI's approach to offering proficiency testing by regulatory or environmental program, matrix type, and analyte.

**Proficiency Testing:** a means of evaluating a laboratory's performance under controlled conditions relative to a given set of criteria through analysis of unknown samples provided by an external source.

**Proficiency Test Sample (PT):** a sample, the composition of which is unknown to the analyst and is provided to test whether the analyst/laboratory can produce analytical results within specified acceptance criteria.

**Quality Assurance:** an integrated system of activities involving planning, quality control, quality assessment, reporting and quality improvement to ensure that a product or service meets defined standards of quality with a stated level of confidence.

**Quality Control:** the overall system of technical activities whose purpose is to measure and control the quality of a product or service so that it meets the needs of users.

**Quality Manual:** a document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users.

**Quality System:** a structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA and QC.

**Quantitation Limits:** the maximum or minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be quantified with the confidence level required by the data user.

**Range:** the difference between the minimum and the maximum of a set of values.

**Raw Data:** any original factual information from a measurement activity or study recorded in a laboratory notebook, worksheets, records, memoranda, notes, or exact copies thereof that are necessary for the reconstruction and evaluation of the report of the activity or study. Raw data may include photography, microfilm or microfiche copies, computer printouts, magnetic media, including dictated observations, and recorded data from automated instruments. If exact copies of raw data have been prepared (e.g., tapes which have been transcribed verbatim, data and verified accurate by signature), the exact copy or exact transcript may be submitted.

**Reagent Blank (method reagent blank or method blank):** a sample consisting of reagent(s), without the target analyte or sample matrix, introduced into the analytical procedure at the appropriate point and carried through all subsequent steps to determine the contribution of the reagents and of the involved analytical steps.

**Reference Material:** a material or substance one or more properties of which are sufficiently well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials.

**Reference Method:** a method of known and documented accuracy and precision issued by an organization recognized as competent to do so.

**Reference Standard:** a standard, generally of the highest metrological quality available at a given location, from which measurements made at that location are derived.

**Replicate Analyses:** the measurements of the variable of interest performed identically on two or more sub-samples of the same sample within a short time interval.

**Requirement:** denotes a mandatory specification; often designated by the term “shall”.

**Resource Conservation and Recovery Act (RCRA):** the enabling legislation under 42 USC 321 *et seq.* (1976), that gives EPA the authority to control hazardous waste from the “Cradle-to-grave”, including its generation, transportation, treatment, storage, and disposal.

**Safe Drinking Water Act (SDWA):** the enabling legislation, 42 USC 300f *et seq.* (1974), (Public Law 93-523), that requires the EPA to protect the quality of drinking water in the U.S. by setting maximum allowable contaminant levels, monitoring, and enforcing violations.

**Sample Duplicate:** two samples taken from and representative of the same population and carried through all steps of the sampling and analytical procedures in an identical manner. Duplicate samples are used to assess variance of the total method including sampling and analysis.

**Spike:** a known mass of target analyte added to a blank sample or sub-sample; used to determine recovery efficiency or for other quality control purposes.

**Standard:** the document describing the elements of laboratory accreditation that has been developed and established within the consensus principles of TNI and meets the approval requirements of TNI procedures and policies.

**Toxic Substances Control Act (TSCA):** the enabling legislation in 15 USC 2601 *et seq.*, (1976), that provides for testing, regulating, and screening all chemicals produced or imported into the United States for possible toxic effects prior to commercial manufacture.

**Traceability:** the property of a result of a measurement whereby it can be related to appropriate standards, generally international or national standards, through an unbroken chain of comparisons.

**United States Environmental Protection Agency (EPA):** the federal governmental agency with responsibility for protecting public health and safeguarding and improving the natural environment (i.e., the air, water, and land) upon which human life depends.

**Validation:** the process of substantiating specified performance criteria.

**Verification:** confirmation by examination and provision of evidence that specified requirements have been met.

NOTE: In connection with the management of measuring equipment, verification provides a means for checking that the deviations between values indicated by a measuring instrument and corresponding known values of a measured quantity are consistently smaller than the maximum allowable error defined in a standard, regulation or specification peculiar to the management of the measuring equipment. The result of verification leads to a decision either to restore in service, to perform adjustment, to repair, to downgrade, or to declare obsolete. In all cases, it is required that a written trace of the verification performed shall be kept on the measuring instrument's individual record.

# **Appendix II**

# **Analytical Capabilities**

## TNI-Accredited Fields of Testing

Method Type	Method Number	Regulatory Program
<b>Organics</b>		
EDB and DBCP 1,4-Dioxane	EPA 504.1 EPA 522	Drinking Water Drinking Water
<b>Metals</b>		
ICP: General Cold Vapor Mercury	EPA 200.7, 1994 EPA 245.1, 1994	Drinking Water Drinking Water
<b>Inorganic WetChem</b>		
Perchlorate by Ion Chromatography	EPA 314.0	Drinking Water
<b>Organics</b>		
EDB and DBCP	EPA 504, SW846 8011**	Non-Potable Water
Volatile Organics	EPA 624, SW846 8260B**	Non-Potable Water
Semi-Volatile Organics	EPA 625, SW846 8270D**	Non-Potable Water
Semi-Volatile Organics	SW846 8270D SIM**	Non-Potable Water
Purgeable Aromatics	EPA 602, SW846 8021A**	Non-Potable Water
Chlorinated Pesticides & PCBs	EPA 608, SW846 8081B**, 8082A**	Non-Potable Water
Poly-Aromatic Hydrocarbons	EPA 610, SW846 8310**	Non-Potable Water
Nitroaromatics	SW846 8091**	Non-Potable Water
Explosives	SW846 8330A**, 8332**	Non-Potable Water
Explosives	SW846 8330B**,	Non-Potable Water
Chlorinated Herbicides	SW846 8151A**	Non-Potable Water
Organophosphorus Pesticides	SW846 8141B**	Non-Potable Water
Perchlorate	SW-846 6850	Non-Potable Water
Dissolved Gases	RSK SOP 147-175**	Non-Potable Water
Alcohols	SW846 8015C,D**	Non-Potable Water
Gasoline Range Organics	SW846 8015C,D**	Non-Potable Water
Diesel Range Organics	SW846 8015C,D**	Non-Potable Water
Total Petroleum Hydrocarbons	FLPRO**	Non-Potable Water
Tennessee EPH	TN-EPH**	Non-Potable Water
Tennessee GRO	TN-GRO**	Non-Potable Water
Wisconsin DRO	WI-DRO**	Non-Potable Water
Petroleum Hydrocarbons	Iowa OA-1**	Non-Potable Water
Petroleum Hydrocarbons	Iowa OA-2**	Non-Potable Water
Volatile Petro. Hydrocarbons	Massachusetts VPH, 2004**	Non-Potable Water

Method Type	Method Number	Regulatory Program
Extractable Petro. Hydrocarbons	Massachusetts EPH, 1998**	Non-Potable Water
Total Petroleum Hydrocarbons	TX-1005**	Non-Potable Water
Acrylamide	SW846 8316	Non-Potable Water
<b>Metals</b>		
ICP: General – EPA WW	EPA 200.7, 1994; SW-846 6010C**	Non-Potable Water
Cold Vapor Mercury – EPA WW	EPA 245.1, 1994; SW-846 7470A**	Non-Potable Water
<b>Inorganic WetChem</b>		
Alkalinity	SM2320B**	Non-Potable Water
CBOD	SM 5210B	Non-Potable Water
COD	SM5220C	Non-Potable Water
BOD	SM5210B	Non-Potable Water
Color, Apparent	SM2120B	Non-Potable Water
Ion Chromatography (Bromide, Fluoride, Chloride, Sulfate, Nitrite, Nitrate,) – Aqueous	EPA 300.0**, SW846 9056A**	Non-Potable Water
Nitrate/Nitrite	EPA 353.2**	Non-Potable Water
Total Kjeldahl Nitrogen	EPA 351.2**	Non-Potable Water
Ammonia	EPA 350.1**	Non-Potable Water
Oil & Grease, Gravimetric – AQ	EPA 1664A**, SW846 9070A**	Non-Potable Water
Orthophosphate	EPA 365.3**	Non-Potable Water
Nitrate	SM 4500NO2-B	Non-Potable Water
pH by electrode (Waters)	SM4500H+B**; SW846 9040C**	Non-Potable Water
Specific Conductance	EPA 120.1	Non-Potable Water
Nitrate-Nitrite	SM 4500 NO3-E	Non-Potable Water
Sulfide	SM4500S=F**	Non-Potable Water
Chloride	SM 4500 Cl-B	Non-Potable Water
Total Dissolved Solids	SM2540C**	Non-Potable Water
Total Organic Carbon	SM5310B**, SW846 9060A**	Non-Potable Water
Total Phosphorus	EPA 365.3	Non-Potable Water
Total Solids	SM2540B**	Non-Potable Water
Total Suspended Solids	SM2540D**	Non-Potable Water
Turbidity	EPA 180.1	Non-Potable Water
Total CN	EPA 335.4, SW846 9012B**	Non-Potable Water
Un-Ionized Ammonia - calculation	FDE SOP10/03/83	Non-Potable Water
Perchlorate	EPA 314	Non-Potable Water
Calcium Hardness by Calculation	SM18 2340B	Non-Potable Water
Hardness, Total by Calculation	SM18 2340B	Non-Potable Water
MBAS (Anionic Surfactants as)	SM5540C	Non-Potable Water

Method Type	Method Number	Regulatory Program
Corrosivity & pH – aqueous	SW846 9040C**	Non-Potable Water
Hexavalent Chromium	SW846 7196A**	Non-Potable Water
<b>Organics</b>		
EDB and DBCP	SW846 8011 Mod**	Solid and Chemical Material
Volatile Organics	SW846 8260B**	Solid and Chemical Material
Semi-Volatile Organics	SW846 8270D**	Solid and Chemical Material
Semi-Volatile Organics	SW846 8270D SIM**	Solid and Chemical Material
Gasoline Range Organics	SW846 8015C,D**	Solid and Chemical Material
Diesel Range Organics	SW846 8015C,D**	Solid and Chemical Material
Alcohols	SW846 8015C,D**	Solid and Chemical Material
Polynuclear-Aromatic Hydrocarbons	SW846 8310**	Solid and Chemical Material
Explosives	SW846 8330A** , 8332**	Solid and Chemical Material
Explosives	SW846 8330B**	Solid and Chemical Material
Organochlorine Pesticides	SW846 8081B**	Solid and Chemical Material
Polychlorinated Biphenyls	SW846 8082A**	Solid and Chemical Material
Chlorinated Herbicides	SW846 8151A**	Solid and Chemical Material
Organophosphorus Pesticides	SW846 8141B**	Solid and Chemical Material
Perchlorate	SW-846 6850	Solid and Chemical Material
Total Petroleum Hydrocarbons	FLPRO**	Solid and Chemical Material
Tennessee EPH	TN-EPH**	Solid and Chemical Material
Tennessee GRO	TN-GRO**	Solid and Chemical Material
Wisconsin DRO	WI-DRO**	Solid and Chemical Material
Petroleum Hydrocarbons	Iowa OA-1**	Solid and Chemical Material

<b>Method Type</b>	<b>Method Number</b>	<b>Regulatory Program</b>
Petroleum Hydrocarbons	Iowa OA-2**	Material Solid and Chemical Material
Volatile Petro. Hydrocarbons	Massachusetts VPH, 2004**	Solid and Chemical Material
Extractable Petro. Hydrocarbons	Massachusetts EPH, 1998**	Solid and Chemical Material
Total Petroleum Hydrocarbons	TX-1005**	Solid and Chemical Material
Acrylamide	SW846 8316	Solid and Chemical Material
<b><i>Metals</i></b>		
ICP: General – EPA WW	SW846 6010C**	Solid and Chemical Material
Cold Vapor Mercury – EPA DW	SW846 7471B**	Solid and Chemical Material
<b><i>Inorganic WetChem</i></b>		
Ion Chromatography (Bromide, Fluoride, Chloride, Sulfate, Nitrite, Nitrate,) – Aqueous	SW846 9056A**	Solid and Chemical Material
Oil & Grease, Gravimetric – Solid	SW846 9071A**	Solid and Chemical Material
Total CN	SW846 9012B**	Solid and Chemical Material
Total Organic Carbon	SW846 9060A**	Solid and Chemical Material
Ammonia	EPA 350.1	Solid and Chemical Material
Total Kjeldahl Nitrogen	EPA 351.2	Solid and Chemical Material
Total Phosphorus	EPA 365.3	Solid and Chemical Material
Waste Ignitability	SW846 1010A**	Solid and Chemical Material
Hexavalent Chromium/soils	SW846 7196A**	Solid and Chemical Material
Corrosivity & pH – aqueous	SW846 9040C**	Solid and Chemical Material
Corrosivity & pH – solid	SW846 9045D**	Solid and Chemical Material

<b>Method Type</b>	<b>Method Number</b>	<b>Regulatory Program</b>
Cyanide Reactivity	SW846 Chapter 7**	Solid and Chemical Material
Sulfide Reactivity	SW846 Chapter 7**	Solid and Chemical Material

**Organics**

Volatile Organics	TO-3	Air and Emissions
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**Preparation Methods\***

Liquid/Liquid Extraction, Water	SW846 3510C
Solid Phase Extraction, Water	SW846 3535A
Solids Extraction by Sonication	SW846 3550B
Microwave-assisted extraction, solids	SW846 3546
Acid/Base Partitioning	SW846 3650B
Sulfur Cleanup of Extracts	SW846 3660B
Sulfuric Acid Cleanup	SW846 3665A
Purge & Trap - Aqueous	SW846 5030B
Purge & Trap – Solids	SW846 5035A
Total Recoverable Metals Digestion	EPA 200.7
Non-Pot. Water Digest: ICP	SW846 3010A
Alkaline Digestion of Soils for Hexavalent Chromium	SW846 3060A
Digestion of Soils for ICP	SW846 3050B
TCLP	SW846 1311
SPLP	SW846 1312

\* Preparation methods are not listed on Primary TNI Accreditation per State of Florida DOH rules. However, for the benefit of other accrediting authorities, these methods are inspected during FDOH visits. Listing of surveyed and approved preparation methods is available from on-site inspection report.

\*\* Methods certified by DoD ELAP

## Non-TNI-Accredited Fields of Testing

Method Type	Method Number	Regulatory Program
<b>Organics</b>		
Thiodiglycol	Accutest in-house method (HPLC)	Solid and Chemical Material
N-Nitroso-N-Ethylurea	Accutest in-house method (HPLC)	Solid and Chemical Material
Volatile Petroleum Hydrocarbons	Missouri Gasoline Range Organics	Solid and Chemical Material
Extractable Hydrocarbons	Missouri Diesel Range Organics	Solid and Chemical Material
Extractable Hydrocarbons	Missouri Oil Range Organic	Solid and Chemical Material
Volatile Petroleum Hydrocarbons	Alaska AK-101**	Solid and Chemical Material
Extractable Hydrocarbons	Alaska AK-102**	Solid and Chemical Material
Extractable Hydrocarbons	Alaska AK-103**	Solid and Chemical Material
Volatile Petroleum Hydrocarbons	OK GRO**	Solid and Chemical Material
Extractable Hydrocarbons	OK DRO**	Solid and Chemical Material
<b>Inorganic WetChem</b>		
Oxidation-Reduction Potential	ASTM D1498-76, mod. for solids	Solid and Chemical Material
Percent Ash (dry basis)	ASTM D2974-87, D482-91	Solid and Chemical Material
Grain Size (hydrometer)	ASTM D422-63	Solid and Chemical Material
Sieve Testing	ASTM D422-63	Solid and Chemical Material
Specific Gravity	ASTM D1298-85	Solid and Chemical Material
Acidity	SM2310B	Non-Potable Water
Dissolved Oxygen	EPA 360.1	Non-Potable Water
Mineral Suspended Solids	EPA 160.2/160.4	Non-Potable Water
Organophosphonic Acids	Accutest in-house method (IC)	Solid and Chemical Material

<b>Method Type</b>	<b>Method Number</b>	<b>Regulatory Program</b>
Perchlorate	EPA 314MOD	Solid and Chemical Material
Percent Solids	SM19 2540G	Solid and Chemical Material
Settleable Solids	EPA 160.5	Non-Potable Water
Total Mineral Solids	EPA 160.4	Non-Potable Water
Total Residual Chlorine	EPA 330.5	Non-Potable Water
Total Volatile Solids	EPA 160.4	Non-Potable Water
Volatile Suspended Solids	EPA 160.2/160.4	Non-Potable Water
CN Amenable to Chlorination	EPA 335.4	Solid and Chemical Material
Bicarbonate, Carbonate, CO2 - calculation	SM19 4500 CO2D	Non-Potable Water
Ferrous Iron	SM19 3500 FE-D	Non-Potable Water
Salinity - calculation	SM19 2520B	Non-Potable Water
Paint Filter Test	SW846 9095	Solid and Chemical Material
Corrosivity towards steel	SW846 1110	Solid and Chemical Material
Corrosivity & pH – aqueous	SW846 9040C	Solid and Chemical Material

# **Appendix III**

## **Equipment List**

**ORGANIC INSTRUMENTATION**

<b>Instrument</b>	<b>Model</b>	<b>Location</b>	<b>Serial #</b>	<b>Year</b>
GC/MS	Agilent 5975C MSD/OI 4551/4660	MS-VOA	US11172705	2011
GC/MS	Agilent 5975C MSD/OI 4551/4660	MS-VOA	US11322911	2011
GC/MS	Agilent 5975C MSD/OI 4551/4660	MS-VOA	US10102029	2010
GC/MS	Agilent 5975C MSD/OI 4551/4660	MS-VOA	US83120965	2008
GC/MS	Agilent 5975N MSD/Agilent 7683 AS	SVOC Lab	US71225975	2007
GC/MS	Agilent 5975N MSD/Agilent 7683 AS	SVOC Lab	US62724401	2006
GC/MS	Agilent 5975N MSD/Agilent 7683 AS	SVOC Lab	US53921303	2005
GC/MS	Agilent 5973N MSD/Agilent 7683 AS	SVOC Lab	US40620599	2004
GC/MS	Agilent 5973 MSD/OI 4660/4552 Archon	MS-VOA	US41746628	2004
GC/MS	Agilent 5973 MSD/OI 4660/4552 Archon	MS-VOA	US41746633	2004
GC/MS	Agilent 5973 MSD/OI 4560/4552 Archon	Soil VOA	US21843765	2002
GC/MS	Agilent 5973 MSD/OI 4551/4660	MS-VOA	US21844034	2002
GC/MS	Agilent 5973 MSD/OI 4660/4552 Archon	MS-VOA	US02440350	2000
GC/MS	Agilent 5973 MSD/OI 4560/4552 Archon	MS-VOA	US94240108	1999
GC/MS	Agilent 5973 MSD/Agilent 7683 AS	SVOC Lab	US82311290	1998
GC/MS	Agilent 5973 MSD/Agilent 7683 AS	SVOC Lab	US81211109	1998
GC/MS	Hewlett-Packard 5970 MSD/OI 4560/4552 Archon	Soil VOA	3034A12782	1989
GC/MS	Hewlett-Packard 5970 MSD/OI 4560/4552 Archon	Soil VOA	2905A11904	1987
GC/MS	Hewlett-Packard 5970 MSD/OI 4560/4552 Archon	Soil VOA	2716A10454	1987
GC	Agilent 7890A/Dual ECD/7683B AS	SVOC Lab	CN10842133	2008
GC	Agilent 7890A/Dual FID/7683B AS	SVOC Lab	CN10902149	2009
GC	Agilent 7890A/Dual FID/7683B AS	SVOC Lab	CN10716029	2009
GC	Agilent 7890A/Dual ECD/7683B AS	SVOC Lab	CN10741128	2007

Instrument	Model	Location	Serial #	Year
GC	Agilent 6890/Dual FPD/7683B AS	SVOC Lab	US10643024	2006
GC	Agilent 6890/Dual FID/7683B AS	SVOC Lab	CN10641049	2006
GC	Agilent 6890/Dual ECD/7683B AS	SVOC Lab	CN10641081	2006
GC	Agilent 6890/Dual ECD/7683B AS	SVOC Lab	US10613003	2006
GC	Agilent 6890/PID/PID/OI 4560/4552 Archon	GC VOA	CN10421047	2004
GC	Agilent 6890/PID/FID/ENTECH 7032A-LB	GC VOA	US10239007	2002
GC	Agilent 6890N/Dual FID/HP 7683 AS	SVOC Lab	CN10425061	2004
GC	Agilent 6890N/Dual ECD/HP 7683 AS	SVOC Lab	US10333015	2003
GC	Agilent 6890/Dual ECD/HP 7683 AS	SVOC Lab	US00036916	2000
GC	Agilent 6890/Dual ECD/HP 7683 AS	SVOC Lab	US00028304	1999
GC	Hewlett-Packard 5890/PID/FID/ OI 4560/4552 Archon	GC VOA	3336A60617	1993
GC	Hewlett-Packard 5890/Dual FID/HP 7673 AS	SVOC Lab	3336A59489	1993
GC	Hewlett-Packard 5890/PID/FID/ OI 4560/4552 Archon	GC VOA	3336A51045	1993
GC	Hewlett-Packard 5890/PID/FID/OI 4560/4552 Archon	GC VOA	3203A41646	1992
GC	Hewlett-Packard 5890/PID/FID/OI 4560/4552 Archon (screening instrument)	GC VOA	3223A4267	1992
GC	Hewlett-Packard 5890/Dual FID/HP 7673 AS	SVOC Lab	3126A51085	1991
GC	Hewlett-Packard 5890/PID/FID/ dual MPM 16	Soil VOA	3029A29748	1990
GC	Hewlett-Packard 5890/FID	Soil VOA	2843A20183	1988
GC	Hewlett-Packard 5890/Dual FID	GC VOA	2728A12705	1987
HPLC	Agilent 1100 Automated LC System	HPLC Room	DE91606857	1999
HPLC	Agilent 1100 Automated LC System	HPLC Room	DE23917648	2002
HPLC	Agilent 1100 Automated LC System	HPLC Room	DE01608404	2000
HPLC	Agilent 1100 Automated LC System	HPLC Room	DE40522115	2004
HPLC	Agilent 1100 Automated LC System	HPLC Room	DE03000863	2003

Instrument	Model	Location	Serial #	Year
HPLC	Agilent 1100 Automated LC System	HPLC Room	DE61800775	2006
O-Prep	ESSA LM2-P Ring and Puck mill	Explosives Prep Lab	215090-004	2008
O-prep	Microwave extractor	Organic Prep Lab	MD3482	2010
O-Prep	TurboVap 4 units	Organic Prep Lab		2001
O-Prep	TurboVap 3 units	Organic Prep Lab		2004
O-Prep	TurboVap 1 unit	Organic Prep Lab		2007
O-Prep	Sonicator 2 units	Organic Prep Lab		2004
O-Prep	Sonicator 3 units	Organic Prep Lab		2007
O-Prep	Midi-Vap 2000 Kontes	Organic Prep Lab	479200-2000	2000
Data System	Hewlett-Packard/MS ChemStation	Labwide		1999, with subsequent upgrades

Inorganic Instrumentation

Instrument	Model	Location	Serial #	Year
ICP	Thermo ICAP 6000 Series	Metals Lab	20100903	2010
ICP	Thermo ICAP 6000 Series	Metals Lab	20103825	2010
Mercury Analyzer	Leeman Hydra AA	Metals Lab	HA-2022	2002
Mercury Analyzer	Leeman Hydra AA II	Metals Lab	2004	2012
TOC Analyzer	Shimadzu	WetChem IC room	H51404235007	2004
TOC Analyzer	Shimadzu	WetChem IC room	H51404735099	2010
IC	Dionex IC-2100	WetChem IC room	10110002	2010
IC	Dionex IC-2000	WetChem IC room	04070250	2004
Auto Analyzer	QuickChem 8500 Series	WetChem main room	050500000130	2005
Auto Analyzer	QuickChem 8500 Series 2	WetChem main room	111200001380	2011
Spectrophotometer	Milton-Roy Spectronic 200	WetChem main room	2 units	2000
Digestion block	DigiPrep	WetChem main room	4 units	2005

Centrifuge	CentraCL2	WetChem main room	42613052	2003
MicroDistillation Block	Lachat	WetChem main room	2 units	2005

<b>LIMS</b>		
<b>Instrument</b>	<b>Model</b>	<b>Year</b>
LIMS	HP True 64	1999

# **Appendix IV**

## **Certification Summary**

<b>Certifying Authority</b>	<b>Certification Program</b>	<b>Registration No.</b>
Alaska	Contaminated Sites	UST-088
Arkansas	Solid/Hazardous Wastes, Non-Potable Water	88-0620
California (NELAP)	Potable Water, Solid/Hazardous Waste	04226CA
Department of Defense (DoD)	Non-Potable Water, Solid and Chemical Materials	L-2229
Florida (NELAP)	Potable, Non-Potable, Solid Waste, UST, Air Toxics	E83510
Georgia	Solid/Hazardous Wastes	Not Applicable
Illinois	Solid/Hazardous Wastes, Non-Potable Water	
Iowa	UST, Solid/Hazardous Wastes, Non-Potable Water	IA366
Kansas (NELAP)	Solid/Hazardous Wastes, Non-Potable Water	E-10327
Kentucky	Underground Storage Tank Program	0065
Louisiana (NELAP)	Solid/Hazardous Wastes	38582
Massachusetts	Non-Potable Water	M-FL946
Mississippi	Potable Water	Not Applicable
Nevada	Non-Potable Water, Solid/Hazardous Wastes	FL009462008A
New Jersey (NELAP)	Solid/Hazardous Wastes, Non-Potable Water	FL002
North Carolina	Solid/Hazardous Wastes, Non-Potable Water	573
Oklahoma	Non-Potable Water, Solid/Hazardous Waste	9959
South Carolina	Solid/Hazardous Wastes, Non-Potable Water	96038001
Texas (NELAP)	Non-Potable Water, Solid/Hazardous Waste	T104704040-08-TX
US Dept. of Agriculture	Foreign Soils Permit	S-56027
Utah (NELAP)	Potable, Non-Potable, Solid/Chemical Materials	FL009462008A
Virginia (NELAP)	Potable, Non-Potable, Solid/Chemical Materials	460177
Washington	Potable, Non-Potable, Solid/Chemical Materials, Air	C2046
Wisconsin	Solid/Hazardous Wastes, Non-Potable Water	399043370

# Appendix V

## SOP List

SOP #	TITLE
Organic Preparation Department	
OP002	SOP for Glassware Cleaning and Storage
OP003	SOP for Reagent Prep
OP006	SOP for the Extraction of Semi-volatile Organics (BNAs) from Aqueous Samples
OP007	SOP for the Extraction of Semi-volatile Organics (BNAs) from Solid Samples
OP008	SOP for the Extraction of Pesticides/PCBs from Aqueous Samples
OP009	SOP for the Extraction of Pesticides/PCBs from Solid Samples
OP009MW	SOP for the Extraction of Pesticides/PCBs from Solid Samples, microwave
OP010	SOP for the Extraction of Diesel Range Organics (DRO) from Aqueous Samples
OP011	SOP for the Extraction of Diesel Range Organics (DRO) from Solid Samples
OP011MW	SOP for the Extraction of Diesel Range Organics (DRO) from Solid Samples
OP012	SOP for the Extraction of Petroleum Related Organics (FL-PRO) from Aqueous Samples
OP013	SOP for the Extraction of Petroleum Related Organics (FL-PRO) from Solid Samples
OP014	SOP for the Extraction of PAHs from Aqueous Samples (HPLC)
OP015	SOP for the Extraction of PAHs from Solid Samples (HPLC)
OP016	SOP for the Extraction of EDB/DBCP from Aqueous Samples
OP017	SOP for the Extraction of EDB/DBCP from Solid Samples
OP018	SOP for the Extraction of Explosives from Aqueous Samples
OP019	SOP for the Extraction of Explosives from Solid Samples
OP020	SOP for Sample Introduction via SW846-5035
OP021	SOP for Sample Introduction via SW846-5030B
OP022	SOP For The Extraction Of Nitroglycerine And Pentaerythritoltetranitrate (PETN) From Water Samples (HPLC Analysis)
OP023	SOP For The Extraction Of Nitroglycerine And Pentaerythritoltetranitrate (PETN) From Solid Samples (HPLC Analysis)
OP024	Standard Operating Procedure For The Extraction Of Nitroaromatics From Water Samples
OP025	SOP For Sample Preparation For Dissolved Gases In Aqueous Samples
OP026	SOP For The Extraction Of Extractable Petroleum Products (OA-2) From Water Samples
OP027	SOP For The Extraction Of Extractable Petroleum Products (OA-2) From Solid Samples
OP028	SOP For The Extraction Of Diesel And Oil Range Organics From Water Samples
OP029	SOP For The Extraction Of Diesel And Oil Range Organics From Solid Samples
OP030	SOP For The Extraction Of Extractable Petroleum Hydrocarbons From

SOP #	TITLE
	Water Samples (Tennessee EPH)
OP031	SOP For The Extraction Of Extractable Petroleum Hydrocarbons From Solid Samples (Tennessee EPH)
OP032	SOP For The Extraction Of Volatile Petroleum Hydrocarbons From Soil Samples, MA-VPH
OP033	SOP For The Extraction Of PCBs From Wipes
OP034	SOP For The Extraction Of Diesel Range Organics (DRO) From Aqueous Samples WI-DRO
OP035	SOP For The Extraction Of Massachusetts Extractable Petroleum Hydrocarbons From Water Samples
OP036	SOP For The Extraction Of Massachusetts Extractable Petroleum Hydrocarbons From Solid Samples
OP037	SOP For The Extraction Of Chlorinated Herbicides From Water Samples
OP038	SOP For The Extraction Of Chlorinated Herbicides From Soil Samples
OP038MW	SOP For The Extraction Of Chlorinated Herbicides From Soil Samples, microwave
OP039	SOP For The Solid Phase Extraction (SPE) Cartridge Cleanup Of Pesticide Extracts
OP040	SOP For SPLP Leaching Of SVOC And Metals
OP041	SOP For TCLP Leaching Of VOC
OP042	SOP For SPLP Leaching Of SVOC And Metals
OP043	SOP For SPLP Leaching Of VOC
OP044	SOP For The Extraction Of Organophosphorus Pesticides From Water Samples
OP044SP	SOP For The Extraction Of Organophosphorus Pesticides From Water Samples, Solid Phase Extraction
OP045	SOP For The Extraction Of Organophosphorus Pesticides From Soil Samples
OP045MW	SOP For The Extraction Of Organophosphorus Pesticides From Soil Samples, microwave
OP046	SOP for the Extraction of Explosives from Solid Samples, SW-8330B
OP047	SOP for the Extraction of Explosives from Aqueous Samples, SW-8330B
OP048	SOP for the Extraction of PCB Congeners from Aqueous Samples
OP049	SOP for the Extraction of PCB Congeners from Solid Samples
OP050	SOP For The Extraction Of Alaska Extractable Petroleum Hydrocarbons From Water Samples
OP051	SOP For The Extraction Of Alaska Extractable Petroleum Hydrocarbons From Solid Samples
OP052	SOP For The Extraction Of Oklahoma Extractable Petroleum Hydrocarbons From Water Samples
OP053	SOP For The Extraction Of Oklahoma Extractable Petroleum Hydrocarbons From Solid Samples
OP054	SOP For The Extraction Of 1,4-Dioxane From Water Samples
OP055	SOP For The Extraction Of Petroleum Hydrocarbons From Water Samples,

SOP #	TITLE
OP056	TX-1005 SOP For The Extraction Of Petroleum Hydrocarbons From Solid Samples, TX-1005
OP057	SOP for Sample Introduction via AK-101
<b>Gas Chromatography/ HPLC SOPs</b>	
GC002	Analysis Of 1,2-Dibromoethane (EDB) And 1,2-Dibromo-3-Chloropropane (DBCP) By Gas Chromatography, Electron Capture Detector
GC004	Aromatic Volatiles By Gas Chromatography Using PID Detectors EPA 602
GC005	Analysis Of Organochlorine Pesticides By Gas Chromatography, Electron Capture Detector EPA 608
GC006	Analysis Of Polychlorinated Biphenyls By Gas Chromatography, Electron Capture Detector EPA 608
GC007	Analysis Of Polynuclear Aromatic Hydrocarbons By Gas Chromatography, Flame Ionization Detector EPA 610
GC008	Analysis Of Petroleum Range Organics By Gas Chromatography Using Flame Ionization Detector
GC009	Analysis Of 1,2-Dibromoethane (EDB) And 1,2-Dibromo-3-Chloropropane (DBCP) By Gas Chromatography, Electron Capture Detector SW-846 8011
GC010	Analysis Of Gasoline Range Organics By Gas Chromatography Using Flame Ionization Detector
GC011	Analysis Of Diesel Range Organics By Gas Chromatography Using Flame Ionization Detector
GC014	Analysis Of Polychlorinated Biphenyls By Gas Chromatography, Electron Capture Detector SW-846 8082
GC015	Analysis Of Organochlorine Pesticides By Gas Chromatography, Electron Capture Detector SW-846 8081
GC016	Analysis Of Nitroaromatics And Nitramines By HPLC
GC017	Aromatic Volatiles By Gas Chromatography Using PID Detectors SW-8021
GC018	Analysis Of Polynuclear Aromatic Hydrocarbons By HPLC SW-846 8310
GC019	Analysis Of Dissolved Gases By Gas Chromatography, Flame Ionization Detector
GC020	Analysis Of Nitroglycerine And PETN By HPLC
GC021	Analysis Of Volatile Petroleum Hydrocarbons By Gas Chromatography
GC022	Analysis Of Extractable Petroleum Products By Gas Chromatography Using Flame Ionization Detector OA-2
GC023	Analysis Of Diesel And Oil Range Organics By Gas Chromatography Using Flame Ionization Detector
GC024	Analysis Of Petroleum Hydrocarbons By Gas Chromatography Using Flame Ionization Detector (Tennessee EPH)
GC025	Analysis Of Nitroaromatics By Gas Chromatography Using Electron Capture Detector
GC026	Method For Determination Of Volatile Petroleum Hydrocarbons By GC-

SOP #	TITLE
	PID/FID
GC027	Analysis Of Non-Halogenated Organics By Gas Chromatography Using Flame Ionization Detector
GC028	Analysis Of Gasoline Range Organics By Gas Chromatography Using Flame Ionization Detector TDEC GRO
GC029	Analysis Of Diesel Range Organics By Gas Chromatography Using Flame Ionization Detector Wi DRO
GC030	Analysis Of Extractable Petroleum Hydrocarbons By Gas Chromatography Using Flame Ionization Detector MA-EPH
GC031	Analysis Of Chlorinated Herbicides Using GC-ECD
GC032	Analysis Of Organophosphorus Pesticides Using GC-NPD Or FPD
GC033	Air Analysis By GC-PID/FID
GC034	Analysis Of Nitroaromatics, Nitramines And Nitrate Esters By HPLC Method 8330b
GC035	Screening Of Volatile Organics By GC-PID/FID
GC036	Analysis of PCB Congeners by ECD
GC037	Analysis of Diesel and Oil Range Organics by GC/FID, AK-102, AK-103
GC038	Analysis of Gasoline Range Organics by GC/FID, AK-101
GC039	Analysis of Diesel Range Organics by GC/FID, OK-GRO
GC040	Analysis of Gasoline Range Organics by GC/FID, OK-GRO
GC041	Analysis of N-Nitroso-N-Ethylurea by HPLC
GC042	Analysis of Thiodiglycol by HPLC
GC043	Analysis of Acrylamide by HPLC
GC044	Analysis of Petroleum Organics by TX-1005

### Mass-Spectrometry SOPs

MS003	Analysis of Volatile Organics by EPA Method 624
MS004	Analysis of Semi-volatile Organics by EPA Method 625
MS005	Analysis of Volatile Organics by EPA Method 8260B
MS006	Analysis of Semi-volatile Organics by EPA Method 8270C
MS008	Analysis of Semi-volatile Organics by EPA Method 8270C SIM
MS009	Analysis of Volatile Organics by GC/MS
MS010	Analysis of Volatile Organics by GC/MS SIM
MS011	Analysis of Semi-volatile Organics by EPA Method 8270D
MS012	Analysis of 1,4-Dioxane by EPA 522
MS013	Analysis of Perchlorate by SW-846 6850

### Quality Assurance SOPs

QA001	Preparation, Approval, Distribution & Archiving Of Standard Operating Procedures (SOPs)
QA002	Calibration Of Thermometers
QA003	Personnel Training And Analyst Proficiency

SOP #	TITLE
QA004	Temperature Monitoring
QA005	Calibration Of Analytical Balances
QA006	Eppendorf Pipette Calibration
QA007	Sample Batching Procedure
QA008	Creating New Accounts
QA009	Creating New Projects
QA010	Confidentiality Protection Procedures
QA011	Signature Authority
QA012	Employee Technical Ethics Responsibilities
QA013	Client Complaint Resolution Procedure
QA014	Procedures For The Purchase Of Laboratory Supplies
QA015	Procedures For The Preparation, Distribution, Use And Archiving Of Laboratory Logbooks
QA016	Corrective Action Procedure
QA017	Standards Traceability Documentation Procedure
QA018	Procedure For Login, Management, Handling, And Reporting Of Proficiency Test (Pt) Samples
QA019	Quality System Review
QA020	Procedure For Developing Method Performance Criteria And Experimental Method Detection Limits
QA021	Subcontracting Procedures
QA022	Internal Audit Procedure
QA023	Fume Hood Inspection
QA027	Review Of Inorganics Data
QA028	Review Of Organics Data
QA029	Manual Integration Of Chromatographic Peaks
QA030	Procedure For The Development And Use Of in-house Quality Control Criteria
QA031	Air Quality Monitoring Of Extraction Laboratory
QA032	Routine Maintenance For Major Analytical Instrumentation
QA033	Laboratory Safety
QA034	Sample Homogenizing
QA035	Solvent Testing And Approval
QA036	Data Package Generation
QA037	Deionized Water Quality Control Procedure
QA038	Data Integrity Training Procedure
QA039	Data Integrity Monitoring Procedure
QA040	Procedure For Conducting Data Integrity Investigations
QA041	Procedure For The Confidential Reporting Of Data Integrity Issues
QA042	Basic Calculations For General Chemistry Methods
QA043	Data Qualifier SOP
QA044	Calibration Of Micro-Distillation Tubes
QA045	Estimation of Uncertainty
QA046	Document Control

SOP #	TITLE
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QA047	Management of Client Project
QA048	Data Entry for Log-In

General Chemistry SOPs

GNSOP: 101	Acidity (pH 8.2)
GNSOP: 102	Alkalinity, Total (pH 4.5)
GNSOP: 103	Ammonia – Distillation Procedure
GNSOP: 104	Nitrogen, Ammonia
GNSOP: 105	Bicarbonate, Carbonate, Free Carbon Dioxide
GNSOP: 106	Chemical Oxygen Demand
GNSOP: 107	Chloride by Titration
GNSOP: 109	Color, Apparent
GNSOP: 110	Chromium, Hexavalent (Water)
GNSOP: 113	Cyanide Distillation/Aqueous And Solid Samples
GNSOP: 115	Cyanide, Total
GNSOP: 116	Dissolved Oxygen
GNSOP: 121	Ignitability
GNSOP: 122	Anionic Surfactants As MBAS
GNSOP: 123	Nitrogen, Nitrite
GNSOP: 126	Ortho Phosphate
GNSOP: 127	Paint Filter Liquids Test
GNSOP: 128	Phenols Distillation, Soil And Water Samples
GNSOP: 130	Phenols, Total Recoverable
GNSOP: 133	Settleable Solids
GNSOP: 134	Total Suspended Solids (Non Filterable Residue)
GNSOP: 135	Total Dissolved Solids (Total Filterable Residue)
GNSOP: 136	Reactive Sulfide And Reactive Cyanide
GNSOP: 137	pH By Electrode - Water
GNSOP: 140	Sulfide
GNSOP: 144	Total Phosphorus
GNSOP: 145	Turbidity
GNSOP: 147	Winkler Titration For DO Standardization
GNSOP: 161	Percent Solids
GNSOP: 163	Specific Conductance At 25 C.
GNSOP: 166	pH By Electrode – Soil
GNSOP: 167	Biochemical Oxygen Demand (BOD)
GNSOP: 171	Hexachromium In Soils
GNSOP: 179	Corrosivity (Soil pH By Electrode)
GNSOP: 182	Total Kjeldahl Nitrogen
GNSOP: 189	Corrosivity Toward Steel
GNSOP: 190	Total Nitrogen, Organic Nitrogen
GNSOP: 191	Nitrogen, Nitrate
GNSOP: 192	Carbonaceous Biochemical Oxygen Demand (CBOD)

<b>SOP #</b>	<b>TITLE</b>
<b>GNSOP: 193</b>	Oxidation-Reduction Potential
<b>GNSOP: 194</b>	Ferrous Iron
<b>GNSOP: 196</b>	Glassware Cleaning
<b>GNSOP: 197</b>	Anions By Ion Chromatography
<b>GNSOP: 211</b>	Oil & Grease And PHC By 1664
<b>GNSOP: 212</b>	Fractional Organic Carbon
<b>GNSOP: 213</b>	Walkley-Black Total Organic Carbon
<b>GNSOP: 214</b>	Particle Size By Sieve
<b>GNSOP: 215</b>	TOC In Water
<b>GNSOP: 216</b>	Particle Size By Hydrometer
<b>GNSOP: 218</b>	Perchlorate
<b>GNSOP: 219</b>	Bulk Density
<b>GNSOP: 222</b>	Un-Ionized Ammonia Calculation
<b>GNSOP: 224</b>	Hardness By Calculation
<b>GNSOP: 225</b>	Cation Exchange Capacity Of Soils (Sodium Acetate)
<b>GNSOP: 226</b>	TOC In Soil
<b>GNSOP: 227</b>	Oil And Grease – Gravimetric Analysis (Soils)
<b>GNSOP: 228</b>	Anions By Ion Chromatography - IC 2000
<b>GNSOP: 229</b>	Determination Of Nitrocellulose In Water
<b>GNSOP: 230</b>	Determination Of Nitrocellulose In Soil
<b>GNSOP: 231</b>	% Ash
<b>GNSOP: 232</b>	Determination Of Nitrate and Nitrite by Lachat

### **Metals SOPs**

<b>MET 100</b>	Metals By Inductively Coupled Plasma
<b>MET 103</b>	Digestion Of Water Samples For Flame And ICP Analysis
<b>MET 104</b>	Digestion Of Soils For ICP Analysis
<b>MET 105</b>	Cold Vapor Analysis Of Mercury For Soils
<b>MET 106</b>	Cold Vapor Analysis Of Mercury For Water Samples

### **Sample Management SOPs**

<b>SAM101</b>	Sample Receipt And Storage
<b>SAM102</b>	Procedure For Sample Bottle Preparation And Shipment
<b>SAM104</b>	Sample Container Quality Control
<b>SAM108</b>	Sample And Laboratory Waste Disposition
<b>SAM109</b>	Foreign Soil receipt and Handling

**Attachment E**  
**FDEP SOPs**

## ***FA 1000. REGULATORY SCOPE AND ADMINISTRATIVE PROCEDURES FOR USE OF DEP SOPS***

### **FA 1100. Intent and Purpose**

This administrative SOP provides guidance and specific instructions concerning the organization and regulatory use of the various components of the collection of DEP SOPs found in DEP-SOP-001/01 (Field Procedures) and DEP-SOP-002/01 (Laboratory Procedures). For those situations where procedures alternative to the DEP SOPs are proposed, see FA 2100, Application to Use Alternative Procedures. In addition, quality assurance management recommendations and requirements for implementation of the DEP SOPs are discussed in FA 3000, Quality Systems. Auditing protocols used by DEP to evaluate individuals and organizations for compliance with the DEP SOPs are described in FA 4000. Minimum personnel qualifications required for certain DEP SOP activities are listed in FA 5000. Definitions and terms used throughout the DEP SOPs are found in the Tables and Glossary included in the Appendix to FA 1000.

#### 1. TERMS SPECIFIC TO RECOMMENDED AND REQUIRED PROCEDURES

Although the entire collection of DEP SOPs comprises minimum requirements under the DEP Quality Assurance Rule, 62-160, F.A.C., certain provisions in the DEP SOPs specifically describe recommendations that are suggested and not mandatory. In addition, certain requirements are emphasized in the text of DEP SOPs according to the terms defined below.

- 1.1. When the words “shall” or “must” are associated with a procedure or other item, the item is mandatory and required in all cases.
- 1.2. When the words “should” or “may” are used, the referenced item is recommended or suggested but not mandatory.

#### 2. COMPLIANCE WITH HEALTH & SAFETY AND WASTE DISPOSAL REGULATIONS

The collection of DEP SOPs is not intended to provide guidance on compliance with personal protection, health & safety or waste disposal regulations. Users of the DEP SOPs should ensure that the requirements of all local, state and federal regulations concerning personal protection, health & safety planning and the storage and disposal of any hazardous or investigation-derived wastes are fulfilled when performing the procedures described in the DEP SOPs.

#### 3. DISCLAIMER FOR USE OF TRADE NAMES

Trade names are used in certain DEP SOPs to provide examples of equipment or materials appropriate for use according to the indicated procedures. Other brand names of equipment may be used interchangeably if they are of equivalent design, construction materials and function. The use of trade names by DEP does not indicate an endorsement of any commercial product. In rare instances, the listed brand name is the only item or material of its kind available meeting specifications required by the associated DEP SOP.

### **FA 1200. Regulatory Use**

All parties producing data for use by DEP are required to use applicable DEP SOPs per the DEP Quality Assurance Rule, 62-160.210, .240, .300 & .320, F.A.C.

**FA 1210. EXCEPTIONS TO USE**

Activities exempted from mandatory use of the DEP SOPs are indicated in the DEP Quality Assurance Rule, 62-160.110 & .210, F.A.C.

**FA 1300. Format, Definitions and Terms****FA 1310. SOP FORMAT**

The SOPs are divided into major topic areas

**1. FA: ADMINISTRATION:**

- 1.1. Outlines the intended use and scope of the SOPs
- 1.2. Defines:
  - Terms
  - Matrices
  - Analyte groups
- 1.3. Outlines procedures to be used when applying for alternative field procedures and how they will be used.
- 1.4. Discusses the required elements of a quality system, personnel responsibilities, and the quality manual.
- 1.5. Describes auditing procedures used by DEP to evaluate individuals and organizations for compliance with the DEP SOPs.
- 1.6. Lists personnel qualifications required for performing certain procedures in the DEP SOPs.

**2. FC: CLEANING PROCEDURES:** Outlines appropriate cleaning procedures for field equipment and sample containers.**3. FD: FIELD DOCUMENTATION:**

- 3.1. Summarizes the types of documentation and records that must be maintained.
- 3.2. Provides field forms that may be used by organizations.

**4. FM: FIELD PLANNING AND MOBILIZATION:**

- 4.1. Discusses recommended procedures for obtaining laboratory services.
- 4.2. Discusses recommended activities to be performed before beginning a sample collection project.

**5. FQ: FIELD QUALITY CONTROL:**

- 5.1. Discusses the types of quality control measures used by sampling organizations.
- 5.2. Outlines the mandatory quality control samples to be collected.
- 5.3. Discusses the quality control measures that are associated with field measurements.

**6. FS: FIELD SAMPLING:** Discusses sample collection procedures based on source:

- 6.1. General sampling procedures applicable to all sampling activities including construction materials, container types, preservation and holding times.

6.2. General aqueous sampling procedures applicable to collecting all water samples.

6.3. Specific SOPs for:

- Surface Water
- Groundwater
- Drinking water
- Wastewater
- Soils
- Sediment
- Waste
- Biological Tissues
- Biological Community
- Contaminated Surface Sampling
- Ultra Trace Metal Sampling

7. FT: FIELD TEST MEASUREMENTS: Discusses procedures to calibrate and maintain instruments and perform field measurements for:

- pH
- Specific Conductance
- Salinity
- Temperature
- Dissolved Oxygen
- Turbidity
- Light Penetration (Transparency and Secchi Depth)
- Water Flow and Velocity (Discharge)
- Multi Parameter Meters
- Residual Chlorine
- Aquatic Biological Habitat Characterization

8. LD: DOCUMENTATION FOR LABORATORY PROCEDURES: Lists documentation requirements for the following laboratory procedures not discussed in the NELAC Quality Systems standards:

- Determination of Biological Indices
- Quality Control for Biological Community Analysis

9. LQ: LABORATORY QUALITY CONTROL: Describes quality control for the following laboratory procedures not discussed in the NELAC Quality Systems standards:

- Taxonomic Identification and Enumeration

10. LT: LABORATORY TESTING PROCEDURES: Describes laboratory methods for procedures not discussed in the NELAC Quality Systems standards:

- Biological laboratory procedures for taxonomic identification and enumeration
- Calculation of Biorecon, Stream Condition, Lake Vegetation and Lake Condition indices

**FA 1320. SOP GLOSSARY**

The glossary, found in FA 1000, Appendix FA 1000 defines the terms used throughout the DEP SOPs.

**FA 1330. MATRIX DEFINITIONS**

Table FA 1000-1 identifies and defines the sample-collection matrices that are used throughout the DEP SOPs.

**FA 1340. ANALYTE GROUP DEFINITIONS**

Tables FA 1000-2 and FA 1000-3 identify and define the sample-collection analyte groups as used throughout the DEP SOPs.

***FA 2000. GENERAL ADMINISTRATIVE PROCEDURES*****FA 2100. Application to Use Alternative Procedures****1. INTRODUCTION**

When protocols described in the collection of DEP SOPs are unsuitable for a specific application, use alternative procedures approved by DEP according to the following conditions and instructions.

**2. SCOPE, REGULATORY REQUIREMENTS AND EXCLUSIONS**

2.1. The procedures in the DEP SOPs are minimum requirements for sample collection, sample handling, field testing and certain laboratory procedures used to generate data for DEP use. Per the DEP Quality Assurance Rule, 62-160.210 & .330, F.A.C., alternative and new procedures require preapproval by DEP before use on a project. Apply for approval to use alternatives to the DEP SOPs except for those DEP SOPs and alternative or new procedures described or listed in sections 2.1.1 – 2.3 below.

2.1.1. Certain DEP SOPs will provide for allowable alternatives to the indicated procedures. See specific SOPs for a description of these preapproved alternatives.

2.1.2. Per the DEP Quality Assurance Rule, 62-160.600, F.A.C., procedures employed for research purposes are not considered alternative procedures. However if the DEP SOPs are required for use in a research project and alternative procedures are proposed instead, an application for alternative procedures must be submitted.

2.1.2.1. Submit research procedures proposed to be incorporated into the collection of DEP SOPs according to FA 2240 below.

2.1.3. Alternative or new procedures submitted in DEP-approved Quality Assurance Plans prior to the adoption of the collection of DEP SOPs in SOP-DEP-001/01 and SOP-DEP-002/01 may be approved by DEP for future specific projects without modification if the procedure meets the data quality objectives of the future project and the request to use the procedure meets the requirements indicated in FA 2200 – FA 2230.

2.1.4. Per the DEP QA Rule, 62-160.220, F.A.C., alternative or new procedures submitted under the provisions of DEP contracts, permits or orders and approved by DEP prior to the effective date of the collection of DEP SOPs in SOP-DEP-001/01 and SOP-DEP-002/01 remain approved for the duration of the project associated with the contract, permit or order. The requirements indicated in FA 2200 – FA 2230 are waived for these procedures.

2.1.5. Procedures used by the DEP Bureau of Emergency Response or its designated representatives and contractors to collect samples under regulations governing emergency response incidents may deviate from the requirements in the DEP SOPs without preapproval to the extent necessary to protect human health, public safety and the environment. The requirements indicated in FA 2200 – FA 2230 are waived for these procedures.

## 2.2. DEP SOPs Not Requiring Preapproved Alternatives

- FC 1000-1430 and Appendix
- FS 8200

## 2.3. Excluded Modifications to DEP SOPs

The following DEP SOPs cannot be modified or replaced by alternative or new procedures:

- FS 7000, General Biological Community Sampling
- FT 3000, Aquatic Habitat Characterization
- LT 7000, Determination of Biological Indices

## **FA 2200. Review and Approval of Alternative Procedures**

### GENERAL INSTRUCTIONS

1. Submit all applications for alternative procedures to the DEP project manager assigned to the site, project, permit, or contract. Do not send applications to DEP headquarters offices in Tallahassee unless the project manager is stationed in Tallahassee or the application is submitted for general approval as a statewide-use procedure.
2. Do not commence using the alternative procedure until approval is granted by DEP.
3. In order to meet the data quality objectives of the proposed project, DEP may impose specific conditions on the use of the alternative procedure or request modifications to the procedure before approval.

## **FA 2210. GENERAL DESCRIPTION OF ALTERNATIVE PROCEDURES**

The degree of modification of a published DEP SOP or the specifications of a proposed new procedure will in part determine whether the procedure is deemed alternative. Evaluate proposed procedures according to the following criteria in determining whether to apply for alternative or new procedure approval.

### 1. INCLUDED MODIFICATIONS AND EFFECTS ASSOCIATED WITH ALTERNATIVE OR NEW SAMPLING PROCEDURES:

Procedures containing the following modifications or potentially producing the indicated effects require the submittal of applications for approval as alternative or new procedures.

1.1. Step-wise, procedural modifications using the equipment specified in an affected DEP SOP that alter the integrity, nature or representativeness of the sample, as determined by comparison with the published DEP SOP.

1.2. Use of equipment or containers composed of materials that may potentially contaminate the sample with substances that interfere with sample preservation or analysis or that otherwise result in a loss or fortification (contamination) of analytes or parameters of interest in the sample.

1.3. Use of substantially different equipment as an alternative to the equipment prescribed in the affected DEP SOP.

1.4. Use of substitute reagents or chemicals, where applicable, to sample collection procedures.

1.5. Use of entirely new procedures or technology not discussed in the DEP SOPs. These procedures are defined as new procedures.

## 2. MODIFICATIONS TO FIELD TESTING METHODS AND NEW FIELD TESTING METHODS

Alternative field-testing methods of all types are subject to the provisions of the DEP Quality Assurance Rule, 62-160.330 FAC, for approval of alternative analytical methods.

## 3. MODIFICATIONS TO SAMPLE PRESERVATION PROTOCOLS/NEW PRESERVATION PROTOCOLS

Sample preservation procedures of all types are subject to the provisions of the DEP Quality Assurance Rule, 62-160.400 F.A.C., which references approved sample preservation protocols listed in FS 1006. Alternative procedures for sample preservation, container types and sample storage are subject to the preapproval requirements described in FA 2100 – FA 2230.

### **FA 2220. GENERAL CRITERIA FOR APPROVAL OF ALTERNATIVE PROCEDURES**

1. The approval of all proposed alternative and new procedures is dependent upon fulfillment of the following general criteria.

1.1. Alternative procedures must be appropriate for the Data Quality Objectives (DQOs) established for the project for which the alternative procedure is proposed.

1.2. Where applicable, the alternative procedure must be demonstrated to be equivalent to or exceed the performance of the DEP SOP that the alternative procedure is proposed to replace.

1.3. Approval will not be granted if the procedure produces data unusable by DEP for the fulfillment of DQOs, or if the procedure produces data that are not comparable to or are otherwise incompatible for use with existing DEP data generated by other approved procedures.

1.4. Approval will not be granted if the alternative procedure is shown to produce data at obvious risk of being invalidated according to the requirements of the DEP Quality Assurance Rule, 62-160.670, F.A.C. or according to data validation criteria established by DEP as specific DQOs for the affected project(s).

1.5. Procedures developed by consensus or standardization organizations, such as ASTM, EPA or USGS, or by manufacturers or vendors and derived from collaborative studies, will be considered on merit for approval as published by the standard-setting organization or commercial interest.

- 1.6. Approval of alternative or new procedures of all types is independent of the operating party and may be used by any entity for the affected project for which the procedure is approved.
- 1.7. Each proposed alternative or new procedure will be evaluated on an individual basis against these criteria according to the specific requirements of the project for which the alternative or new procedure will be used.
2. Although most requests for alternative procedure approval must be routed through the designated DEP project or contract manager for a site or project, approval will be granted by DEP through internal review that includes other staff in addition to the project manager.
3. See additional discussion for statewide-use approval in FA 2230, section 2.

## **FA 2230. PROJECT-SPECIFIC AND STATEWIDE-USE ALTERNATIVE PROCEDURES**

The protocol for applying for alternative procedure approval differs depending on whether the alternative or new procedure is intended for project-specific or statewide use, and will determine the scope of approval for the procedure.

1. PROJECT-SPECIFIC ALTERNATIVE FIELD PROCEDURES: Submit all applications for project-specific alternative or new procedures to the DEP project manager assigned to the project, legal case, site, permit, order, contract or other agreement. Approvals of project-specific procedures are subject to the following:
  - 1.1. Apply for project-specific alternative procedures on a site or project basis. The approval will not be portable and the alternative procedures cannot be used on other sites or projects, **but may be used by any party performing the alternative procedure approved for the affected project.**
    - 1.1.1. Alternative procedures employed for experimental purposes, where data derived from the alternative procedure will not be used by DEP, will be handled informally with the DEP project manager and are not subject to the approval requirements of this SOP.
    - 1.1.2. The statewide-use application will not be required for any project-specific approval, but a statewide-use approval for an alternative procedure will satisfy project-specific approval requirements if the procedure meets the data quality objectives of the project and the request to use the procedure meets the requirements indicated in FA 2200 – FA 2230.
2. STATEWIDE-USE ALTERNATIVE FIELD PROCEDURES:
  - 2.1. Submit applications for approval for alternative or new procedures for statewide use for general approval or for use on multiple sites in the state.
    - 2.1.1. Statewide-use procedures require the design of a collaborative multi-party study to investigate the efficacy of the proposed procedure for specified site conditions and sample types. An evaluation of the proposed procedure on multiple sites representing different environmental conditions may be required to demonstrate the robustness of the procedure. Each application will be considered on a case-by-case basis by DEP. Approval for statewide use does not guarantee applicability of the procedure for all projects.
    - 2.1.2. The statewide-use application will not be required for any project-specific approval, but a statewide-use approval for an alternative or new procedure will satisfy project-specific approval requirements if the procedure meets the data quality objectives

of the project and the request to use the procedure meets the requirements indicated in FA 2200 – FA 2230.

2.2. Submit written study designs and applications for approval to the DEP project manager assigned to the project, site, permit, case, contract or other agreement. If the procedure is being submitted for general approval and not for use on a specific project, submit the application for approval to the Environmental Assessment Section (EAS) at DEP headquarters in Tallahassee.

2.2.1. Consult with the DEP project manager or the EAS prior to submittal. The format and content of the application, as well as the study design, will be determined on a case-by-case basis in collaboration with all affected parties.

2.3. Procedures approved for statewide use become part of the public domain and are made available to any party.

2.3.1. DEP will not accept applications for alternative or new procedures for statewide use where proprietary rights, exclusive use or other limitations on use of the procedures are claimed.

#### **FA 2240. ADDITION OF ALTERNATIVE PROCEDURES TO THE COLLECTION OF DEP SOPs**

1. Incorporation of procedures or methods into the collection of DEP SOPs requires approval of the procedure or method for Statewide Use, per the DEP Quality Assurance Rule, 62-160.210 & .330, F.A.C.

1.1. See FA 2230, section 2, above.

2. Upon request to the Environmental Assessment Section at DEP headquarters in Tallahassee, and after approval for statewide use, the procedure will be added to the collection of DEP SOPs at the next publication date.

2.1. Approval for statewide use is effective at the time of original approval of the procedure or method, regardless of publication date of the revised collection of DEP SOPs.

### **FA 3000. QUALITY SYSTEMS**

Each organization shall establish and maintain a quality system that will:

1. Identify, implement and promote quality assurance policies and procedures that will produce data of a known and verifiable quality;
2. Create and/or identify and follow standard operating procedures for all activities, both technical and administrative;
3. Monitor adherence to the established policies, procedures and written standard operating procedures;
4. Establish and use procedures for continual improvement through both corrective and preventive action policies; and
5. Monitor the quality of the organization's product.

## **FA 3100. Quality Assurance Policies and Procedures**

Each organization shall ensure that there are policies and procedures in place for the following activities:

### **1. ORGANIZATION**

1.1. Policies and procedures on how information concerning quality assurance issues is distributed and communicated.

1.2. Personnel procedures and documentation - DEP will review this type of information relative to the understanding and training of each individual for their assigned duties and quality assurance responsibilities. DEP will assess these items:

- Hiring procedures and policies
- Position qualifications including education and experience requirements
- Training requirements and training records
- Position descriptions
- Expectations on ethical behavior
- Consequences of poor performance, unethical behavior or any activity that might misrepresent the quality of the organization's work.

### **2. REVIEW AND ASSESSMENT**

2.1. Procedures on how data are reviewed, evaluated and reported.

2.2. Policies concerning how non-standard or unacceptable results are handled.

2.3. Procedures describing how the entire quality system is monitored (audited) at the technical and managerial level.

2.4. Policies and procedures on how external audits are reviewed and used.

2.5. Policies and procedures on how the outcomes of all audits are handled including initiating and monitoring both corrective and preventive actions.

2.5.1. Identification of key personnel who are responsible for ensuring that the system is evaluated and for issuing audit reports and follow-up corrective/preventive action summaries.

2.6. Identification of key personnel who review such reports and are in a position to make decisions about the effectiveness of the quality system.

2.7. Policies and procedures on how to deal with activities that did not follow the organization's procedures.

2.8. Policies and procedures on how to document the use of procedures that are different from those in the DEP SOPs or are new technology.

### **3. CLIENT SERVICES**

3.1. Policies and procedures that are used to review requests for services.

3.2. Policies and procedures relating to how customer concerns or complaints about any activity addressed in the DEP SOPs are handled. This must include but is not limited to conducting audits and initiating corrective actions.

3.3. When applicable, policies and procedures to ensure and protect client confidentiality.

4. **PROCUREMENT:** These policies must reflect the specifications and requirements of the DEP SOPs as well as any additional considerations an organization might impose on how purchases are made.

4.1. Policies and procedures describing how equipment, supplies and other services are obtained including:

4.1.1. Specifications for equipment, containers, testing equipment, reagents and other supplies; and

4.1.2. Specifications and procedures for obtaining laboratory services.

## **FA 3200. Quality Assurance Responsibilities**

1. Each individual in an organization has a responsibility for ensuring that their assigned tasks meet the organization's stated quality assurance goals, policies and procedures.

2. The following discussions assign certain tasks to various levels of responsibility. DEP recognizes that the organization structure within a company may vary. With the exception of the QA Officer, the duties specified below may differ from suggested job titles and may be assigned to more than one person.

3. All tasks outlined below must be performed by an individual or individuals within the organization.

## **FA 3210. QUALITY ASSURANCE OFFICER**

1. The role of the Quality Assurance Officer (QAO) is one of oversight. In addition to coordinating and overseeing data quality activities, monitoring adherence to company policies and procedures and corrective actions, the QAO must have the ability and authority to recommend and implement immediate corrective measures, without going through chains of command. Therefore, organizational and functional position of QAO cannot be placed in direct lines of authority.

2. The Quality Assurance Officer must be able to objectively evaluate data and perform audits without outside influences. The responsibilities of the QAO may be divided among several individuals (i.e. corporate QAO, regional QA managers) and the designated QA Officer may be assigned other duties (e.g., project management). Any other responsibilities of a QAO cannot bias the performance of any of the following tasks.

3. The QAOs (however named) must :

3.1. Review quality control data to determine if data are acceptable;

3.2. Perform annual systems audits to ensure compliance with all quality assurance plans and standard operating procedures;

3.2.1. Distribute results of internal and external audits to management and all affected individuals;

3.2.2. Oversee responses to internal and external audits;

3.2.3. Oversee and recommend corrective actions as a result of the audits;

3.2.4. Verify corrective action implementation.

3.3. Oversee administration of performance audits;

- 3.4. Coordinate preparation of quality assurance reports to management, clients and regulatory agencies;
- 3.5. Coordinate and oversee the preparation of quality manuals and quality assurance project plans;
- 3.6. Review new or proposed procedures to determine appropriate use. Also reviews associated method validation information;
- 3.7. Review, in writing, initiated corrective actions to assure effectiveness. Recommend additional measures if necessary.

#### **FA 3220.           TECHNICIAN LEVEL**

The field technician or sample collector must:

1. Perform field measurement tests according to DEP SOPs including calibrations;
2. Verify that all calculations (e.g., purge volume) are correct;
3. Collect samples following the DEP SOPs (or company SOPs) using appropriate equipment;
4. Ensure that sample containers are properly and accurately labeled;
5. Ensure that appropriate preservatives are added and that appropriate sample containers are used to collect required fractions;
6. Legibly and fully document all activities in field logs or field data sheets;
7. Ensure that all field information is accurately recorded;
8. Identify and/or document potential quality control problems (e.g., unacceptable calibrations, environmental conditions, procedure and equipment variances, etc.); and
9. Maintain equipment and test instruments in working condition, and document all preventative maintenance and repairs.
10. Implement any corrective action procedures that are a result of any type of audit.

#### **FA 3230.           SUPERVISORS AND/OR SUBSECTION/SECTION MANAGEMENT**

These individuals must:

1. Ensure that all activities (either sampling or field or laboratory testing) are performed according to methods and protocols specified in any quality planning document, sampling and analysis plan and the DEP SOPs.
2. Review all field and laboratory generated data by:
  - 2.1. Checking documentation for completeness and proper sample identification
  - 2.2. Checking raw data for calculation, interpretation or clerical errors
  - 2.3. Assuring that produced quality control data are acceptable
3. Coordinate analytical work or field activities to assure completion of all tasks within established time frames.
4. Oversee preventative maintenance activities.
5. Evaluate and implement changes in methodology and quality control measures.

6. Identify quality control problems and takes measures to correct or eliminate the problem source.
7. Monitor and/or implement any corrective action procedures that are a result of any audit type.
8. Assume the responsibility for validating all field generated documentation and data and ensure that final field reports are accurate before final review by management.

**FA 3240. PROJECT MANAGEMENT**

1. Acts as a liaison between the client and the organization.
2. Oversees and coordinates project activities including workplans, quality assurance plans, data quality objectives, standard operating procedures and scheduling.
3. Ensures that there are adequate qualified personnel, equipment, and time to produce a completed project of a specified quality.
4. Reviews project data prior to final report to assure that all data (field and laboratory) are acceptable and within specified project objectives.

**FA 3250. MANAGEMENT**

These individual(s) are responsible for overall operation of the organization including fiscal resources and personnel. They must:

1. Ensure that all organizational activities are conducted according the organization's established quality system, quality manual and standard operating procedures and that all policies and procedures are consistent with the quality manual.
2. Conduct management reviews at regularly scheduled intervals, not to exceed 12 months:
  - 2.1. The review and the procedures for such a review must be documented.
  - 2.2. The review must assess the organization's quality system, and related activities to determine the effectiveness of the system, and its continuing suitability. The review must include, but is not limited to:
    - Policy and procedures review
    - Outcome of internal and external audits
    - Corrective and preventative actions
    - Reports from managerial and supervisory staff
    - Changes in volume and type of work
    - Client feedback
    - Complaints and their resolution
    - Staff training
  - 2.3. The findings and recommendations of this management review must be documented, as well as any actions that are the result of the review.
3. Ensure that there is sufficient managerial, technical and support staff with the authority and resources (equipment, etc.) to perform their stated duties.

4. Establish procedures to ensure that all personnel are free from any undue internal or external commercial, financial and other pressures or influences that adversely affect the performance and quality of their work.
5. Ensure that the staff has the necessary education, experience and/or training to perform their stated duties.

## **FA 3300. Quality Manual**

Each organization must have a quality manual that outlines their current quality system, quality assurance policies and quality control procedures. All topics specified in FA 3100 and 3200 must be addressed by descriptive discussions or reference to specific policies and procedures.

At a minimum, the quality manual must address the following:

1. A title page signed by the quality assurance officer(s), and the highest level of management responsible for field activities with:
  - Document Title
  - Organization's full name, address and telephone number
  - Identification of all major organizational units covered by the document
  - The effective date of the version.
2. A table of contents, and applicable lists of references, glossaries, appendices, tables and figures.
3. A statement of policy which must outline the organization's commitment to generating data through the use of sound Quality Assurance and Quality Control management practices.
4. An ethics statement which must outline (or make reference to) the organization's ethics policy and employee training on ethics.
5. ORGANIZATIONAL TOPICS:
  - 5.1. A discussion on the organizational structure, including lines of authority, identification of key personnel and their responsibilities, the relationship of all units (including administration, management and support services) to the quality system.
  - 5.2. Stated job descriptions for all staff or reference to such information.
  - 5.3. A list of all approved signatories (e.g., Professional Geologist, Professional Engineer, Quality Assurance Officer).
  - 5.4. Discussion on or reference to procedures and policies dealing with employee credentials and training.
6. DOCUMENTATION
  - 6.1. Discussion on or reference to procedures and policies concerning how records are generated, retained, and stored.
  - 6.2. Discussion on or reference to procedures dealing with how documentation is controlled and maintained.
  - 6.3. Discussion on or reference to the types of documents/reports that are generated by the organization.

- 6.4. Discussion on or reference to procedures to ensure accurate sample identification and data integrity.
- 6.5. Discussion on or reference to procedures to protect client confidentiality (when applicable).
7. CAPABILITIES
  - 7.1. Specify the organization's capabilities. This must include the types of sampling, sampling matrix and laboratory and field testing relevant to execution of the DEP SOPs, and may include other services such as hydrology, engineering, etc.
  - 7.2. Reference to the specific sampling procedures to be used.
  - 7.3. List all field and laboratory test methods.
  - 7.4. List the types of field and laboratory instruments and equipment used by the organization for implementation of the DEP SOPs.
  - 7.5. Reference to or discussion on how samples are handled and transported/submitted to a laboratory.
8. EQUIPMENT AND INSTRUMENTS
  - 8.1. Discussion on or reference to procedures used for calibrating instruments; source, preparation and documentation of standards; and procedures used to generate, assess and document calibrations.
  - 8.2. Discussion on or reference to routine procedures used to maintain analytical instruments and sampling equipment and the associated documentation.
9. REVIEW AND ASSESSMENT
  - 9.1. Reference to or discussion on the types of quality control measures to be used. Include:
    - 9.1.1. Types and frequency of field generated quality controls (blanks, replicates, etc.);
    - 9.1.2. Types and frequency of any ongoing quality control program to ensure the accuracy of laboratory data;
    - 9.1.3. The criteria against which each quality control measure will be assessed;
  - 9.2. Discussion on or reference to procedures to be used to review and assess raw data, laboratory data, and project data. At a minimum include:
    - 9.2.1. Data reduction: how raw data are reviewed and assessed (including criteria for accepting initial and continuing calibrations), and the formulas for calculating final sample results.
    - 9.2.2. Data verification: how data are assessed with respect to calculations (are the correct values reported?) and to quality control (were the systems in control according to all QC criteria?).
    - 9.2.3. Data validation: how project data are reviewed and assessed, including the content of any reports.
  - 9.3. Discussion on or reference to the criteria for determining when corrective action must be initiated for each QC measure and the procedures used to implement corrective action.
  - 9.4. Discussion on or reference to procedures to be used in the case of deviations from the documented policies and procedures.

9.5. Discussion on or reference to the types of performance, systems, and management audits to be performed including the frequency, the participants, and the process.

#### 10. CONSUMER RELATIONS

10.1. Discussion on or reference to policies and procedures regarding review of proposed work to ensure adequate personnel and equipment.

10.2. Discussion on or reference to policies and procedures for dealing with complaints.

## **FA 4000. AUDITS AND DATA VALIDATION PROCEDURES**

### **FA 4100. Regulatory Requirements**

All field and laboratory procedures conducted in accordance with the DEP SOPs or approved alternative procedures are subject to audits and data validation per the DEP Quality Assurance Rule, 62-160.650 & .670, F.A.C.

### **FA 4200. Auditing Procedures**

All organizations must conduct internal audits to verify compliance with the DEP SOPs. Advisory checklists are included in Appendix FA 1000.

### **FA 4300. Initial Demonstration of Proficiency for Biological Community Assessment Procedures**

Auditing protocols in this section are applicable to biological procedures described in the following DEP SOP series:

- FS 7000
- FT 3000
- LT 7000

### **FA 4310. PROFICIENCY CRITERIA FOR STREAM AND RIVER HABITAT BENTHIC MACROINVERTEBRATE SAMPLING**

#### 1. SCOPE AND APPLICABILITY

This auditing protocol is applicable to stream and river benthic macroinvertebrate sampling procedures described in FS 7410 and FS 7420.

1.1. Personnel must complete the training topics in FA 5710 and FA 5720 prior to requesting an audit.

1.2. Personnel anticipating performing the procedures in FS 7410, Rapid Bioassessment (Biorecon) Method and FS 7420, Stream Condition Index (D-Frame Dip net) sampling for the purpose of determining biological indices as calculated per LT 7100, Biorecon Determination and LT 7200, Stream Condition Index (SCI) Determination should be audited by DEP according to the auditing protocol described in section 2 below and produce a satisfactory evaluation and score according to the audit and scoring criteria listed below in sections 3 & 4 prior to collecting samples.

#### 2. Auditing PROTOCOL FOR STREAM AND RIVER BENTHIC MACROINVERTEBRATE SAMPLING

## 2.1. General Auditing Protocols

- 2.1.1. Audits are conducted in an appropriate physical field setting selected by DEP.
- 2.1.2. Audit candidates are required to provide proper equipment in good working order necessary to conduct sampling.
- 2.1.3. Audit candidates will be asked a series of questions designed to evaluate their conceptual knowledge of appropriate sampling methods.
- 2.1.4. Audit candidates are expected to demonstrate satisfactory skill in performing the procedures detailed in the Biorecon and SCI sampling SOPs.

## 3. AUDITING EVALUATION CRITERIA FOR STREAM AND RIVER BENTHIC MACROINVERTEBRATE SAMPLING

Personnel must demonstrate a satisfactory working knowledge of and demonstrate the ability to perform the following:

- 3.1. Identify the best available habitats in a 100-meter stream reach (snags, leaf packs, roots, aquatic plants, limerock).
  - 3.1.1. Identification of best available habitat must include the following:
    - Length of inundation considered
    - Siltation and sedimentation effects considered
    - Leaf packs partially decayed
    - Flow considerations taken into account
- 3.2. Discuss and recognize circumstances where SCI or Biorecon sampling should be postponed, (e.g., in the event of recent increase in water level or during flooding).
- 3.3. Know correct number of dip net sweeps for SCI (20) and Biorecon (4).
- 3.4. Properly apportion dip net sweeps to available habitats.
- 3.5. Efficiently capture invertebrates during dip net sweeps while properly agitating substrates with at least 3 passes of the dip net along a 0.5 meter sample sweep length (sweep length sampled is 0.5 meters, plus or minus 0.1 m, absent consistently high or low bias).
- 3.6. Sample only productive portions of habitats while not diluting sample with unproductive detritus.
- 3.7. Properly transfer sampled material to sample container (SCI) or pick pan (Biorecon) without sample loss.
- 3.8. Biorecon Sorting
  - 3.8.1. Dispense proper density of detritus into pick pan for sorting efficiency.
  - 3.8.2. Methodically search for organisms in pick pan.
  - 3.8.3. Efficiently capture organisms using forceps and pipets.
  - 3.8.4. Process entire dip net contents.
  - 3.8.5. Attain >95% picking efficiency (1 point; between 90% and 95% efficiency, 0.5 point; < 90%, no points, non-attainment).

## 4. AUDIT EVALUATION SCORING FOR BENTHIC MACROINVERTEBRATE SAMPLING

For mastery of each component in section 3 above, 1 point is awarded. Only 0.5 point is awarded if the applicable component is evaluated as partially correct. To pass, only 0.5 point can be missed. No item can be found partially correct more than once (see section 3.8.5 above also).

## **FA 4320. PROFICIENCY CRITERIA FOR LAKE CONDITION INDEX (LCI) SAMPLING**

### **1. SCOPE AND APPLICABILITY**

This auditing protocol is applicable to Lake Condition Index (Lake Composite) sampling procedures described in FS 7460.

1.1. Personnel anticipating performing the procedures in FS 7460, Lake Condition Index (Lake Composite) Sampling for the purpose of determining the LCI (biological index), as calculated per LT 7300, Lake Condition Index (LCI) Determination should be audited by DEP according to the auditing protocol described in section 2 below and produce a satisfactory evaluation and score according to the audit and scoring criteria listed below in sections 3 & 4 prior to collecting samples.

### **2. AUDITING PROTOCOL FOR LAKE CONDITION INDEX (LCI) SAMPLING**

#### **2.1. General Auditing Protocols**

2.1.1. Audits are conducted in an appropriate physical field setting selected by DEP.

2.1.2. Audit candidates are required to provide proper equipment in good working order necessary to conduct sampling.

2.1.3. Audit candidates will be asked a series of questions designed to evaluate their conceptual knowledge of appropriate sampling methods.

2.1.4. Audit candidates are expected to demonstrate satisfactory skill in performing the procedures detailed in the LCI sampling SOP.

### **3. AUDITING EVALUATION CRITERIA FOR LAKE CONDITION INDEX (LCI) SAMPLING**

Personnel must demonstrate a satisfactory working knowledge of and demonstrate the ability to perform the following:

3.1. Appropriately subdivide lake into sampling units, using a map, GPS and landmarks (12 subunits in lakes less than 1000 acres, 2-4 subunits in larger systems).

3.2. Discuss and recognize circumstances where LCI sampling is not appropriate and should be replaced by wetlands sampling procedures, i.e., aquatic system with greater than 50% emergent macrophyte cover and depth less than 2 meters.

3.3. Follow correct sampling procedure using dredges:

- Deploy dredge from correct location on boat.
- Deploy and retrieve dredge to properly sample the benthos.
- Collect samples in the requisite sampling unit from the specified water depth (2 to 4 m).
- Repeat dredge deployment for each designated sampling unit.

3.4. Correctly process retrieved samples:

3.4.1. Examine the sediment and document visual characteristics on the Composite Lake Sampling Sheet (Form FD 9000-2) or equivalent record.

- 3.4.2. Check for sample loss from dredge before sieving sample.
- 3.4.3. Properly sieve sample without losing portions of sample.
- 3.4.4. Concentrate and transfer sample into collection container without loss.
- 3.5. Record appropriate location information for collected samples.

#### 4. AUDIT EVALUATION SCORING FOR LAKE CONDITION INDEX (LCI) SAMPLING

For mastery of each component in section 3 above, 1 point is awarded. Only 0.5 point is awarded if the applicable component is evaluated as partially correct. To pass, only 0.5 point can be missed (i.e., no more than one item can be partially correct).

### **FA 4330. PROFICIENCY CRITERIA FOR LAKE VEGETATION INDEX (LVI) SAMPLING**

#### 1. SCOPE AND APPLICABILITY

This auditing protocol is applicable to Lake Vegetation Index (LVI) sampling procedures described in FS 7310.

1.1. Organizations anticipating performing the procedures in FS 7310, Lake Vegetation Index Sampling for the purpose of determining the LVI (biological index), as calculated per LT 7500, Lake Vegetation Index (LVI) Determination should participate yearly in a DEP sponsored field exercise described in section 2 below and produce a satisfactory evaluation and score according to the criteria listed below in sections 3.

#### 2. LAKE VEGETATION INDEX (LVI) SAMPLING FIELD EXERCISE

##### 2.1. General Protocols

2.1.1. DEP will conduct a proficiency field exercise yearly at a minimum of 3 geographically separate (Panhandle, Northern Peninsula, Southern Peninsula) sites throughout the state.

2.1.2. DEP will announce the proficiency test 15 days prior to the beginning of the sampling window, which will be 30 days in length.

2.1.3. Perform an LVI, FS 7310, within the sampling window on one of the lakes identified.

2.1.4. Submit to DEP:

- the final LVI score (as calculated per LT 7500),
- taxa list on form FD 9000-7,
- name of organization,
- name of samplers performing the exercise and
- date the analysis was performed.

2.1.5. DEP will evaluate the scores, per section 3 below, and post the results.

#### 3. EVALUATION CRITERIA FOR LVI SAMPLING

3.1. DEP will determine the LVI score for the lakes announced in section 2.1 above.

3.1.1. The LVI score will be determined within the same sampling period announced in section 2.1.

3.2. The final LVI score for an organization must be within plus or minus 12 points from the DEP determined score to have “passed” the exercise.

3.3. Organizations with scores outside the plus or minus 12 point range will be deemed as failing.

**FA 4400. Data Validation (Reserved)**

***FA 5000. FIELD PERSONNEL QUALIFICATIONS AND TRAINING***

Certain procedures described in the DEP SOPs necessitate commensurate levels of expertise for the user. Recommended, minimum qualifications and training for personnel are described below for the indicated procedures.

**FA 5100. (Reserved)**

**FA 5200. (Reserved)**

**FA 5300. (Reserved)**

**FA 5400. (Reserved)**

**FA 5500. (Reserved)**

**FA 5600. (Reserved)**

**FA 5700. Qualifications and Training for Biological Procedures**

**FA 5710. SAMPLING FOR BENTHIC MACROINVERTEBRATES**

1. TRAINING FOR BENTHIC MACROINVERTEBRATE SAMPLING: Personnel anticipating performing Stream Condition Index (SCI) sampling according to FS 7420 or Biorecon sampling according to FS 7410 should complete the training specified in FS-7420 Training Checklist included in Appendix FA 1000.

2. QUALIFICATIONS FOR BENTHIC MACROINVERTEBRATE SAMPLING: Personnel performing macroinvertebrate sampling according to FS 7410, Rapid Bioassessment (Biorecon) Method and FS 7420, Stream Condition Index (D-Frame Dipnet) Sampling for the purpose of determining biological indices as calculated per LT 7100, Biorecon Determination and LT 7200, Stream Condition Index (SCI) Determination or, according to FS 7460, Lake Condition Index (Lake Composite) Sampling for the purpose of determining the LCI (biological index), as calculated per LT 7300, Lake Condition Index (LCI) Determination, should successfully complete an audit evaluation administered by DEP according to FA 4310, Proficiency Criteria for Stream and River Habitat Benthic Macroinvertebrate Sampling or FA 4320, Proficiency Criteria for Lake Condition Index (LCI) Sampling, as applicable.

**FA 5720. AQUATIC HABITAT CHARACTERIZATION**

1. TRAINING FOR HABITAT ASSESSMENT TESTING: Personnel performing Habitat Assessments according to FT 3000 should complete the Habitat Assessment training program specified in FT-3000 Training Checklists included in Appendix FA 1000.

**Appendix FA 1000**  
**Tables, Figures and Forms**

Table FA 1000-1 Sample Collection Matrices

Table FA 1000-2 Aqueous Sample Collection Analyte Groups

Table FA 1000-3 Non-Aqueous Sample Collection Analyte Groups

Example Audit Checklists (note: additional or revised versions of these **advisory** checklists are found on the DEP Website)

FD 1000 Audit Checklist

FQ 1000 Audit Checklist

FT-Series Audit Checklists

FS 1000 Audit Checklist

FS 2000 Audit Checklist

FS 2100 Audit Checklist

FS 2200 Audit Checklist

Training Standard Operating Procedure

FS-7420 Stream Condition Index Training Checklist

FT-3000 Habitat Assessment Training Checklist

Glossary

**Table FA 1000-1**  
**Sample Collection Matrices**

NOTE: Matrix terms are organized on the basis of differentiation of sample collection technique and sample source, not analytical matrix.

1. AQUEOUS ENVIRONMENTAL MATRICES

Potable water

Groundwater

Surface water

Rainwater

Soil interstitial (pore) water

Sediment interstitial (pore) water

Stormwater

2. AQUEOUS WASTE MATRICES

Aqueous chemical waste

Aqueous leachate

Aqueous industrial sludge

Aqueous domestic wastewater sludge

Industrial wastewater

Domestic wastewater

3. NON-AQUEOUS ENVIRONMENTAL MATRICES

Soil

Sediment

4. NON-AQUEOUS WASTE MATRICES

Non-aqueous liquid industrial sludge

Non-aqueous liquid chemical waste

Mixed-media liquid industrial sludge

Mixed-media liquid chemical waste

Solid industrial waste

Solid chemical waste

Solid domestic waste

Construction & demolition debris

Refuse-derived fuel

Domestic wastewater sludge cake

Industrial sludge cake

Compost

**Table FA 1000-1**  
**Sample Collection Matrices**

Screened material

5. BIOLOGICAL TISSUE MATRICES

Finfish

Shellfish

Mammals

Birds

Reptiles

Other animals

Plants

6. AIR MATRICES

Remedial treatment system exhaust

Soil vapor

7. SUBSTRATES

Contaminated surfaces

Natural biological community substrates

Artificial biological community substrates

**Table FA 1000-2**  
**Aqueous Sample Collection Analyte Groups**

NOTE: Examples are given for most of the analyte groups listed below, but the lists are not comprehensive. The analyte groups are organized according to the following criteria as they apply to sample collection only: 1) uniqueness of the group name to signify common sample collection technique and compatible sampling equipment materials; 2) familiarity of group name and conventional usage; 3) special sampling technique associated with the group name; and 4) brevity in the interest of avoiding a longer list.

1. VOLATILE ORGANICS: Volatile organic aromatics, volatile organic halocarbons, EDB
2. EXTRACTABLE ORGANICS: Base/neutral/acid individual, synthetic organics typically analyzed by GC, GCMS and HPLC (e.g., phenols, PCBs, PAHs, pesticides, herbicides, dioxins, etc.)
3. PETROLEUM HYDROCARBONS AND OIL & GREASE: Samples collected for all Oil & Grease, TRPH and FL-PRO analyses
4. RADIONUCLIDES: Total Alpha and Beta emitters, but not Radon
5. BIOLOGICALS: Aquatic toxicity tests (biotoxicity/whole effluent toxicity), algal growth potential, phytoplankton and chlorophyll
6. METALS
7. ULTRA-TRACE METALS: Metals collected by "clean-hands" sampling techniques for sub-ppb analyses
8. INORGANIC NON-METALLICS: Nutrients and other inorganic anions, residual chlorine, dissolved oxygen, neutral-charge chemical species
9. AGGREGATE ORGANICS: TOX, BOD, COD, TOC, total phenols and surfactants
10. MICROBIOLOGICAL-BACTERIA: Fecal and total coliforms, enterococcus and fecal strep
11. MICROBIOLOGICAL-PROTOZOA: Giardia, cryptosporidium and microscopic particulate analysis (MPA)
12. MICROBIOLOGICAL-VIRUSES
13. VOLATILE INORGANICS: Sulfide, hydrogen sulfide, sulfite
14. PHYSICAL AND AGGREGATE PROPERTIES: Color, conductivity, hardness, alkalinity, odor, residues (solids), turbidity, salinity, asbestos, SOUR test, acidity, hazardous waste characteristics

**Table FA 1000-3****Non-Aqueous Sample Collection Analyte Groups**

NOTE: This list is applicable to liquid, solid and mixed-phase non-aqueous matrices. Examples are given for most of the analyte groups listed below, but the lists are not comprehensive. The analyte groups are organized according to the following criteria, as they apply to sample collection only: 1) uniqueness of the group name to signify common sample collection technique and compatible sampling equipment materials; 2) familiarity of group name and conventional usage; 3) special sampling technique associated with the group name; and, 4) brevity in the interest of avoiding a longer list

1. VOLATILE ORGANICS: Volatile organic aromatics, volatile organic halocarbons, EDB
2. EXTRACTABLE ORGANICS: Base/neutral/acid individual, synthetic organics typically analyzed by GC, GCMS and HPLC, e.g., phenols, PCBs, PAHs, pesticides, herbicides, dioxins, etc.
3. PETROLEUM HYDROCARBONS AND OIL & GREASE: Samples collected for all Oil & Grease, TRPH and FL-PRO analyses
4. RADIONUCLIDES: Total Alpha and Beta emitters, but not Radon
5. BIOLOGICALS: Benthic macroinvertebrates and periphyton from natural and artificial substrates, toxicity studies conducted in non-aqueous media
6. METALS
7. INORGANIC NON-METALLICS: Nutrients and inorganic anions, neutral-charge chemical species
8. AGGREGATE ORGANICS: TOX, SOD, COD, TOC, total phenols
9. MICROBIOLOGICAL-BACTERIA: Fecal and total coliforms, enterococcus and fecal strep
10. MICROBIOLOGICAL-VIRUSES
11. Volatile Inorganics: Sulfide, hydrogen sulfide
12. PHYSICAL AND AGGREGATE PROPERTIES: Residues (solids), SOUR test, hazardous waste characteristics, particle size, etc.

### **FD 1000 Audit Checklist**

*To use this field audit checklist effectively, the auditor must be familiar with FD 1000 (Documentation Procedures) in "DEP Standard Operating Procedures for Field Activities", February 1, 2004 (DEP-SOP-001/01)*

#### **Universal Documentation Requirements**

Waterproof ink was used for all paper documentation.

Errors in documentation were corrected without obliteration.

All cleaning procedures associated with the project were documented.

All instrument calibrations were properly documented.

Names of all sampling personnel were recorded.

The type(s) of sampling equipment used to collect all samples was recorded in the field record.

Where applicable to the analyte groups collected, the location and use of fuel-powered vehicles or equipment during the sampling project was recorded.

Date of sample collection was recorded for all samples.

Time of sample collection was recorded for all samples having maximum holding times of <24 hours.

Ambient field conditions were recorded for all samples.

A specific description of all sampling locations (sources) was recorded.

Where applicable, latitude and longitude were recorded for all sampling locations.

Where applicable, sampling locations were designated on scaled maps and drawings.

The matrix collected was recorded for all samples.

For composite samples, the number of subsamples, the amount collected for each subsample and the location of collection (sampling point or source) and, where applicable, the time of collection for each subsample was recorded.

The types, number, collection location and collection sequence of all field quality control samples was recorded in the field record.

Preservation information and verification was recorded for each sample, as applicable.

Ancillary records such as photographs, videotapes and maps were archived and linked to the sample unique field identification codes and the date of the sampling project.

Each sample container or group of containers was tagged or labeled with a unique field identification code that distinguishes the sample from all other samples.

Sample containers and labels were attached so as to prevent contact between the sample and the label or tag when pouring or dispensing from the container.

The unique identification codes for samples were recorded in a manner that linked the codes to all other field records associated with the samples.

**FD 1000 Audit Checklist**

*To use this field audit checklist effectively, the auditor must be familiar with FD 1000 (Documentation Procedures) in "DEP Standard Operating Procedures for Field Activities", February 1, 2004 (DEP-SOP-001/01)*

**Groundwater monitoring well purging and sampling**

Information about the following topics was recorded for each sample, as applicable:

- Purging equipment
- Purging procedure
- Well casing composition
- Well diameter
- Water table depth
- Depth of well
- Volume of water in the well
- Equipment dimensions and volumes for pumps, tubing and flow containers (flow cells)
- Purge volume calculations
- Total volume of water purged
- Total well volumes or equipment volumes purged
- Date of purging
- Starting and ending times for purging
- Purging rate (pumping or flow rate) and associated calculations
- Flow meter readings
- Stabilization measurements for purge completion criteria
- Elapsed time for one well volume or equipment volume purge at stabilized flow rate
- Water level drawdown measurements during purging (depth to water table)

**Groundwater sampling of plumbing systems (groundwater sources)**

Information about the following topics was recorded for each sample, as applicable:

- Plumbing and tap material construction
- Purging rate (flow rate)
- Total purge time at stabilized purge rate (flow rate)
- Flow rate at time of sample collection
- Identification number for public supply system, if applicable
- Name, address and emergency phone number of public supply system, if applicable

### **FD 1000 Audit Checklist**

*To use this field audit checklist effectively, the auditor must be familiar with FD 1000 (Documentation Procedures) in "DEP Standard Operating Procedures for Field Activities", February 1, 2004 (DEP-SOP-001/01)*

#### **Soil and Sediment Sampling**

Information about the following topics was recorded for each sample, as applicable:

- Sample collection depth
- Areal location of sample
- Sample collection devices
- Tare weight of VOC vials, if applicable (EPA method 5035)
- Weight of VOC sample and vial, if applicable (EPA method 5035)

#### **Surface Water Sampling**

Information about the following topics was recorded for each sample, as applicable:

- Depth of all samples and subsamples
- Beginning and ending times for all timed composites
- Type of composite sample

#### **Biological sampling**

Physical and chemical characterization information was documented for each waterbody assessment, as applicable.

Stream or river habitat assessment information was documented for each waterbody reach, as applicable.

Lake habitat assessment information was documented for each waterbody or lake sector, as applicable.

Biorecon (rapid bioassessment) information was documented for each waterbody or lake sector, as applicable.

#### **Field-Testing Instrument Calibrations**

Information about all calibration standards and reagents used for field testing were linked to the calibration information associated with the field testing measurements for the project.

The concentration or other assay value, the vendor catalog number and the description of the standard or reagent were recorded for all preformulated solutions, neat liquids and powders.

Certificates of assay, grade and other vendor specifications for all standards and reagents were retained and recorded for the standards and reagents linked to the sampling project.

For standards formulated in-house for use on the sampling project, the dates of preparation and all calculations used to prepare calibration standards and reagents were recorded.

For standards formulated in-house for use on the sampling project, the records of preparation for all related calibration standards and reagents were linked to indicate the source of parent standards or reagents and any dilutions performed.

### **FD 1000 Audit Checklist**

*To use this field audit checklist effectively, the auditor must be familiar with FD 1000 (Documentation Procedures) in "DEP Standard Operating Procedures for Field Activities", February 1, 2004 (DEP-SOP-001/01)*

Expiration dates for all calibration standards and reagents used on the sampling project were recorded.

Verified analyses (calibration acceptance) were recorded for all expired standards and reagents used on the sampling project.

Preparation steps in all procedures used for preparation of standards or reagents in-house were documented either by description or reference to an SOP (DEP SOP or internal SOP).

All acceptable initial calibrations and calibration verifications were documented and linked to the field measurements for the sampling project.

Manufacturer-certified calibration specifications were retained for all factory-calibrated instruments used for the sampling project.

For each instrument unit used for the sampling project, the following information was recorded for all calibrations:

- Unique identification (designation code) for the instrument calibrated
- Date and time of each calibration or calibration verification
- Instrument reading or result (display value) for all calibration verifications, with appropriate measurement units
- Names of analysts performing each calibration for the instrument
- Designation of each calibration standard used to calibrate or verify the instrument, linked to the associated records for the calibration standard
- The acceptance criteria for each calibration and verification used to accept the instrument calibration or verification
- The assay specifications or acceptance criteria for any QC standard or sample used to independently verify the calibration of the instrument
- Positive indication in the record of acceptable (successful) initial calibration and acceptable initial and continuing calibration verifications
- Positive indication of all failed calibrations or verifications
- All corrective actions performed on the instrument prior to attempting re-verification or recalibration of the instrument are linked to the records required for preventive maintenance
- Any instances of discontinuation of use of the instrument due to calibration or verification failures
- A description or citation of the specific calibration and verification procedures used for the instrument (DEP SOP or internal SOP)

**FD 1000 Audit Checklist**

*To use this field audit checklist effectively, the auditor must be familiar with FD 1000 (Documentation Procedures) in "DEP Standard Operating Procedures for Field Activities", February 1, 2004 (DEP-SOP-001/01)*

**Field Testing Measurements (Field Analysis of Samples)**

All field measurement tests and related data were recorded and linked to the project, the date and the sample source.

All field measurements were recorded with the appropriate reporting units, the value of the test result, the parameter measured or tested, the name of the analyst performing the test, the time of the measurement and the unique identification for the test instrument used.

**Transmittal of Samples and Sample Information to a Laboratory or Other Party**

For all samples, the following information was transmitted to the analyzing lab or other party.

- Site name and address
- Client code substituted for but linked to site name and address, where applicable
- Date and time of sample collection
- Name of sampler responsible for sample transmittal
- Unique field identification code for each sample container or group of containers
- Total number of samples transmitted
- Required analyses for each sample container or group of containers
- Sample preservation used for each container or group of containers
- Comments about samples, sample sources or other relevant field conditions
- Identification of common carrier used to transport the samples, when applicable

Shipping invoices and related records from common carriers were archived with the field records, when applicable.

**Decontamination of equipment and sample containers**

Cleaning steps in all procedures used for decontamination were documented either by description or reference to an SOP (DEP SOP or internal SOP).

Certificates of cleanliness provided by vendors supplying cleaned equipment or sample containers were archived and linked to the date of the sampling project and the types of equipment or sample containers used for the project.

For equipment decontaminated on-site in the field, the date and time of the cleaning procedure associated with the affected equipment was recorded in the field records.

If sampling kits (sample containers, sampling equipment and ancillary supplies) were provided to another party, the following information was recorded for the kit:

- Quantity, description and material composition of all containers, container closures or closure liners

**FD 1000 Audit Checklist**

*To use this field audit checklist effectively, the auditor must be familiar with FD 1000 (Documentation Procedures) in "DEP Standard Operating Procedures for Field Activities", February 1, 2004 (DEP-SOP-001/01)*

- Intended application for each sample container type indicated by approved analytical method or analyte group(s)
- Type and concentration of preservative added to clean sample containers and/or shipped as additional preservative
- Intended use of any additional preservatives or reagents
- Description of any analyte-free water (i.e., deionized, organic-free, etc.)
- Date of analyte-free water containerization
- Date of sampling kit preparation
- Description and material composition of all reagent transfer implements (e.g., pipets) shipped in the sampling kit
- Intended use of all implements
- Quantity, description and material composition of all sampling equipment
- Tare weight of VOC vials, as applicable (this item is necessary in cases where EPA 5035 VOC sample vials are provided by a third party supplier)

**Documentation for reagents and other chemicals used for cleaning and sample preservation**

The lot numbers and inclusive dates of use were recorded for all reagents, detergents, solvents and other chemicals used for decontamination and preservation of samples.

**Documentation of equipment and instrument maintenance**

Each applicable instrument or equipment unit (inventory item) was identified with a unique designation or identification code that distinguishes the unit from all others.

The following information was recorded for all equipment associated with the sampling project:

- Maintenance and repair procedures for equipment or instrument unit
- Routine cleaning procedures for each unit
- Filling solution replacement for probes
- Parts replacement for instruments or probes
- Calendar date for each procedure performed on each unit
- Names of personnel performing maintenance and repair tasks for each unit
- Description of malfunctions associated with any maintenance and repair for each unit

Vendor service records were retained for all affected equipment or instruments associated with the sampling project.

**FD 1000 Audit Checklist**

*To use this field audit checklist effectively, the auditor must be familiar with FD 1000 (Documentation Procedures) in "DEP Standard Operating Procedures for Field Activities", February 1, 2004 (DEP-SOP-001/01)*

The inclusive rental dates, types and unique descriptions of rental equipment associated with the sampling project were recorded.

Manufacturers' operation & maintenance manuals and instructions were retained for all equipment and instruments associated with the sampling project.

**FQ 1000 Audit Checklist**

*To use this field audit checklist effectively, the auditor must be familiar with FQ 1000 (Field Quality Control Requirements) in "DEP Standard Operating Procedures for Field Activities", February 1, 2004 (DEP-SOP-001/01)*

Equipment blanks or field blanks were collected at a rate of 5% of the number of field samples collected over the life of the project for each reported test result and matrix combination.

At least one equipment blank or field blank was collected for each test result and matrix combination for each year of the project.

Field-cleaned equipment blanks were collected if equipment was decontaminated in the field.

Precleaned equipment blanks were collected if equipment was cleaned by the sampling organization or if equipment vendors did not certify cleanliness of equipment for the specific uses for the project.

Field blanks were collected when the sample containers were used as the sampling device.

Field blanks were collected if no equipment was cleaned by the sampling organization.

Where applicable to the project, one trip blank was transported in each storage container, shipping container or ice chest containing empty, clean VOC sample containers or VOC samples.

### **FT 1000 – FT 2200 Audit Checklists**

To use this field audit checklist effectively, the auditor must be familiar with FT 1000 to FT 2200 (Field Testing and Measurement) in “DEP Standard Operating Procedures for Field Activities”, February 1, 2004 (DEP-SOP-001/01)

#### **General Requirements for Calibration Activities (FT 1000)**

All field-testing equipment and instruments brought to the field appeared to function properly.

All sample measurements were chronologically bracketed between acceptable calibration verifications.

All sample measurements were quantitatively bracketed with an appropriate choice of calibration standards for calibrations or verifications.

Historical, instrument-specific data justified calibration verification intervals of greater than 24-hours.

Instruments failing to meet calibration verification acceptance criteria were recalibrated or removed from service.

Sample measurements were qualified as estimated (“J” data qualifier code) when the instrument calibration could not be verified.

An explanatory narrative was provided in the field record for all sample “J” values.

The time interval between calibration verifications did not exceed one month, or, if less, the life of the sampling project (except for temperature measurements).

#### **pH (FT 1100)**

The pH meter and electrode system met DEP SOP specifications for accuracy, reproducibility and design.

All measurements were corrected for temperature (manual or automatic).

The temperature sensor calibration was verified according to FT 1400.

A pH 7 buffer was used as the first calibration standard for the initial calibration.

All sample measurements were chronologically bracketed with acceptable calibration verifications.

All sample measurements were quantitatively bracketed with an appropriate choice of at least two calibration buffers for calibrations or verifications.

All calibration verifications met the acceptance criteria of + 0.2 standard pH units.

The meter system was checked on a weekly basis to ensure a >90% theoretical electrode slope.

The pH electrode was rinsed with deionized or distilled water between buffer solutions and between sample measurements.

The instrument pH readings stabilized before pH values were recorded.

#### **Conductivity (FT 1200)**

The specific conductance meter and electrode system met DEP SOP specifications for accuracy, reproducibility and design.

### **FT 1000 – FT 2200 Audit Checklists**

To use this field audit checklist effectively, the auditor must be familiar with FT 1000 to FT 2200 (Field Testing and Measurement) in “DEP Standard Operating Procedures for Field Activities”, February 1, 2004 (DEP-SOP-001/01)

All sample measurements were quantitatively bracketed with an appropriate choice of calibration standards for calibrations or verifications.

All continuing calibration verifications were performed using standards within the range of sample measurements.

All calibration verifications met the acceptance criteria of + 5% of the verification standard value.

All measurements were corrected for temperature (manual or automatic).

The temperature sensor calibration was verified according to FT 1400.

The conductivity electrode was rinsed with deionized or distilled water between standard solutions and between sample measurements.

The instrument conductivity readings stabilized before measurement values were recorded.

#### **Temperature (FT 1400)**

The temperature measurement device met DEP SOP specifications for design and measurement resolution.

All sample measurements were quantitatively bracketed with calibration verifications of the temperature measurement device at a minimum of two temperatures using the NIST-traceable thermometer.

All sample measurements were chronologically bracketed with acceptable calibration verifications.

Historical, device-specific data justified calibration verification intervals of greater than one month (extended chronological calibration bracket).

The temperature device readings stabilized before measurement values were recorded.

Groundwater samples were measured in situ (downhole) or by using a flow-through container.

#### **Dissolved Oxygen (FT 1500)**

The dissolved oxygen meter and electrode system met DEP SOP specifications for accuracy, reproducibility and design.

All sample measurements were chronologically bracketed with acceptable calibration verifications.

All calibration verifications met the acceptance criteria of + 0.3 mg/L dissolved oxygen when compared to the table of theoretical values for water-saturated air.

All measurements were corrected for temperature (manual or automatic).

The temperature sensor calibration was verified according to FT 1400.

All measurements were corrected for salinity, where applicable (manual or automatic).

The salinity (conductivity) sensor calibration was verified according to FT 1200 or FT 1300.

**FT 1000 – FT 2200 Audit Checklists**

To use this field audit checklist effectively, the auditor must be familiar with FT 1000 to FT 2200 (Field Testing and Measurement) in “DEP Standard Operating Procedures for Field Activities”, February 1, 2004 (DEP-SOP-001/01)

The dissolved oxygen electrode was rinsed with deionized or distilled water between sample measurements.

The dissolved oxygen electrode was stored in a water-saturated air environment when not in use.

The instrument dissolved oxygen readings stabilized before measurement values were recorded.

**Turbidity (FT 1600)**

The turbidimeter met DEP SOP design specifications.

Alternative design turbidimeters used for groundwater stabilization measurements met DEP performance criteria.

All sample measurements were chronologically bracketed with acceptable calibration verifications.

All sample measurements were quantitatively bracketed with an appropriate choice of calibration standards for calibrations and verifications.

Initial calibration of the turbidimeter was performed using formazin or styrene divinylbenzene primary standards, whichever was required by the manufacturer of the instrument.

All calibration verifications met the DEP SOP acceptance criteria applicable to the NTU ranges associated with the verification standard values. FT 1600 section 3.2

The sample cells (optical cuvettes) were inspected for scratches and discarded or coated with a silicone oil mask, as necessary.

The sample cells (optical cuvettes) were optically matched for calibrations and sample measurements.

The sample cells (optical cuvettes) were cleaned with detergent and deionized or distilled water between standard solutions and between sample measurements, as applicable.

The sample cells (optical cuvettes) were rinsed with deionized or distilled water between standard solutions and between sample measurements, as applicable.

The sample cells (optical cuvettes) were rinsed with sample prior to filling with sample for measurement.

The exterior of the sample cell (optical cuvette) was kept free of fingerprints and dried with a lint-free wipe prior to insertion in the turbidimeter.

### **FS 1000 Audit Checklist**

To use this field audit checklist effectively, the auditor must be familiar with FS 1000 (General Sampling Procedures) in “DEP Standard Operating Procedures for Field Activities”, February 1, 2004 (DEP-SOP-001/01)

#### **Preliminary Activities**

Equipment construction was appropriate for the analytes of interest.

Equipment was brought precleaned to the field.

Dedicated equipment was decontaminated prior to use.

Sample container construction and materials were appropriate for the analytes collected.

All containers and container caps were free of cracks, chips, discoloration and other features that might affect the integrity of collected samples.

#### **Contamination Prevention**

Every effort was made to prevent cross-contamination of samples and contamination of environment.

Sampling originated from the least contaminated or background location (source or site) first and progressed to the most contaminated location.

Samples were segregated during storage, transport and shipping where cross-contamination potential was suspected.

Samples for different analyte groups were collected in the appropriate order, unless field conditions or the sampling plan required an alternative collection sequence.

#### **Composite Samples**

Composite samples were collected according to the sampling plan, permit or other DEP program requirements.

Composite subsamples or aliquots were collected from each designated sampling point (source, location or depth).

Equal amounts of each subsample or aliquot were collected in appropriate cleaned sample containers.

Approximate or measured amounts of each aliquot or subsample collected were recorded in the field documentation, if applicable to the sampling plan.

Soil and sediment samples were collected without mixing, if required by the sampling plan.

The analyzing laboratory was instructed to mix the composite sample, if required by the sampling plan.

#### **Use of protective gloves**

Gloves were worn by all samplers handling purging equipment, sampling equipment, measurement equipment and sample containers as applicable.

Care was taken to avoid contact with samples and sample container interiors.

New, clean unpowdered gloves were used for each glove change.

### **FS 1000 Audit Checklist**

To use this field audit checklist effectively, the auditor must be familiar with FS 1000 (General Sampling Procedures) in "DEP Standard Operating Procedures for Field Activities", February 1, 2004 (DEP-SOP-001/01)

Gloves were worn and changed as needed to avoid sample contamination and personal exposure.

#### **Use of fuel-powered equipment and vehicles**

All fuel-powered equipment was placed and vehicles were parked downwind of or well away from sampling locations where fuel contamination of samples, purging equipment or sampling equipment interfered with representative sample collection.

Samplers wore disposable gloves while handling fuel powered equipment and disposed of fuel contaminated gloves downwind or well away from the sampling location.

Sampling activities were interrupted while fueling of vehicles or storage tanks occurred near the sampling location.

#### **Preservation of samples**

All sample preservation conformed to DEP SOP requirements.

All grab samples were preserved within 15 minutes of collection.

#### **Handling of hazardous waste (HW) and other investigation-derived waste (IDW)**

Wastes generated as a result of the sampling project were containerized and stored for proper disposal according to applicable local, state and federal regulations.

All HW and IDW containers were properly labeled.

#### **Collection of VOC samples**

VOC sample containers were kept removed and protected from any fuel sources and fuel-powered equipment.

VOC sample containers remained capped until just prior to sample collection and remained capped after sample collection.

#### **Preventive Maintenance and Repair of Equipment and Instruments**

Manufacturers' suggested maintenance activities and any repairs are performed and documented for all applicable equipment and instruments.

Each equipment or instrument unit requiring documented maintenance or repair is assigned a unique identification code or designation.

### **FS 2000 Audit Checklist**

To use this field audit checklist effectively, the auditor must be familiar with FS 2000 (General Aqueous Sampling) in "DEP Standard Operating Procedures for Field Activities", February 1, 2004 (DEP-SOP-001/01)

#### **Contamination prevention and equipment rinsing**

Samples were collected starting at the downstream location and progressed to the upstream location, if applicable.

Intermediate collection devices were rinsed with ample amounts of site water prior to collecting the sample.

Rinse water from intermediate devices was discarded away from and downstream of the sampling location.

Sample containers containing premeasured preservatives were not rinsed with sample prior to collection.

Sample containers for oil & grease or TPH samples were not rinsed with sample prior to collection.

#### **Sample preservation and preservation verification**

All samples requiring pH adjustment were tested for proper pH preservation during first-time sampling for the project.

One sample per analyte group requiring pH adjustment was tested for proper pH preservation during repeat sampling for the project.

One sample per analyte group requiring pH adjustment was tested for proper pH preservation once per month for sampling projects repeated weekly.

One sample per analyte group requiring pH adjustment was tested for proper pH preservation once per week for sampling projects repeated daily.

pH paper was not inserted into sample containers.

VOC samples were dechlorinated, if applicable, with chemical preservative added to the VOC vial prior to addition of the sample.

Dechlorinated VOC samples were preserved with acid after dechlorination and prior to complete filling to convex meniscus.

All composite samples collected with automatic samplers were preserved within 15 minutes of collection of the last composite subsample.

Applicable samples collected with automatic samplers were chilled on wet ice or refrigerated at 4 °C.

#### **Sample filtration**

Applicable samples were filtered within 15 minutes of collection, before addition of chemical preservatives.

Unless otherwise specified by the sampling plan, applicable samples were filtered using a 0.45 um pore size for the filter.

### **FS 2000 Audit Checklist**

To use this field audit checklist effectively, the auditor must be familiar with FS 2000 (General Aqueous Sampling) in "DEP Standard Operating Procedures for Field Activities", February 1, 2004 (DEP-SOP-001/01)

#### **Collection of VOC samples**

Bubbles present in the VOC sample comprised a combined volume of less than 5mm in diameter (pea-sized).

Unacidified VOC samples were collected where effervescence or large bubbles were observed after addition of acid.

#### **Collection of bacteriological samples**

Unless specified otherwise in the sampling plan, all samples were collected as grab samples.

All samples were collected in properly sterilized containers.

Sterilized caps were used with all bottles and vials used to contain samples.

All sterilized containers remained sealed until just prior to filling with sample and remained sealed after filling with sample.

Sample containers were not prerinsed with sample.

At least 125 ml of volume was collected for each sample.

Caution was taken to avoid contacting the opening (mouth) of sample containers or cap interiors.

Where applicable, samples were collected with rigid containers using standard surface water grab-sample techniques.

Where applicable, samples were collected with Whirlpak bags from surface water by immersing the closed Whirlpak and opening the bag underwater.

Where applicable, samples were collected with Whirlpak bags from surface water by immersing the closed Whirlpak upstream of the hands and fingers and opening the bag into (facing) the current.

Where applicable, samples were collected with Whirlpak bags from surface water by opening the Whirlpak before attaching it to an extension pole, plunging the bag opening downward below the surface (and towards the current) in a continuous sweeping arc before returning to the surface.

Where applicable, samples were collected from taps, spigots and faucets without interruption of flow from the plumbing.

Where applicable, samples were collected with an intermediate device without interruption of flow as the sample was poured or drained from the device.

Bacteriological samples were collected as the last analyte group in the collection sequence in order to maximize available holding time.

Headspace was left in each sample container after sample collection.

Where applicable, samples were dechlorinated by addition of sodium thiosulfate to the sample container to achieve a final sodium thiosulfate concentration of 100 mg/L.

### **FS 2000 Audit Checklist**

To use this field audit checklist effectively, the auditor must be familiar with FS 2000 (General Aqueous Sampling) in "DEP Standard Operating Procedures for Field Activities", February 1, 2004 (DEP-SOP-001/01)

#### **Collection of Oil & Grease or TPH samples**

All oil & grease samples were collected as discrete grab samples.

Unless specified otherwise by the sampling plan, samplers avoided surface skimming when collecting oil & grease or TPH samples.

The sample containers or intermediate sampling device were not pre-rinsed with sample water.

Automatic samplers were not used for sample collection.

#### **Collection of Cyanide Samples**

Cyanide samples were tested for the presence of sulfides and pretreated, if necessary, before preservation with sodium hydroxide.

Untested or untreated cyanide samples are designated with a holding time of 24 hours.

#### **Contamination prevention, selection of sampling location and general cautions**

Samples were collected starting at the downstream location and progressed to the upstream location, where applicable.

The bow of the motorized watercraft was pointed upstream, where applicable.

Samples were collected at or near the bow of the watercraft, away and upwind from the watercraft engine and any other fuel or oil sources.

When wading, samples were collected upstream and away from the body.

Care was exercised to not disturb bottom sediments during sample collection.

Water samples were collected prior to sediment sampling at the same location or sample source.

Representative sampling locations and depths were selected to account for homogeneous and heterogeneous conditions in the water body.

Unless directed by permit or other regulation, samples were collected away from artificial structures such as bridges, docks, weirs, dams, etc.

#### **Manual sampling using sample containers as the collection device**

Pre-preserved (pre-dosed) containers were not used as the sample collection device.

Sample containers were submerged neck first, inverted into the oncoming direction of flow where applicable, slowly filled leaving headspace and returned to the surface for preservation, if appropriate.

Pole samplers were used in a fashion similar to that described above, as practical.

#### **Use of intermediate vessels as the collection device**

The use of intermediate collection devices was avoided when sampling for VOCs, oil & grease or microbiologicals, where practical.

**FS 2100 Audit Checklist**

To use this field audit checklist effectively, the auditor must be familiar with FS 2100 (Surface Water Sampling) in "DEP Standard Operating Procedures for Field Activities", February 1, 2004 (DEP-SOP-001/01)

Intermediate collection devices were constructed of material appropriate for the analytes to be measured.

Intermediate collection devices were rinsed with ample amounts of site water prior to collecting the sample.

Rinse water from intermediate devices was discarded away from and downstream of the sampling location.

For depth sampling, the following procedures were performed:

- The water column was measured for maximum depth or was otherwise determined from reference information.
- The sampling point depth was accurately determined and recorded.
- Care was exercised to keep bottom sediments undisturbed during the depth-sampling procedure.

If double-valve bailers were used, care was taken to determine the appropriateness of use for the sampling application and discrete depth samples were not required.

Bailers were slowly lowered through the water column to allow maximum flushing of the bailer during descent.

**Use of pumps as sample collection devices**

VOC samples were not pumped through the roller assembly (pump head) of the peristaltic pump and the "straw technique" was used.

Oil & grease, FL-PRO and TRPH samples were not collected with pumps.

The pump and tubing assembly was flushed with site water to allow at least 3 volumes of the pump and tubing to pass through the system prior to collecting the sample.

For surface collection, the pump tubing intake was placed 6-12 inches below the water surface.

For depth sampling, the following procedures were performed:

- The water column depth was measured or determined from reference sources.
- The sample collection depth was determined and recorded.
- The pump or tubing intake placement at the required depth was accomplished by appropriate weighting or anchoring with non-contaminating materials to ensure unobstructed flow at the intake.

**Well head inspection and water level measurement**

Standing water present in the wellhead was removed.

Water levels were measured to the nearest 0.01 foot.

The well bottom was not sounded with the measuring tape.

**General purging procedures**

Well volume was correctly determined.

**FS 2200 Audit Checklist**

To use this field audit checklist effectively, the auditor must be familiar with FS 2200 (Groundwater Sampling) in "DEP Standard Operating Procedures for Field Activities", February 1, 2004 (DEP-SOP-001/01)

Equipment volume was correctly determined.

The pump, tubing or bailer was not allowed to drop to the bottom of the well.

Depth to groundwater was measured at frequent intervals during purging.

The placement of the pump or tubing intake was correctly determined according to the position of the water level in relation to the well screen interval and the purging procedure used.

The placement depth of the pump or tubing intake was recorded for each instance of positioning.

**Purging with bailers**

The bailer was lowered and raised at the rate of 2 cm/sec into the top of the water column.

The clean bailer was kept in protective wrap until just before use or was decontaminated immediately prior to use.

At least one well volume was removed prior to measuring stabilization parameters.

At least  $\frac{1}{4}$  well volume of additional water was purged from the well prior to each subsequent (successive) measurement of stabilization parameters.

A minimum total of at least  $1\frac{1}{2}$  well volumes was purged prior to collecting samples.

**General procedures for purging with a pump**

Drawdown was stabilized so that the pumping rate matched the formation recharge rate.

**Purging minimal (equipment) volumes with a pump from the middle of a fully submerged well screen interval**

- The well screen interval (length) was <10 feet.
- The pump or tubing intake was placed within the middle of the screen interval.
- A minimum total of at least 3 equipment volumes was purged.
- The purging pump was also used to collect the samples.

**Purging from the top of the water column with a pump**

- The pump or tubing was placed at the top of the water column above the submerged well screen and a minimum total of  $1\frac{1}{2}$  well volumes was purged.
- The pump or tubing was placed at the top of the water column in the partially submerged well screen interval and a total of at least one well volume was purged prior to commencing measurement of stabilization parameters.

**Purging in the middle of the partially submerged screen interval with a pump**

- The pump or tubing was placed within the middle of the submerged portion of the screen interval and a minimum total of at least one well volume was purged prior to commencing measurement of stabilization parameters.
- The purging pump was also used to collect the samples.

### FS 2200 Audit Checklist

To use this field audit checklist effectively, the auditor must be familiar with FS 2200 (Groundwater Sampling) in "DEP Standard Operating Procedures for Field Activities", February 1, 2004 (DEP-SOP-001/01)

#### Frequency of measurement for purge stabilization parameters

A flow cell was used to measure stabilization parameters during pumping.

Downhole measurements were used for wells purged by bailing.

If the well was purged from the top of the water column above a fully submerged screen, at least one well volume was purged prior to commencing purge stabilization measurements and at least ¼ well volume was purged at the stabilized pumping rate between consecutive purge stabilization measurements.

If the well was purged from the top of the water column in a partially submerged screen interval, at least one well volume was purged prior to commencing purge stabilization measurements and at least 2 minutes of continuous purging at the stabilized pumping rate elapsed between consecutive purge stabilization measurements.

If the well was purged from the middle of a fully submerged screen interval, at least one equipment volume was purged prior to commencing purge stabilization measurements and at least 2 minutes of continuous purging at the stabilized pumping rate elapsed between consecutive purge stabilization measurements.

#### Determination of purging completion

Three (3) consecutive measurements of the three parameters listed below were within stated limits

- Temperature:  $\pm 0.2^{\circ}$  C
- pH:  $\pm 0.2$  standard pH units
- Specific Conductance:  $\pm 5.0\%$  of reading

Measured dissolved oxygen and turbidity were below the following thresholds.

- DO <20% saturation at the measured temperature
- Turbidity <20 NTU

For wells where DO and turbidity thresholds could not be met for justified reasons, consecutive measurements were within the above stated limits for pH, conductivity and temperature; and, DO and turbidity measurements were within the following stated limits.

- DO:  $\pm 0.2$  mg/L or 10%, whichever is greater
- Turbidity:  $\pm 5$  NTUs or 10%, whichever is greater

For wells failing to meet stabilization criteria after five (5) well volumes, testing instrumentation, calibrations, purging flow rate, flowcells and all tubing connections were determined to be functional and acceptable for measuring stabilization parameters.

Dry-purged wells were purged only once according to FS 2212, section 3.4.1

#### Purging Low Permeability Wells

The well was known to purge dry due to low formation permeability and the samplers determined that the well could not be purged according to FS 2212 and FS 2213.

**FS 2200 Audit Checklist**

To use this field audit checklist effectively, the auditor must be familiar with FS 2200 (Groundwater Sampling) in "DEP Standard Operating Procedures for Field Activities", February 1, 2004 (DEP-SOP-001/01)

Very small diameter Teflon, PE or PP tubing and the smallest possible pump chamber and flow cell volumes were used.

The pump tubing wall was thick enough to minimize oxygen transfer.

The pump or tubing intake was placed within the well screen interval.

The purging flow rate was <100 mL/min.

Pump rate was adjusted to minimize drawdown.

A minimum total of at least 2 equipment volumes was purged before stabilization parameters were measured and samples were collected.

Temperature, pH, conductivity, DO and turbidity were measured once immediately prior to collecting the samples during stabilized pumping after at least 2 equipment volumes were purged.

The same pump was used to purge and collect the samples.

**Collecting samples from Low Permeability Wells**

The same pump and tubing was used to purge and collect the samples.

The purge position of the pump or tubing intake was maintained throughout sample collection.

The stabilized purge pumping rate was maintained throughout sample collection unless pumping was ceased to allow formation recharge.

Samples were collected immediately after purging was completed while continuing a stabilized pumping rate or as soon as sufficient recharged sample water was available.

**Maximum elapsed times between purging and sampling**

Stabilization parameters were re-measured if the start of sample collection began more than one hour after completion of purging.

The well was re-purged if the second set of stabilization measurements exceeded the original measurements by more than + 10%.

Dry-purged wells were allowed to recharge after one purge before measuring stabilization parameters and collecting samples.

Samples were collected within 6 hours of purging completion.

**General Requirements for Sample Collection Equipment**

Pumps were decontaminated or replaced between wells.

Pump tubing was decontaminated or replaced between wells.

Reusable bailers were decontaminated between wells.

Material construction of pumps, tubing and bailers conformed to requirements of Tables FS 1000-1 through FS 1000-3 and Table FS 2200-1 for the analytes collected.

**Collecting samples with pumps**

**FS 2200 Audit Checklist**

To use this field audit checklist effectively, the auditor must be familiar with FS 2200 (Groundwater Sampling) in "DEP Standard Operating Procedures for Field Activities", February 1, 2004 (DEP-SOP-001/01)

Collection of volatile organic (VOC) samples with peristaltic pumps employed the "straw technique" for collection from the well and either gravity flow or reverse pumping for container filling.

**Collecting samples with bailers**

Bailers were used to collect samples under the conditions specified in Table FS 2200-3.

The bailer was lowered and raised at the rate of 2 cm/sec into the top of the water column.

VOC samples were poured or drained into sample vials with no aeration or agitation.

Samples for sulfites, sulfides or hydrogen sulfide were poured or drained into sample vials with no aeration or agitation.

**Filtering groundwater samples for metals**

The metals sample filtration procedure was preapproved by the DEP/DEP project manager for the site or project.

A 0.45 µm filter was used for filtering constituents other than metals.

A 1µm in-line filter was used for filtering metal samples.

All oxygen (air) was flushed from the in-line filter and any connected tubing prior to sample filtration.

The equipment configuration for filtering metals conformed with prohibitions in FS 2225 section 1.4.

**Purging and sampling wells with in-place plumbing, air strippers or other plumbed remedial systems**

The purging and sampling point was located upstream of storage or pressure tanks where possible.

Hoses, aerators and filters removed were removed prior to purging and sampling where possible.

The plumbed system was purged at the selected purge point (valve or spigot) until the purge completion criteria listed in FS 2212 section 3 were met.

Air strippers and other remedial systems were purged for a minimum of one minute.

The flow rate was reduced to less than 500 mL/minute (1/8" stream) or approximately 0.1 gal/minute before collecting samples.

**FS-7420 Training for Stream Condition Index Sampling Checklist****Checklist to Document Training for Stream Condition Index Sampling**

One copy of this document will exist for each Trainee. The Trainee (or their supervisor) must retain the document. The Trainee will be required to provide this document as proof of completion of these training requirements.

**Prerequisite/Concurrent Training Signoffs**

FT-3000 FT 3000 Aquatic Habitat Characterization Training Checklist

**Introduction**

This sampling procedure requires specific training and a demonstration of competency due to the expert judgment exercised during field sampling. It is recommended that individuals conducting this procedure train with qualified staff (who have passed the DEP Stream Condition Index audit) and successfully obtain all required training and evaluation signatures.

In an effort to establish standardization and consistency, individuals performing the training are required to adhere to the competencies and principles detailed in this document. Following these training protocols will encourage the establishment of an equal foundation among samplers performing the Stream Condition Index. The items below do not need to be completed in any particular order, nor do they need to be completed in a single event. However, each training or evaluation event must be identified in the Training Event Log, regardless of whether a competency was completed or not.

First, trainers will follow the items described in the Training Activities Section and initial upon completion.

Evaluators will then follow the Evaluation Activities and initial upon completion. Evaluators should not sign off on an item unless the trainee has demonstrated complete competency.

The same individual may be both a trainer and an evaluator.

**Objective**

To provide trainers and trainees a standardized set of training and evaluation activities for performing a SCI. Trainers and trainees must understand, convey, discuss and demonstrate (where applicable) the proper techniques and principles for performing a SCI, to include the following:

1. Identify appropriate and applicable SOPs and forms used or referenced for performing a SCI.
2. Previously or concurrently completes training for Aquatic Habitat Characterization.
3. Discuss and recognize circumstances when the SCI should be postponed or not used.
4. Identify, measure and mark the 100-meter length sampling area.
5. Complete Form FD 9000-4, Stream/River Habitat Sketch Sheet.
6. Complete Form FD 9000-3, Physical/Chemical Characterization Field Sheet.
7. Complete Form FD 9000-5, Stream/River Habitat Assessment Field Sheet.
8. Identifies best available habitats to include snags, leaf material, roots, aquatic plants, rock/rubble.
9. Considers length of inundation when choosing habitats to sample.
10. Discusses flow considerations to take into account.
11. Knows correct number of sweeps for SCI (20).
12. Properly apportions sweeps to habitats available.

**FS-7420 Training for Stream Condition Index Sampling Checklist**

13. Demonstrates ability to capture invertebrates during sweep, including proper agitation of substrates. Completes at least 3 passes with net, sampling an area equivalent to a sweep length of 0.5 meters times the width of the net for each pass.
14. Samples only productive portions of habitats, does not dilute sample with unproductive detritus.
15. Area sampled with each sweep is equivalent to  $0.5 \pm 0.1$  meters times the width of the net. Note if consistently high or low.
16. Properly transfers sampled material to jug without sample loss.
17. During at least twelve (12) separate training sessions, performs objectives 3-16.

**Training Activities**

The trainer will discuss, convey, instruct and demonstrate (where applicable) each of the following items. Once completed to satisfaction, the trainer will initial and date the item. The trainee will also initial in the appropriate area to signify the item was demonstrated to them and they have received an understanding and developed competency.

1. Identify the required SOPs and supporting references.
  - a. DEP-SOP-001/01 FT 3000 Aquatic Habitat Characterization
  - b. DEP-SOP-001/01 FS 7420 Stream Condition Index (D-Frame Dip net) Sampling
  - c. "Sampling and Use of the Stream Condition Index (SCI) for Assessing Flowing Waters: A Primer", FDEP, Environmental Assessment Section, Bureau of Laboratories, DEP/EA/002/07, June 2007
  - d. Obtains the documentation required for the sampling.
    - i. Go to the Bureau of Laboratory Library Files (<http://www.floridadep.org/labs/library/index.htm>), scroll down to Standard Operating Procedures (SOPs), click External SOPs, then selects either or SOP Documents Listing or SOP Forms Listing.
    - ii. Print out the form DEP-SOP-001/01 FD 9000-3 Physical/Chemical Characterization Field Sheet.
    - iii. Print out the form DEP-SOP-001/01 FD 9000-4 Stream/River Habitat Sketch Sheet.
    - iv. Print out the form DEP-SOP-001/01 FD 9000-5 the Stream/River Habitat Assessment Field Sheet.
2. Discuss circumstances when the SCI should be postponed (or not used).
  - a. List the normal stream factors to consider for the determination of representative sample as continuous water flow, availability of substrate and accessibility for sampling.
  - b. Determine if the stream flow has remained continuous and has not been intermittent or stagnant.
    - i. Determine stream height either from recent rainfall data or from gaging stations.
  - c. If intermittent, do not sample until continuous flow is reestablished.
  - d. Do not sample if dry conditions occur. Wait 3 months (90 days) after the stream returns to normal flow to sample. This lets the organisms re-establish populations in the habitats.
  - e. If flood conditions occur (> 0.5 meter above normal), wait 28 days or until the water recedes, normal flow returns and the habitats become accessible. Organisms are not destroyed, but their normal habitats are not accessible due to high water.
  - f. If water levels are  $\leq 0.5$  meter above normal, sample habitats at the normal stream shoreline, not the flooded shoreline.
  - g. Sampling for SCI is not used for Ecoregion 76, the Southern Florida Coastal Plain, where few natural streams exist and for which the SCI is not calibrated.
3. Measure and mark the 100-meter reach.
4. Complete habitat sketch on Form FD 9000-4.

**FS-7420 Training for Stream Condition Index Sampling Checklist**

5. Complete Physical/Chemical Characterization Field Sheet, FD 9000-3.
6. Perform a habitat assessment and record information on Form FD 9000-5.
7. Discuss the productive habitat substrates and the conditions that make them productive.
  - a. Productive means the habitat is currently or can sustain invertebrate populations.
  - b. Must be in contact with the water.
  - c. Minimum of 2 square meters in the entire reach to be counted as present.
  - d. Do not count smothered portions of habitats.
  - e. Identify the major habitats to include snags, leaf material, roots, aquatic macrophytes, rock/rubble.
  - f. List the characteristics for productive snag habitat.
    - i. Count only woody debris, not herbaceous.
    - ii. Count only snags greater than thumb size in diameter.
    - iii. Count portion of wood directly in contact with water, not out of water or smothered.
    - iv. Preferentially, sample only in the normal, continuous stream flow.
    - v. Count old snags as more productive than young snags.
    - vi. Avoid new snags.
    - vii. Look for snag bark that is malleable, old and decayed, with lots of crooks and crannies.
  - g. List the characteristics for productive leaf material substrate.
    - i. Count only leaf litter that is in contact with water.
    - ii. Sample leaf packs and leaf mats only in the normal, continuous stream flow.
    - iii. Define a leaf pack as leaves packed up against an obstruction at surface or in water.
    - iv. Define a leaf mat as piles of leaf material on the stream bottom.
    - v. Generally, leaf packs are better than leaf mats due to higher flow and dissolved oxygen.
    - vi. Count leaf packs/mats as productive only if partially decayed.
    - vii. Sample only the top 2 cm of leaf mats as a productive aerobic habitat.
    - viii. Describe anaerobic versus aerobic conditions.
    - ix. Do not count anaerobic (no oxygen) leaf litter.
    - x. State that leaf material such as pine needles is not considered productive.
  - h. List the characteristics for productive roots.
    - i. Count only roots less than thumb size in diameter.
    - ii. Count roots only in contact with the water.
    - iii. Count only if in the normal, continuous stream flow.
    - iv. Indicate that finer roots are more productive.
    - v. Count woody, adventitious roots hanging into the water.
    - vi. Do not count the herbaceous roots of aquatic macrophytes or roots from herbaceous vegetation overhanging the water. These are instead counted as aquatic macrophytes.
    - vii. Do not count if silt is excessive to the point where the roots are clumped together or the root material is not visible.
    - viii. Do not count undercut banks as a productive substrate if productive roots are not present.
  - i. List the characteristics for productive aquatic macrophytes.
    - i. Count only aquatic vegetation in contact with water.
    - ii. Count only aquatic vegetation in normal, continuous flow.
    - iii. Do not count non-aquatic macrophytes that are temporarily inundated.
  - j. List the characteristics for productive rock/rubble habitat.
    - i. Count rocky outcrops or rocks in contact with the water.
    - ii. Count rocks only in the normal, continuous stream flow.

**FS-7420 Training for Stream Condition Index Sampling Checklist**

- iii. Count only if greater than 5 cm of productive surface.
  - iv. Indicate rougher surfaces as more productive than smooth surfaces.
  - v. State concrete is considered a rock if weathered and present for a long time.
  - vi. Do not count asphalt (possibly toxic) or pipe clay (not stable) as productive substrates.
  - k. Identify minor habitats as sand, muck, silt, mud.
8. Identify that older rather than younger substrates are preferred because the older ones allow time for organism communities to develop and flourish.
9. Flow must be considered when assessing the productivity of habitat. Habitats in good flow should be sampled over habitats in lesser flow.
10. Identify that the SCI consist of a total of 20 sweeps.
- a. A sweep is defined as a sampled area equivalent to the width of the dip net by 0.5 meter length.
11. Apportion the 20 sweeps based on the number of productive habitats in the reach.
- a. In 1 productive habitat, perform 10 sweeps in the major productive habitat and 10 sweeps in the minor.
  - b. In 2 productive habitats, perform 7 sweeps in the major productive habitats and 6 sweeps in the minor.
  - c. In 3 productive habitats, perform 5 sweeps in the major productive habitats and 5 sweeps in the minor.
  - d. In 4 productive habitats, perform 4 sweeps in the major productive habitats and 4 sweeps in the minor.
  - e. In 5 productive habitats, perform 3 sweeps in the major productive habitats and 5 sweeps in the minor.
  - f. Generally, sweeps in the minor habitat should be performed in sand or sand/muck areas with good flow.
  - g. If less then 2 square meters of a snag, leaf matter, roots, macrophytes or rock is in the stream reach and was therefore not counted as "major" habitat; perform as many sweeps as possible and count as "minor" sweeps.
12. Demonstrate ability to capture invertebrates during sweep, including proper agitation of substrates.
- a. Disturb, agitate, or dislodge organisms from substrates by using hands, feet, brush or other tool.
  - b. Position the dip net as closely to and no more than 0.5 m downstream of the substrate in order to capture organisms. In low velocity areas, create a current into the net while agitating the substrate.
  - c. If using a brush, brush into the net and not to the side to capture all organisms that are dislodged.
  - d. Complete at least 3 passes with net over the sample area.
  - e. If possible, submerge fine roots and removable snags into net, then agitate and scrub.
  - f. When sampling a leaf pack, place all material into dip net.
  - g. For large removable snags, position net to capture organism when removing snag from water.
  - h. In heavily vegetated areas, place the net at the base of the vegetation and dislodge organisms using your hand.
  - i. If there is not enough substrate at one location to complete a full sweep, go to the same substrate at an alternative location to complete the sweep. These partial sweeps are combined to complete the full sweep.
  - j. Once collected, pull dip net up and wash water through to dislodge, silt, etc.

**FS-7420 Training for Stream Condition Index Sampling Checklist**

- k. When discarding large pieces of substrate from the dip net, individually scrub each piece before discarding.
  - l. Visibly inspects collected materials for organisms.
13. Sample only productive portions of habitats, do not dilute sample with unproductive detritus.
- a. Collect only top 2 cm of leaf mats, sand, silt, mud, or muck.
  - b. Sample only in the normal flow of the stream.
14. Sample an area equal to 1 dip net wide and 0.5 meters long.
- a. Use the width of the dip net and the marked dip net handle or other measuring device to determine sampling area.
  - b. For thick, 3-dimensional habitats such as roots and leaf packs, visually spread out the substrate to a thickness of 2 cm.
  - c. Completely sweep the 0.5 meter sample area within 0.1 meters during each pass.
15. Transfer material to jug and preserve. Once collected, pull dip net up and wash water through to dislodge, silt, etc.
- a. When discarding large pieces of substrate from the dip net, individually scrub each piece before discarding.
  - b. Visibly inspect collected materials for organisms.
  - c. Transfer sample into 4 liter wide mouth jug without losing any organisms (e.g. put jug in net to transfer handfuls of material, then invert the remaining material in the net into jug).
  - d. Wash down/transfer from dip net to jug using a squirt bottle, turkey baster, etc.
  - e. Preserve with 10% buffered formalin. 1:10 dilution. Either add 1 part buffered formalin to 9 parts site water or fill the whole jug with already mixed 10% formalin solution.
16. Observe and critique trainee for items 2-15 above at twelve (at least) separate training sites; include at least four (4) good sites (minimally disturbed), four (4) poor sites (disturbed or altered) and three (3) non-wadeable systems.

**FS-7420 Training for Stream Condition Index Sampling Checklist****Evaluation Activities**

The trainee will convey and/or demonstrate (where applicable) a mastery of the following items. Once completed to satisfaction, the Evaluator will initial and date the item.

1. Identify appropriate and applicable SOPs and forms used or referenced for performing an SCI.
  - a. DEP-SOP-001/01 FT 3000 Aquatic Habitat Characterization
  - b. DEP-SOP-001/01 FS 7420 Stream Condition Index (D-Frame Dip net) Sampling
  - c. DEP-SOP-001/01 FD 9000-3 Physical/Chemical Characterization Field Sheet.
  - d. DEP-SOP-001/01 FD 9000-4 Stream/River Habitat Sketch Sheet.
  - e. DEP-SOP-001/01 FD 9000-5 the Stream/River Habitat Assessment Field Sheet.
  - f. "Sampling and Use of the Stream Condition Index (SCI) for Assessing Flowing Waters: A Primer", FDEP, Environmental Assessment Section, Bureau of Laboratories, DEP/EA/002/07, June 2007
2. Completed training for Habitat Assessment, TT-3000.
3. Recognize circumstances when the SCI should be postponed or not used.
  - a. Lists the normal stream factors to consider for the determination of representative sample as continuous water flow, availability of substrate and accessibility for sampling.
  - b. Determines if the stream flow has remained continuous and has not been intermittent or stagnant.
  - c. Determines stream height either from recent rainfall data or from gaging stations.
  - d. If intermittent, does not sample until continuous flow is reestablished.
  - e. Does not sample if dry conditions occur. Waits 3 months (90 days) after the stream returns to normal flow to sample.
  - f. Demonstrates an understanding of when the SCI should be postponed. If flood conditions occur (>0.5 meter above normal), waits 28 days until the water recedes, normal flow returns and the habitats become accessible.
  - g. If water levels are  $\leq 0.5$  meter above normal, samples habitats at the normal stream shoreline, not the flooded shoreline.
  - h. Sampling for SCI is not used for Ecoregion 76, the Southern Florida Coastal Plain, where few natural streams exist and for which the SCI is not calibrated.
4. Measures and marks the 100-meter reach.
5. Completes habitat sketch on Form FD 9000-4.
6. Completes Physical/Chemical Characterization Field Sheet, FD 9000-3.
7. Performs a habitat assessment and records information on Form FD 9000-5.
8. Identifies the productive habitat substrates and the conditions that make them productive.
  - a. States productive means the habitat is currently sustaining or has the potential to sustain invertebrate populations.
  - b. Understands habitats must be in contact with the water to be considered productive.
  - c. States a minimum of 2 square meters in the entire reach is needed to be counted as present.
  - d. Does not count smothered portions of habitats.
  - e. Identifies the major habitats to include snags, leaf material, roots, aquatic macrophytes, rock/rubble.
  - f. Lists the characteristics for productive snag habitat.
    - i. Counts only woody debris, not herbaceous.
    - ii. Counts only snags greater than thumb size in diameter.
    - iii. Counts portion of wood directly in contact with water, not out of water or smothered.
    - iv. Prefers snags in the normal, continuous stream flow.
    - v. Counts old snags as more productive than young snags.

**FS-7420 Training for Stream Condition Index Sampling Checklist**

- vi. Avoids new snags.
- vii. Looks for snag bark that is malleable, old and decayed, with lots of crooks and crannies.
- g. Lists the characteristics for productive leaf material substrate.
  - i. Counts only leaf litter that is in contact with water.
  - ii. Samples leaf packs and leaf mats only in the normal, continuous stream flow.
  - iii. Defines a leaf pack as leaves packed up against an obstruction at surface or in water.
  - iv. Defines a leaf mat as piles of leaf material on the stream bottom.
  - v. Understands leaf packs are better than leaf mats due to higher flow and dissolved oxygen.
  - vi. Counts leaf packs/mats as productive only if partially decayed.
  - vii. Considers only the top 2 cm of leaf mats as a productive aerobic habitat.
  - viii. Does not count anaerobic (no oxygen) leaf litter.
  - ix. States that leaf material such as pine needles is not considered productive.
- h. Lists the characteristics for productive roots.
  - i. Counts only roots less than thumb size in diameter.
  - ii. Counts roots only in contact with the water.
  - iii. Counts only if in the normal, continuous stream flow.
  - iv. Indicates that finer roots are more productive.
  - v. Counts woody, adventitious roots hanging into the water.
  - vi. Does not count the herbaceous roots of aquatic macrophytes or roots from herbaceous vegetation overhanging the water. These are instead counted as aquatic macrophytes.
  - vii. Does not count roots where silt is excessive to the point where the roots are clumped together or the root material is not visible.
  - viii. Does not count undercut banks as a productive substrate if productive roots are not present.
- i. Lists the characteristics for productive aquatic macrophytes.
  - i. Counts only aquatic vegetation in contact with water.
  - ii. Counts only aquatic vegetation in normal, continuous flow.
  - iii. Does not count non-aquatic macrophytes that are temporarily inundated.
- j. Lists the characteristics for productive rock/rubble habitat.
  - i. Counts rocky outcrops or rocks in contact with the water.
  - ii. Counts rocks only in the normal, continuous stream flow.
  - iii. Counts only if greater than 5 cm of productive surface.
  - iv. Identifies rougher surface as more productive than smooth surfaces.
  - v. States concrete is considered a rock if weathered and present for a long time.
  - vi. Does not count asphalt or pipe clay as productive substrates.
- k. Identifies minor habitats as sand, muck, silt, mud.
- 9. Prefers older rather than younger substrates because the older ones allow time for organism communities to develop and flourish.
- 10. Considers flow conditions when assessing the productivity of habitat. Habitats in good flow should be sampled over habitats in lesser flow.
- 11. Identifies that the SCI consist of a total of 20 sweeps.
  - a. Defines a sweep as the width of the dip net by 0.5 meter length.
- 12. Apportions the 20 sweeps based on the number of productive habitats in the reach.
  - a. In 1 productive habitat, performs 10 sweeps in the major productive habitat and 10 sweeps in the minor.

**FS-7420 Training for Stream Condition Index Sampling Checklist**

- b. In 2 productive habitats, performs 7 sweeps in the major productive habitats and 6 sweeps in the minor.
  - c. In 3 productive habitats, performs 5 sweeps in the major productive habitats and 5 sweeps in the minor.
  - d. In 4 productive habitats, performs 4 sweeps in the major productive habitats and 4 sweeps in the minor.
  - e. In 5 productive habitats, performs 3 sweeps in the major productive habitats and 5 sweeps in the minor.
  - f. Identifies that sweeps in the minor habitat should be performed in sand or sand/muck areas with good flow.
  - g. If less than 2 square meters of a snag, leaf matter, roots, macrophytes or rock is in the stream reach and was therefore not counted as "major" habitat; performs as many sweeps as possible and count as "minor" sweeps.
13. Demonstrates ability to capture invertebrates during sweeps, including proper agitation of substrates.
- a. Disturbs, agitates or dislodges organisms from substrates by using hands, feet, brush or other tool.
  - b. Positions the dip net as closely to and no more than 0.5 m downstream of the substrate in order to capture organisms. In low velocity areas, creates a current into the net while agitating the substrate.
  - c. If using a brush, brushes into the net and not to the side to capture all organisms that are dislodged.
  - d. Completes at least 3 passes with net over the sample area.
  - e. When sampling a leaf pack, places all material into dip net and not just agitates leaves.
  - f. If possible, submerses fine roots and removable snags into net, then agitates and scrubs.
  - g. For large removable snags, positions net to capture organism when removing snag from water.
  - h. In heavily vegetated areas, places the net at the base of the vegetation and dislodges organisms using the hand.
  - i. If there is not enough substrate at one location to complete a full sweep, goes to the same substrate at an alternative location to complete the sweep.
  - j. Once collected, pulls dip net up and washes water through to dislodge, silt, etc.
  - k. When discarding large pieces of substrate from the dip net, individually scrubs each piece and visibly inspects for organisms before discarding.
  - l. Visibly inspects collected materials for organisms.
14. Samples only productive portions of habitats, does not dilute sample with unproductive detritus.
- a. Collects only top 2 cm of leaf mats, sand, silt, mud, or muck.
  - b. Samples only in the normal flow of the stream.
15. Samples an area equivalent to 1 dip net wide and 0.5 meters long.
- a. Uses the width of the dip net and the marked dip net handle or other measuring device to determine sampling area.
  - b. For thick, 3-dimensional habitats such as roots and leaf packs, states that the habitats should be visually spread out to a thickness of 2 cm.
  - c. Completely sweeps the sampled area for a length of 0.5 meter  $\pm$  0.1 meter during each pass.
16. Transfers material to jug without loss of organisms and preserves.
- a. Once collected, pulls dip net up and washes water through to dislodge, silt, etc.

**FS-7420 Training for Stream Condition Index Sampling Checklist**

- b. When discarding large pieces of substrate from the dip net, individually scrubs each piece and visibly inspects for organisms before discarding.
  - c. Transfers sample into 4 liter wide mouth jug without losing any organisms (e.g. put jug in net to transfer handfuls of material, then invert the remaining material in the net into jug).
  - d. Washes down/transfer from dip net to jug using a squirt bottle, turkey baster, etc...
  - e. Preserves with 10% buffered formalin. 1:10 dilution. Add 10% buffered formalin to full jug of site water.
17. Performs training at twelve (at least) separate sites; including at least four (4) good sites (minimally disturbed), four (4) poor sites (disturbed or altered) and three (3) non-wadeable systems.

**Training Event Log**

1. Trainer or Evaluators are the only ones authorized to make an entry into this table.
2. Indicate the type of training event conducted by checking the TR column for training events or the EV column for evaluation events.
3. Initial and date the entry.
4. Write a brief description of the training. Describe the activities performed, site name, habitats swept, etc.

**FT-3000 Training for Stream Habitat Assessment Checklist****Checklist for Documenting Training for FT 3000 – Stream Habitat Assessment**

One copy of this document will exist for each Trainee. The Trainee (or supervisor) must retain the document. The Trainee will be required to provide this document as proof of completion of these training requirements.

By signing this card, the Trainee and Supervisor attest to the completion of ALL competencies outlined in this SOP.

**Introduction**

This sampling procedure requires specific training and a demonstration of competency due to the expert judgment exercised during field sampling. It is recommended that individuals conducting this procedure train with qualified staff (who have passed the DEP Stream Condition Index audit) and successfully obtain all required training and evaluation signatures.

In an effort to establish standardization and consistency, individuals performing the training are required to adhere to the competencies and principles detailed in this document. Following these training protocols will encourage the establishment of an equal foundation among samplers performing the Habitat Assessment. The items below do not need to be completed in any particular order, nor do they need to be completed in a single event. However, each training or evaluation event must be identified in the Training Event Log, regardless of whether a competency was completed or not.

First, **trainers** will follow the items described in the **Training Activities Section** and initial upon completion.

**Evaluators** will then follow the **Evaluation Activities** and initial upon completion. Evaluators should not sign off on an item unless the trainee has demonstrated complete competency.

**Objective**

To provide trainers and trainees a standardized set of training and evaluation activities for performing a Habitat Assessment. Trainers and trainees must understand, convey, discuss and demonstrate (where applicable) the proper techniques and principles for performing a Habitat Assessment, to include the following:

1. Identify appropriate and applicable SOPs and forms used or referenced for performing a Habitat Assessment.
2. Discuss and recognize circumstances where a Habitat Assessment should be postponed, e.g., in the event of recent increase in water level or during flooding.
3. Identify, measure and mark the 100-meter length sampling area.
4. Complete Form FD 9000-4, Stream/River Habitat Sketch Sheet.
5. Complete Form FD 9000-3, Physical/Chemical Characterization Field Sheet.
6. Complete Form FD 9000-5, Stream/River Habitat Assessment Field Sheet.
7. During at least twelve (12) separate training sessions, perform objectives 1-6 above.

**FT-3000 Training for Stream Habitat Assessment Checklist****Training Activities**

The trainer will discuss, convey, instruct and demonstrate (where applicable) each of the following items. Once completed to satisfaction, the trainer will initial and date the item. The trainee will also initial in the appropriate area to signify the item was demonstrated to them and they have received an understanding and developed competency.

1. Identify the appropriate and applicable SOPs and forms used or referenced for performing a Habitat Assessment. This includes DEP-SOP-001/01:
  - a. FT 3000 Aquatic Habitat Characterization,
  - b. FS 7000 General Biological Community Sampling
  - c. Form FD 9000-3 Physical/Chemical Characterization Field Sheet
  - d. Form FD 9000-4 Stream/River Habitat Sketch Sheet
  - e. Form FD 9000-5 Stream/River Habitat Assessment Field Sheet
2. Discuss and recognize circumstances where a Habitat Assessment should be postponed.
  - a. List the normal stream factors to consider for the determination of representative sample as continuous water flow, intact and available substrate, and accessibility for sampling.
  - b. Determine if the stream flow has remained continuous and has not been intermittent or stagnant.
  - c. In flood or high water conditions, wait until habitats become accessible, the water recedes, normal flow returns, and/or the habitats have reestablished (approximately 28 days).
  - d. Look for flood or high water evidence (locate recent high water mark).
  - e. Look for evidence of disturbed vegetation and branches, substrates that have been relocated, high water has scoured and stripped substrates, new sand and silt piles, new flow patterns, and smothered habitat.
  - f. In dry conditions, do not sample; wait a minimum of 3 months after the stream returns to normal or sets a new normal level. This allows the habitat and the macroinvertebrate community to reestablish.
3. Identify, measure and mark the 100-meter length sampling area.
  - a. State that the stream is commonly broken up into 10 meter intervals for sketching purposes.
  - b. State that the downstream end of the stretch is the beginning or the 0 meter mark.
  - c. State that the upstream end of the stretch is the end or the 100 meter mark.
  - d. State that the left and right banks are determined by facing upstream from the 0 meter mark.
  - e. State that the sketch always uses the downstream end as the start position and is marked as the 0 meter interval.
  - f. Extend tape measure from 0 meter mark to the 100 meter mark.
  - g. Place flagging tape on visible substrates to signify the 0, 50, and 100 meter intervals.
  - h. Note that it is common to place additional flags every 10 meters.
  - i. Note that it is common to place a double flag at the 0, 50, and 100 meter intervals.
4. Complete Form FD 9000-4, Stream/River Habitat Sketch Sheet
  - a. Record name, date, site name, site location, and county.
  - b. Enter a legend symbol for each habitat encountered (snags, roots, leaf material, macrophytes and 3 "other").
  - c. State the major habitats as snags, roots, leaf material, macrophytes, and rocks.
  - d. State the minor habitats as sand, silt, muck, and mud.
  - e. State that the stream sketch should map the observable (by sight or touch) location and amount of each productive substrate type in the 100 meter stretch. The habitats are

**FT-3000 Training for Stream Habitat Assessment Checklist**

drawn 2-dimensionally, but the sketch is understood as a 3-dimensional representation (ex., full coverage floating aquatic vegetation does not equal 100% habitat).

- f. Start at the downstream end (0 meter mark) and proceed upstream.
- g. Stand within the first meter, and look upstream to obtain the basic layout of the stream banks, stream width and curves; select an appropriate scale for sketching the stream.
- h. Sketch the stream banks within the first 10 meter interval of the stream to approximate scale.
- i. Locate the major and minor productive habitats present.
- j. Identify minor habitats as sand, muck, silt, mud.
- k. Discuss the productive habitat substrates and the conditions that make them productive.
  - i. General Considerations
    - a) Productive means the habitat is currently sustaining or has the potential to sustain organisms.
    - b) Must be in contact with the water.
    - c) Minimum of 2 square meters in the entire reach to be counted as "present".
    - d) Ideally positioned in the flow areas with adequate water velocity to support sufficient oxygenation.
    - e) Do not count smothered portions of habitats.
  - ii. Snags
    - a) Count only woody debris, not herbaceous vegetation.
    - b) Count only snags greater than thumb size in diameter.
    - c) Count portion of snag directly in contact with water.
    - d) Do not count smothered portion of snags.
  - iii. Roots
    - a) Count only roots less than thumb size in diameter.
    - b) Count portion of roots directly in contact with water.
    - c) State that finer (feathery or hairy) roots are usually more productive.
    - d) State that roots may contain silt as long as silt is not excessive to the point where the roots are clumped together or the roots are not visible.
    - e) Count woody, adventitious roots hanging into the water.
    - f) Do not count the herbaceous roots of aquatic macrophytes or roots from herbaceous vegetation overhanging the water. These are instead counted as aquatic macrophytes
    - g) If the banks are undercut, determine if roots are actually present.
    - h) Do not count undercut banks as a productive substrate if roots are not present.
  - iv. Leaf Material
    - a) Count leaf litter directly in contact with water.
    - b) Count leaf packs and leaf mats positioned in flow areas with adequate water velocity to support sufficient oxygenation.
    - c) Define a leaf pack as leaf material suspended up against an obstruction in the water column.
    - d) Define a leaf mat as an area of leaf material settled on the stream bottom.
    - e) State that leaf packs are more productive than leaf mats.
    - f) Describe anaerobic versus aerobic conditions for leaf packs/mats.
    - g) Count leaf packs as productive only if partially decomposed and aerobic.
    - h) Count leaf mat as productive only if partially decomposed and aerobic.
    - i) State that the top 2 cm of aerobic leaf mats can be counted as productive habitat.
    - j) State that leaf material such as pine needles is not considered productive.
  - v. Aquatic Macrophytes
    - a) Count aquatic vegetation directly in contact with water.

**FT-3000 Training for Stream Habitat Assessment Checklist**

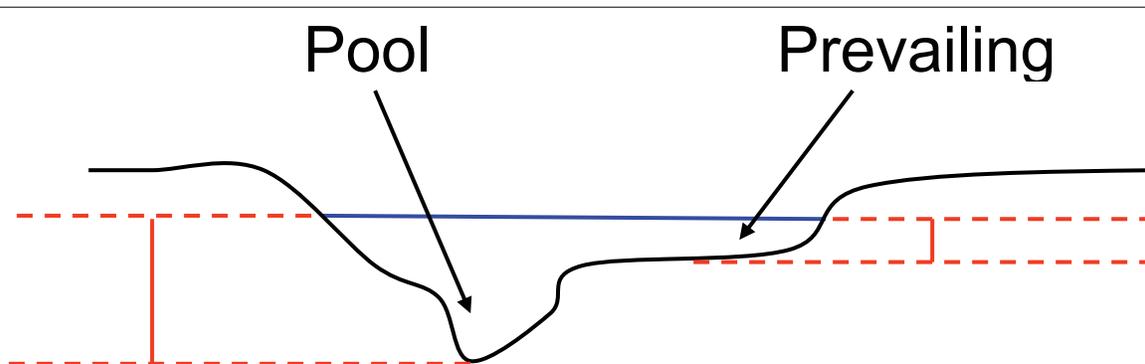
- b) Count only aquatic vegetation in normal, continuous flow.
  - c) Large mats of vegetation may not receive sufficient flow in the center to be considered productive.
  - d) Do not count non-aquatic (terrestrial) macrophytes that are temporarily inundated.
- vi. Rock
- a) Count rocky outcrops or rocks directly in contact with the water.
  - b) Count only rock in normal, continuous flow.
  - c) Count only if greater than 5 cm of productive surface.
  - d) State rougher surfaces as more productive than smooth surfaces.
  - e) State that concrete is considered rock if weathered and present for a long time.
  - f) Do not count asphalt (possibly toxic) or pipe clay (not stable) as productive substrates.
- l. Using the established legend symbol, draw to scale each habitat encountered for the first 10 meter interval.
  - m. Repeat the sketch process in each 10 meter stream section of the stream, being careful to reevaluate (and compensate for) stream width.
  - n. Using the grid on the map, count the number of grid spaces for each productive substrate type.
  - o. Divide each of these substrate numbers by the total number of grid spaces contained within the site sketch and multiple by 100 to get the percentage of productive habitat.
  - p. If portions of the system are not observable (e.g., due to depth), include only the number of grids where observations were possible as the denominator in this calculation.
  - q. Indicate on the sketch where the velocity measurement is taken.
  - r. Indicate areas on sketch where sand or silt smothering is present.
  - s. Indicate areas on sketch with unstable or eroding banks.
  - t. Indicate areas on sketch where natural vegetation along banks is altered or eliminated (riparian buffer zone width).
  - u. Record the common vegetation (aquatic and/or terrestrial) present at the stream site.
  - v. Record any additional comments that assist in site characterization.
5. Complete Form FD 9000-3, Physical/Chemical Characterization Field Sheet.
- a. Fill in the information requested at the top of the Physical/Chemical Characterization Field Sheet (FD 9000-3), including the STORET station number, sampling date, sampling location, field identification and receiving body of water. Much of this information can be recorded prior to field sampling. Record the time of sampling when water quality samples are first taken or when the assessment begins. If available, use a GPS tool to identify the latitude and longitude of the sampling location.
  - b. Observe and estimate the percentage of land-use types in the watershed that drain to the site, including all that potentially affect water quality. Examination of maps prior to field sampling is a necessary component of this determination.
  - c. Rate the potential for erosion within the portion of the watershed that affects your site.
  - d. "Local non-point-source pollution" refers to contamination introduced by stormwater runoff. Estimate this input and record this information.
  - e. When sampling a 100 meter section of a river or stream, measure or estimate the width of the system, from shore to shore, at a transect representative of the site.
  - f. Take three measurements of water depth across this transect using the ruled dip net handle or ruled rope of the Secchi disk and record this information.
  - g. Take three measurements of water velocity (one at each of the locations where water depth was measured) using either a flow meter or the ruled dip net handle, watch/stopwatch, and a floating leaf or other object. Record this information on the data

**FT-3000 Training for Stream Habitat Assessment Checklist**

- sheet. If there is no water velocity to measure, note that on the form. In some systems, the velocity will depend upon tidal cycle. Note the velocity during sampling and relate that to where it occurs in the tidal cycle.
- h. Measure the vegetated riparian buffer zone width on each side of the stream or river; this is the distance from the edge of the water to where clearing or other human activities begin. Record the distance for the least buffered side or point of the system. If the vegetated buffer zone width for the least buffered side or point is greater than 18 m, record ">18 m."
  - i. Indicate whether or not the area in the vicinity of the sampling station has been artificially channelized and to what extent the system has recovered.
  - j. Indicate the presence or absence of impoundments in the area of the sampling station that potentially alter the natural flow regime or the movement of biota.
  - k. Where applicable, estimate and record the vertical distance from the current water level to the peak overflow level. Peak overflow level is indicated by debris hanging in bank, floodplain vegetation, or deposition of silt or soil. When bank overflow is rare, a high water mark may not be apparent. Add this distance to the current water depth (see letter f above) to determine the distance of the high water mark above the streambed and record this value.
  - l. Check the box for the percentage range that best describes the degree of shading in the sampling area. This percentage should be an integration over the entire 100 meter reach and is not influenced by the season (for example, in the fall or winter when leaves are not present on surrounding trees, this is not to be interpreted as "open" canopy cover).
  - m. Note any odors associated with the bottom sediments and check the appropriate box. Note the presence or absence of oils in the sediment. For this step, it may be helpful to observe the extent of sheen on the water after the substrate has been disturbed. Finally, note any deposits in the area, including the degree of smothering by sand or silt.
  - n. Indicate the type of aquatic system being sampled. If the station is in a stream or river, indicate stream order.
  - o. Note the presence and types of any noticeable water odors and check the appropriate box. Note the term that best describes the relative coverage of any oil on the water surface.
  - p. Based on visual observation, check the term that best describes the amount of turbidity in the water before it was disturbed by sampling.
  - q. Check box for the term that best describes the color of the water, indicating whether the water is tannic, green, clear or other. If "other" is checked, indicate what the color is.
  - r. Describe the weather conditions during the time of sampling, particularly the relative amount of sunshine/cloud cover, temperature, and wind speed and direction. Record any other conditions/observations that are helpful in characterizing the site.
  - s. Estimate and record the relative abundances of the following: periphyton, fish, aquatic macrophytes, and iron/sulfur bacteria. Note that periphyton and fish are very seldom absent from most systems. Abundant periphyton can be thick enough to prevent macroinvertebrate colonization on habitats.
  - t. Sign and date the form.
6. Complete Form FD 9000-5, Stream/River Habitat Assessment Field Sheet.
    - a. Fill in the information requested at the top of the Stream/River Habitat Assessment Field Sheet (FD 9000-5), including the STORET station number, sampling date, sampling location, field identification and receiving body of water. Record the time of sampling as described in FT 3001, section 2.1.

**FT-3000 Training for Stream Habitat Assessment Checklist**

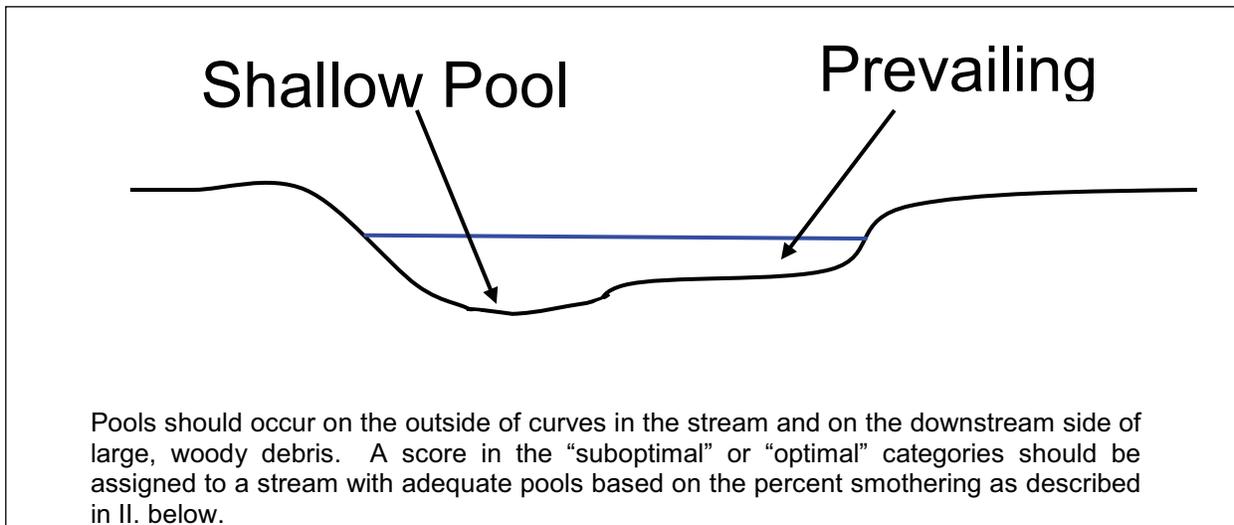
- b. Follow the criteria given on the data sheet within each category to determine the appropriate score for that category.
- c. Score the **Substrate Diversity** by evaluating the number of different kinds of productive substrates present. Refer to the Stream/River Habitat Sketch Sheet (FD 9000-4) and the Physical/Chemical Characterization Field Sheet (FD 9000-3). The following substrates are considered productive: snags (woody debris or logs larger than thumb diameter); roots (less than thumb diameter, with finer roots usually being more productive); aquatic vegetation (in contact with the water); leaf material in association with flow (leaves must be partially decomposed to be better habitat; leaf mats at the bottom may be productive if sufficient oxygen is present, but anaerobic leaf mats are not considered productive habitat); rocky substrate (rock diameters greater than 5 cm). Once the number of substrates has been determined, assign a score for substrate diversity in the appropriate spot on the sheet. (Higher values indicate a better condition than lower values.) The quality of the substrates present should then be given consideration in the scoring process. For example, partially decomposed leaf packs and “old” snags are better than fresh substrates and should be given higher scores within the same category. A minimum occurrence of two square meters of a particular substrate in the reach is necessary to count that substrate as being “present”.
- d. **Substrate Availability** is the relative spatial abundance of productive habitats present. Refer to the entry on FD 9000-3, as determined from FD 9000-4. A minimum occurrence of two square meters of a particular substrate in the reach is necessary to count that substrate as being “present”. Include only productive habitats in the mapping and scoring process. Score substrate availability on the data sheet based on the sum of the percentages of productive habitats in the stream reach.
- e. Using the ranges given on the data sheet, assign a **Water Velocity** score based on the maximum velocity observed at the typical cross-section of stream or river. Note that in the majority of Florida streams, velocities over 1 m/s are considered unusually high, and should be included in the “poor” category. An exception to this policy would be in narrow or shallow areas of streams with natural limestone bottoms, where velocities approaching 1 m/s may be normal and, thus, would be scored in the “optimal” category.
- f. The **Habitat Smothering** parameter is an assessment of sand and silt deposition onto what would otherwise be productive habitats. Scoring is a two-step process. Assign a habitat smothering score as determined by the following two steps:
  - i. First, determine (by referring to FD 9000-4) if adequate pools are present. A pool is defined as an area where the depth is at least 2 times the prevailing depth.



A natural system should have 1 to 2 pools every 12 times the width of the stream. (For large rivers it may be more appropriate to base estimates on the amount of smothering present on the actual habitats rather than the number of pools.) For example, a 3 meter wide stream should have at least 1 pool every 36 meters or a total of 3-6 pools per 100

**FT-3000 Training for Stream Habitat Assessment Checklist**

meter reach ( $100\text{m}/36\text{m} = 2.8$  segments). If there are no pools; i.e., the stream depth is nearly the same throughout the 100m reach, assign a score in the “poor” category. For large rivers, if there are minimal (less than 1 pool every 12 times the width) or shallow pools (a shallow pool is any pool where the depth is much less than 2 times the prevailing depth), score the stream in the “marginal” category.

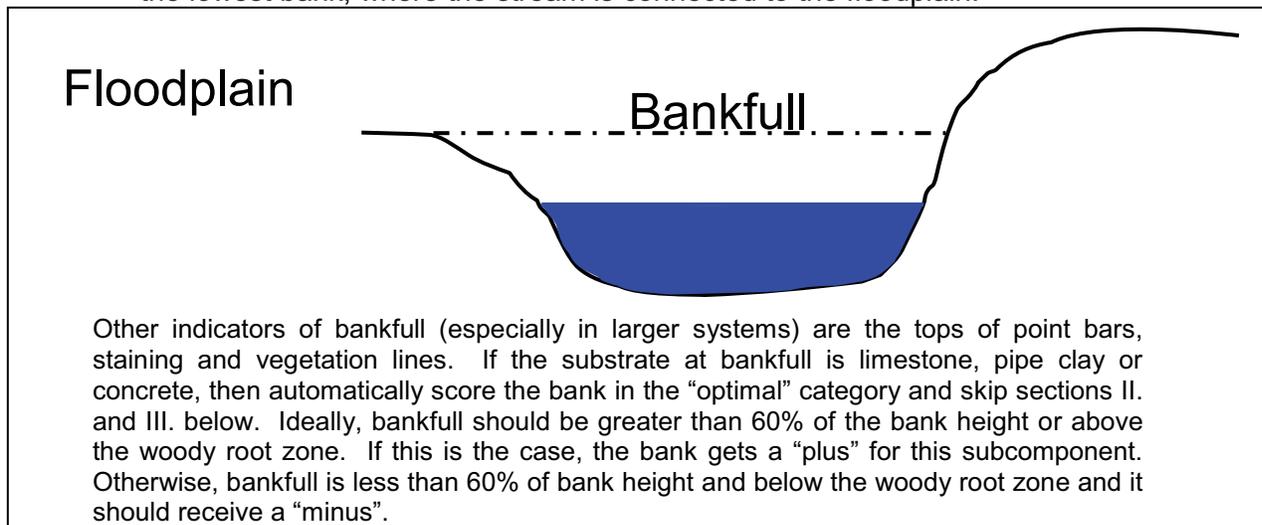


- ii. Second, check for deposition of sand or silt on visible habitats. While a light dusting of sand or silt is normal, excessively thick coatings will reduce habitability of the substrate. Sand smothering on visible habitats is indicated if sand is present on a substrate in an amount greater than a light dusting (3-5 mm). Silt smothering is indicated if a substantial turbidity plume results from agitating the substrate, especially fine roots and leaf packs. Silt smothering can sometimes also be determined by direct observation of the silt coating. Determine a percentage value for visible habitats that are not habitable due to sand and/or silt smothering.
- g. Add the scores for the primary habitat components (see sections c - f above) and record this primary score on the form. The primary habitat components refer to in-stream features.
- h. Observe whether or not the reach of stream or river in the sampling area is artificially channelized. Assign a score for **Artificial Channelization** using the following guide:
  - i. Poor - A highly altered system with ALL of the following; straightened stream channel, box-cut banks and a monotypic depth. Spoil banks or other indications of dredging may be visible.
  - ii. Marginal - An altered system with some sinuosity in stream channel, often developed within the old dredged area, OR some diversity in depth but no pools as defined in 2.6 above. Spoil banks may be visible.
  - iii. Suboptimal - Good sinuosity has developed within and outside of the old channelized area AND the bottom has a diversity of depths approaching what's expected of a non-dredged system (1 to 2 pools every 12 times the width of the stream). Spoil banks may be visible, but have established vegetation growing on them.
  - iv. Optimal - A system with good stream channel sinuosity AND a diversity of depths as defined in section f. above. No evidence of dredging or straightening.
- i. Refer to FD 9000-4 for areas along the bank that have eroded or have the potential for bank sloughing. Score artificially stable banks such as concrete according to bank stability, not according to natural vs. artificial stability. Determine the extent of erosion

**FT-3000 Training for Stream Habitat Assessment Checklist**

potential for the site and assign a Bank Stability score for each bank (The “left bank” is on your left when you are looking upstream).

- i. First, determine where “bankfull” is in relation to the height of each bank. Bankfull is defined as the stage at which channel maintenance is most effective and occurs on average every 1-2 years. For most natural Florida streams, bankfull is the height of the lowest bank, where the stream is connected to the floodplain.



- ii. Second, determine the slope of the bank. The more gentle the slope the more stable the bank. Score a bank with a slope less than 60° with a plus for this subcomponent. A bank with a slope of greater than 60° warrants a minus.
- iii. Third, determine if bankfull is above or below the root zone. If bankfull is above the root zone and there are few raw or eroded areas, score this subcomponent a plus. Otherwise, score it a minus. Woody vegetation/roots are more stable than herbaceous and should be scored accordingly.
- iv. Lastly, count up the number of pluses from each subcomponent (a total of 3 possible) and score within each category as described below:
  - a) Poor- 0 pluses
  - b) Marginal- 1 plus
  - c) Suboptimal- 2 pluses
  - d) Optimal- 3 pluses
- j. Assign a score for the Riparian Buffer Zone Width that best characterizes the width of vegetation on each side of the channel. This zone is measured from the edge of the stream bank to where clearing or other adverse human activity begins. A native vegetated buffer zone of greater than 18 meter (approximately 60 feet) is currently considered optimal. Adjust scores accordingly if human activities encroach on some part of the 18 m buffer. For example, if approximately 20 meters of the stream bank is cleared but the other 80 m has the required buffer, the score should be reduced by approximately 20%.
- k. Identify the plants in the riparian zone, determining the extent of coverage and whether the vegetation is native or exotic. Look for these classes of plants: bottomland or mesic hardwoods, understory shrubs and non-woody macrophytes. Assign a Riparian Zone Vegetation Quality score based on the classes of plants present, the degree of bank vegetative cover, and how closely the plant community at the site approaches that expected of an undisturbed community in the region.

**FT-3000 Training for Stream Habitat Assessment Checklist**

- l. Add the scores for the secondary habitat components (see sections h - k) and record this secondary score on the form. The secondary habitat components refer to morphological and riparian zone features.
  - m. Add the primary score (see section g) and the secondary score (see section l) to get the habitat assessment total score. Record the habitat assessment total score on the form.
  - n. Sign and date the form.
7. Observe and critique trainee for items 2-6 above at twelve (at least) separate training sites; include at least four good sites (minimally disturbed), four poor sites (disturbed or altered), and 3 non-wadeable systems.

**Evaluation Activities**

The trainee will convey and/or demonstrate (where applicable) a mastery of the following items. Once completed to satisfaction, the Evaluator will initial and date the item.

1. Identifies the appropriate and applicable SOPs and forms used or referenced for performing a Habitat Assessment. This includes DEP-SOP-001/01:
  - a. FT 3000 Aquatic Habitat Characterization
  - b. FS 7000 General Biological Community Sampling
  - c. Form FD 9000-3 Physical/Chemical Characterization Field Sheet
  - d. Form FD 9000-4 Stream/River Habitat Sketch Sheet
  - e. Form FD 9000-5 Stream/River Habitat Assessment Field Sheet.
2. Discusses and recognizes circumstances where a Habitat Assessment should be postponed.
  - a. Lists the normal stream factors to consider for the determination of representative sample as continuous water flow, intact and available substrate, and accessibility for sampling.
  - b. Determines if the stream flow has remained continuous and has not been intermittent or stagnant.
  - c. In flood or high water conditions, waits until habitats become accessible, the water recedes, normal flow returns, and/or the habitats have reestablished (approximately 28 days).
  - d. Looks for flood or high water evidence (locate recent high water mark).
  - e. Looks for evidence of disturbed vegetation and branches, substrates that have been relocated, high water has scoured and stripped substrates, new sand and silt piles, new flow patterns, and smothered habitat.
  - f. In dry conditions, does not sample; waits a minimum of 3 months after the stream returns to normal or sets a new normal level. This allows the habitat and the macroinvertebrate community to reestablish.
3. Identifies, measures and marks the 100-meter length sampling area.
  - a. States that the stream is commonly broken up into 10 meter intervals for sketching purposes.
  - b. States that the downstream end of the stretch is the beginning or the 0 meter mark.
  - c. States that the upstream end of the stretch is the end or the 100 meter mark.
  - d. States that the left and right banks are determined by facing upstream from the 0 meter mark.
  - e. States that the sketch always uses the downstream end as the start position and is marked as the 0 meter interval.
  - f. Extends tape measure from 0 meter mark to the 100 meter mark.
  - g. Places flagging tape on visible substrates to signify the 0, 50, and 100 meter intervals.
  - h. Notes that it is common to place additional flags every 10 meters.
  - i. Notes that it is common to place a double flag at the 0, 50, and 100 meter intervals.

**FT-3000 Training for Stream Habitat Assessment Checklist**

4. Completes Form FD 9000-4, Stream/River Habitat Sketch Sheet
  - a. Records name, date, site name, site location, and county.
  - b. Enters a legend symbol for each habitat encountered (snags, roots, leaf material, macrophytes and 3 "other").
  - c. States the major habitats as snags, roots, leaf material, macrophytes, and rocks.
  - d. States the minor habitats as sand, silt, muck, and mud.
  - e. States that the stream sketch should map the observable (by sight or touch) location and amount of each productive substrate type in the 100 meter stretch. The habitats are drawn 2-dimensionally, but the sketch is understood as a 3-dimensional representation (ex., full coverage floating aquatic vegetation does not equal 100% habitat).
  - f. Starts at the downstream end (0 meter mark) and proceed upstream.
  - g. Stands within the first meter, and looks upstream to obtain the basic layout of the stream banks, stream width and curves; selects an appropriate scale for sketching the stream.
  - h. Sketches the stream banks within the first 10 meter interval of the stream to approximate scale.
  - i. Locates the major and minor productive habitats present.
  - j. Identifies minor habitats as sand, muck, silt, mud.
  - k. Discusses the productive habitat substrates and the conditions that make them productive.
    - i. General Considerations
      - a) Productive means the habitat is currently sustaining or is capable of sustaining organisms.
      - b) Must be in contact with the water.
      - c) Minimum of 2 square meters in the entire reach to be counted as "present".
      - d) Ideally positioned in the flow areas with adequate water velocity to support sufficient oxygenation.
      - e) Does not count smothered portions of habitats.
    - ii. Snags
      - a) Counts only woody debris, not herbaceous vegetation.
      - b) Counts only snags greater than thumb size in diameter.
      - c) Counts portion of snag directly in contact with water.
      - d) Does not count smothered portion of snags.
    - iii. Roots
      - a) Counts only roots less than thumb size in diameter.
      - b) Counts portion of roots directly in contact with water.
      - c) States that finer (feathery or hairy) roots are usually more productive.
      - d) States that roots may contain silt as long as silt is not excessive to the point where the roots are clumped together or the roots are still visible.
      - e) Counts woody, adventitious roots hanging into the water.
      - f) Does not count the herbaceous roots of aquatic macrophytes or roots from herbaceous vegetation overhanging the water. These are instead counted as aquatic macrophytes
      - g) If the banks are undercut, determines if roots are actually present.
      - h) Does not count undercut banks as a productive substrate if roots are not present.
    - iv. Leaf Material
      - a) Counts leaf litter directly in contact with water.
      - b) Counts leaf packs and leaf mats positioned in flow areas with adequate water velocity to support sufficient oxygenation.
      - c) Defines a leaf pack as leaf material suspended up against an obstruction in the water column.

**FT-3000 Training for Stream Habitat Assessment Checklist**

- d) Defines a leaf mat as an area of leaf material settled on the stream bottom.
- e) States that leaf packs are more productive than leaf mats.
- f) Describes anaerobic versus aerobic conditions for leaf packs/mats.
- g) Counts leaf packs as productive only if partially decomposed and aerobic.
- h) Counts leaf mats as productive only if partially decomposed and aerobic.
- i) States that the top 2 cm of aerobic leaf mats can be counted as productive habitat.
- j) States that leaf material such as pine needles is not considered productive.
- v. Aquatic Macrophytes
  - a) Counts aquatic vegetation directly in contact with water.
  - b) Counts only aquatic vegetation in normal, continuous flow.
  - c) Large mats of vegetation may not receive sufficient flow in the center to be considered productive.
  - d) Does not count non-aquatic (terrestrial) macrophytes that are temporarily inundated.
- vi. Rock
  - a) Counts rocky outcrops or rocks directly in contact with the water.
  - b) Counts only rock in normal, continuous flow.
  - c) Counts only if greater than 5 cm of productive surface.
  - d) States rougher surfaces as more productive than smooth surfaces.
  - e) States that concrete is considered rock if weathered and present for a long time.
  - f) Does not count asphalt (possibly toxic) or pipe clay (not stable) as productive substrates.
- l. Using the established legend symbol, draws to scale each habitat encountered for the first 10 meter interval.
- m. Repeats the sketch process in each 10 meter stream section of the stream, being careful to reevaluate (and compensate for) stream width.
- n. Using the grid on the map, counts the number of grid spaces for each productive substrate type.
- o. Divides each of these substrate numbers by the total number of grid spaces contained within the site sketch and multiplies by 100 to get the percentage of productive habitat.
- p. If portions of the system are not observable (e.g., due to depth), includes only the number of grids where observations were possible as the denominator in this calculation.
- q. Indicates on the sketch where the velocity measurement is taken.
- r. Indicates areas on sketch where sand or silt smothering is present.
- s. Indicates areas on sketch with unstable or eroding banks.
- t. Indicates areas on sketch where natural vegetation along banks is altered or eliminated (riparian buffer zone width).
- u. Records the common vegetation (aquatic and/or terrestrial) present at the stream site.
- v. Records any additional comments that assist in site characterization.
- 5. Completes Form FD 9000-3, Physical/Chemical Characterization Field Sheet.
  - a. Fills in the information requested at the top of the Physical/Chemical Characterization Field Sheet (FD 9000-3), including the STORET station number, sampling date, sampling location, field identification and receiving body of water. Much of this information can be recorded prior to field sampling. Records the time of sampling when water quality samples are first taken or when the assessment begins. If available, uses a GPS tool to identify the latitude and longitude of the sampling location.

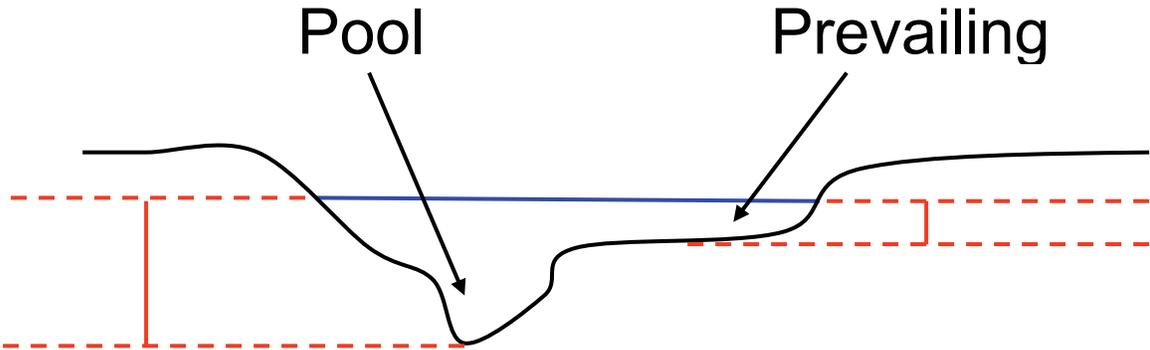
**FT-3000 Training for Stream Habitat Assessment Checklist**

- b. Observes and estimates the percentage of land-use types in the watershed that drain to the site, including all that potentially affect water quality. Examination of maps prior to field sampling is a necessary component of this determination.
- c. Rates the potential for erosion within the portion of the watershed that affects your site.
- d. "Local non-point-source pollution" refers to contamination introduced by stormwater runoff. Estimates this input and records this information.
- e. When sampling a 100 meter section of a river or stream, measures or estimates the width of the system, from shore to shore, at a transect representative of the site.
- f. Takes three measurements of water depth across this transect using the ruled dip net handle or ruled rope of the Secchi disk and records this information.
- g. Takes three measurements of water velocity (one at each of the locations where water depth was measured) using either a flow meter or the ruled dip net handle, watch/stopwatch, and a floating leaf or other object. Records this information on the data sheet. If there is no water velocity to measure, notes that on the form. In some systems, the velocity will depend upon tidal cycle. Notes the velocity during sampling and relates that to where it occurs in the tidal cycle.
- h. Measures the vegetated riparian buffer zone width on each side of the stream or river; this is the distance from the edge of the water to where clearing or other human activities begin. Records the distance for the least buffered side or point of the system. If the vegetated buffer zone width for the least buffered side or point is greater than 18 m, records ">18 m."
- i. Indicates whether or not the area in the vicinity of the sampling station has been artificially channelized and to what extent the system has recovered.
- j. Indicates the presence or absence of impoundments in the area of the sampling station that potentially alter the natural flow regime or the movement of biota.
- k. Where applicable, estimates and records the vertical distance from the current water level to the peak overflow level. Peak overflow level is indicated by debris hanging in bank, floodplain vegetation, or deposition of silt or soil. When bank overflow is rare, a high water mark may not be apparent. Adds this distance to the current water depth (see letter f above) to determine the distance of the high water mark above the streambed and records this value.
- l. Checks the box for the percentage range that best describes the degree of shading in the sampling area. This percentage should be an integration over the entire 100 meter reach and is not influenced by the season (for example, in the fall or winter when leaves are not present on surrounding trees, this is not to be interpreted as "open" canopy cover).
- m. Notes any odors associated with the bottom sediments and check the appropriate box. Notes the presence or absence of oils in the sediment. For this step, it may be helpful to observe the extent of sheen on the water after the substrate has been disturbed. Finally, notes any deposits in the area, including the degree of smothering by sand or silt.
- n. Indicates the type of aquatic system being sampled. If the station is in a stream or river, indicates stream order.
- o. Notes the presence and types of any noticeable water odors and check the appropriate box. Notes the term that best describes the relative coverage of any oil on the water surface.
- p. Based on visual observation, checks the term that best describes the amount of turbidity in the water before it was disturbed by sampling.
- q. Checks box for the term that best describes the color of the water, indicating whether the water is tannic, green, clear, or other. If "other" is checked, indicate what the color is.

**FT-3000 Training for Stream Habitat Assessment Checklist**

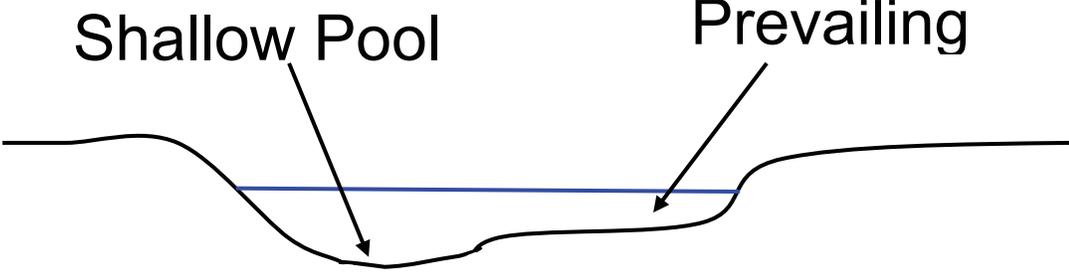
- r. Describes the weather conditions during the time of sampling, particularly the relative amount of sunshine/cloud cover, temperature, and wind speed and direction. Records any other conditions/observations that are helpful in characterizing the site.
  - s. Estimates and records the relative abundances of the following: periphyton, fish, aquatic macrophytes and iron/sulfur bacteria. Notes that periphyton and fish are very seldom absent from most systems. Abundant periphyton can be thick enough to prevent macroinvertebrate colonization on habitats.
  - t. Signs and dates the form.
6. Completes Form FD 9000-5, Stream/River Habitat Assessment Field Sheet.
- a. Fills in the information requested at the top of the Stream/River Habitat Assessment Field Sheet (FD 9000-5), including the STORET station number, sampling date, sampling location, field identification and receiving body of water. Record the time of sampling as described in FT 3001, section 2.1.
  - b. Follows the criteria given on the data sheet within each category to determine the appropriate score for that category.
  - c. Scores the **Substrate Diversity** by evaluating the number of different kinds of productive substrates present. Refers to the Stream/River Habitat Sketch Sheet (FD 9000-4) and the Physical/Chemical Characterization Field Sheet (FD 9000-3). The following substrates are considered productive: snags (woody debris or logs larger than thumb diameter); roots (less than thumb diameter, with finer roots usually being more productive); aquatic vegetation (in contact with the water); leaf packs/mats in association with flow (leaves must be partially decomposed to be better habitat; leaf mats at the bottom may be productive if sufficient oxygen is present, but anaerobic leaf mats are not considered productive habitat); rocky substrate (with rock diameters greater than 5 cm). Once the number of substrates has been determined, assigns a score for substrate diversity in the appropriate spot on the sheet. (Higher values indicate a better condition than lower values.) The quality of the substrates present should then be given consideration in the scoring process. For example, partially decomposed leaf packs and "old" snags are better than fresh substrates and should be given lower scores within the same category. A minimum occurrence of two square meters of a particular substrate in the reach is necessary to count that substrate as being "present".
  - d. **Substrate Availability** is the relative spatial abundance of productive habitats present. Refers to the entry on FD 9000-3, as determined from FD 9000-4. States that a minimum occurrence of two square meters of a particular substrate in the reach is necessary to count that substrate as being "present". Includes only productive habitats in the mapping and scoring process. Scores substrate availability on the data sheet based on the sum of the percentages of productive habitats in the stream reach.
  - e. Using the ranges given on the data sheet, assigns a **Water Velocity** score based on the maximum velocity observed at the typical cross-section of stream or river. Avoid areas where the run has been obstructed by snags or other material unless this represents the majority of the run. Notes that in the majority of Florida streams, velocities over 1 m/s are considered unusually high, and should be included in the "poor" category. An exception to this policy would be in narrow or shallow areas of streams with natural limestone bottoms, where velocities approaching 1 m/s may be normal and, thus, would be scored in the "optimal" category.
  - f. The **Habitat Smothering** parameter is an assessment of sand and silt deposition onto what would otherwise be productive habitats. Scoring is a two-step process. Assigns a habitat smothering score as determined by the following two steps:
    - i. First, determines (by referring to FD 9000-4) if adequate pools are present. A pool is defined as an area where the depth is at least 2 times the prevailing depth.

## FT-3000 Training for Stream Habitat Assessment Checklist



**Pool** **Prevailing**

A natural system should have 1 to 2 pools every 12 times the width of the stream. (For large rivers, it may be more appropriate to base estimates on the amount of smothering present on the actual habitats rather than the number of pools.) For example, a 3 meter wide stream should have at least 1 pool every 36 meters or a total of 3-6 pools per 100 meter reach ( $100\text{m}/36\text{m} = 2.8$  segments). If there are no pools; i.e., the stream depth is nearly the same throughout the 100m reach, assigns a score in the “poor” category. If there are minimal (less than 1 pool every 12 times the width) or shallow pools (a shallow pool is any pool where the depth is much less than 2 times the prevailing depth), scores the stream in the “marginal” category.



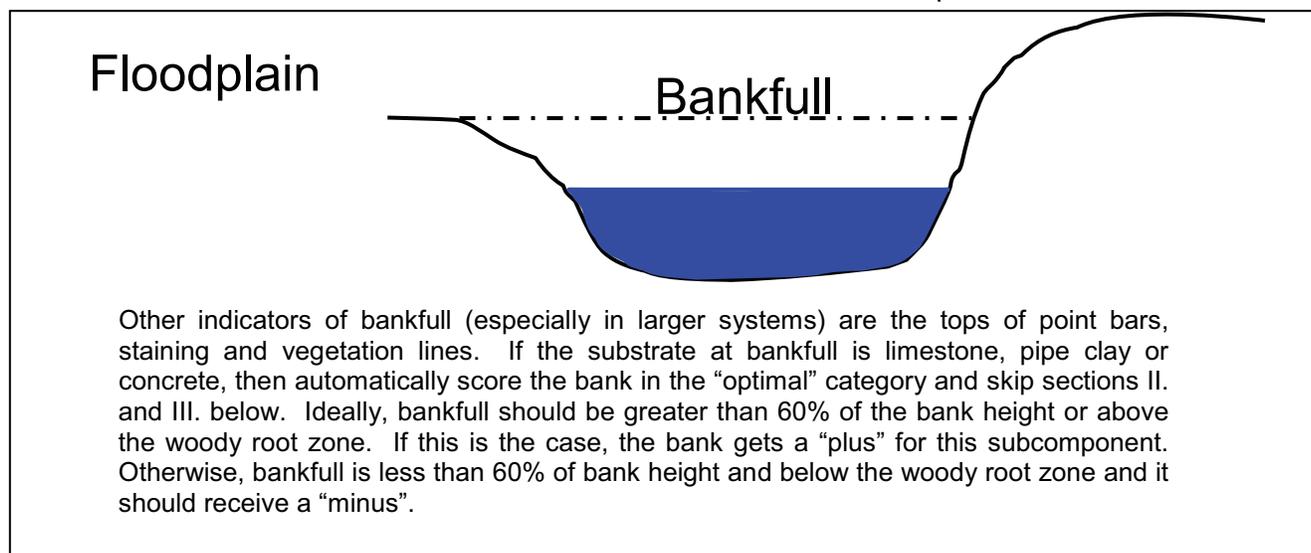
**Shallow Pool** **Prevailing**

Pools should occur on the outside of curves in the stream and on the downstream side of large, woody debris. A score in the “suboptimal” or “optimal” categories should be assigned to a stream with adequate pools based on the percent smothering as described in II. below.

- ii. Second, checks for deposition of sand or silt on visible habitats. While a light dusting of sand or silt is normal, excessively thick coatings will reduce habitability of the substrate. Sand smothering on visible habitats is indicated if sand is present on a substrate in an amount greater than a light dusting (3-5 mm). Silt smothering is indicated if a substantial turbidity plume results from agitating the substrate, especially fine roots and leaf packs. Silt smothering can sometimes also be determined by direct observation of the silt coating. Determines a percentage value for visible habitats that are not habitable due to sand and/or silt smothering.
- g. Adds the scores for the primary habitat components (see sections c - f above) and record this primary score on the form. The primary habitat components refer to in-stream features.
- h. Observes whether or not the reach of stream or river in the sampling area is artificially channelized. Assigns a score for **Artificial Channelization** using the following guide:

**FT-3000 Training for Stream Habitat Assessment Checklist**

- i. Poor - A highly altered system with ALL of the following; straightened stream channel, box-cut banks and a monotypic depth. Spoil banks or other indications of dredging may be visible.
  - ii. Marginal - An altered system with some sinuosity in stream channel, often developed within the old dredged area, OR some diversity in depth but no pools as defined in section h. above. Spoil banks may be visible.
  - iii. Suboptimal - Good sinuosity has developed within and outside of the old channelized area AND the bottom has a diversity of depths approaching what's expected of a non-dredged system (1 to 2 pools every 12 times the width of the stream). Spoil banks may be visible, but have established vegetation growing on them.
  - iv. Optimal - A system with good stream channel sinuosity AND a diversity of depths as defined in section f. above. No evidence of dredging or straightening.
- i. Refers to FD 9000-4 for areas along the bank that have eroded or have the potential for bank sloughing. Scores artificially stable banks such as concrete according to bank stability, not according to natural vs. artificial stability. Determines the extent of erosion potential for the site and assigns a Bank Stability score for each bank (The "left bank" is on the left when looking upstream).
- i. First, determines where "bankfull" is in relation to the height of each bank. Bankfull is defined as the stage at which channel maintenance is most effective and occurs on average every 1-2 years. For most natural Florida streams, bankfull is the height of the lowest bank, where the stream is connected to the floodplain.



- ii. Second, determines the slope of the bank. The more gentle the slope the more stable the bank. Scores a bank with a slope less than 60° with a plus for this subcomponent. A bank with a slope of greater than 60° warrants a minus.
- iii. Third, determines if bankfull is above or below the root zone. If bankfull is above the root zone and there are few raw or eroded areas, scores this subcomponent a plus. Otherwise, scores it a minus. Woody vegetation/roots are more stable than herbaceous and should be scored accordingly.
- iv. Lastly, counts up the number of pluses from each subcomponent (a total of 3 possible) and scores within each category as described below:
  - a) Poor- 0 pluses
  - b) Marginal- 1 plus
  - c) Suboptimal- 2 pluses

**FT-3000 Training for Stream Habitat Assessment Checklist**

- d) Optimal- 3 pluses
  - j. Assigns a score for the Riparian Buffer Zone Width that best characterizes the width of native vegetation on each side of the channel. This zone is measured from the edge of the stream bank to where clearing or other adverse human activity begins. A native vegetated buffer zone of greater than 18 meter (approximately 60 feet) is currently considered optimal.
  - k. Identifies the plants in the riparian zone, determining the extent of coverage and whether the vegetation is native or exotic. Looks for these classes of plants: bottomland or mesic hardwoods, understory shrubs and non-woody macrophytes. Assigns a Riparian Zone Vegetation Quality score based on the classes of plants present, the degree of bank vegetative cover, and how closely the plant community at the site approaches that expected of an undisturbed community in the region.
  - l. Adds the scores for the secondary habitat components (see sections h - k) and records this secondary score on the form. The secondary habitat components refer to morphological and riparian zone features.
  - m. Adds the primary score (see section g) and the secondary score (see section l) to get the habitat assessment total score. Records the habitat assessment total score on the form.
  - n. Signs and dates the form.
7. Performs training at twelve (at least) separate sites.

**Training Event Log**

1. Trainer or Evaluators are the only ones authorized to make an entry into this table.
2. Indicate the type of training event conducted by checking the TR column for training events or the EV column for evaluation events.
3. Initial and date the entry.
4. Write a brief description of the training. Describe the activities performed, site name, habitats swept, etc.

## Glossary

<b>Acceptance criteria</b>	The numerical limits, prescribed by an approved analytical method, internal data or other preestablished data quality objectives, by which an analytical system or analysis result is verified. Also known as control limits. Acceptance criteria are usually established for calibration, precision, sensitivity and accuracy.
<b>Accuracy</b>	The degree of agreement of a measurement (or an average of measurements of the same thing), X, with an accepted reference or true value, T, usually expressed as the difference between the two values, X-T, or the difference as a percentage of the reference or true value, $100(X-T)/T$ , and sometimes expressed as a ratio, X/T. Accuracy is a measure of the bias in a system.
<b>Analyte</b>	Any measured quantity reported in final units of concentration.
<b>Analyte group</b>	A categorical grouping of analytes based on shared sample collection procedure and equipment construction restrictions. See Tables FA 1000-2 and FA 1000-3.
<b>Analyte-free water</b>	Water free of all positive or negative analytical interferences in which all analytes of interest are below method detection limits.
<b>Audit</b>	A systematic check to determine the quality of the operation of a function, procedure or activity.
<b>Best management practices (BMPs)</b>	Procedures designed to mitigate against adverse environmental consequences associated with human activities.
<b>Bioaccumulation</b>	The accumulation of contaminants in the tissue of organisms through any route, including respiration, ingestion, or direct contact with contaminated water, sediment, pore water, or dredged material.
<b>Bioconcentration</b>	A process by which there occurs a net accumulation of a chemical directly from water into aquatic organisms resulting from simultaneous uptake (e.g., by gill or epithelial tissue) and elimination.
<b>Biological tissue</b>	Includes tissues of plant or animal origin. The most common of these are shellfish, finfish and aquatic plants.
<b>Biomagnification</b>	Result of the process of bioconcentration and bioaccumulation by which tissue concentrations of bioaccumulated chemicals increase as the chemical passes upwards through two or more trophic levels. The term implies an efficient transfer of chemical from food to consumer, so that residue concentrations increase systematically from one trophic level to the next.
<b>Blank</b>	An artificial quality control sample of an analytical matrix designed to monitor the introduction of artifacts and interferences into a sample collection or analytical system.
<b>Blind sample</b>	A quality control sample of known composition whose analytical characteristics are unknown to an audited analyst or organization.
<b>Calibration</b>	The process by which the correlation between instrument response and actual value of a measured analyte or parameter is determined.

## Glossary

<b>Calibration curve</b>	A curve that plots the concentration of known analyte standards against the instrument response to the analyte. Also known as a standard curve.
<b>Calibration standard</b>	Solutions or purified quantities of a substance or material with a verifiable composition that are used to measure the amount or value of an analyte or parameter in an unknown sample. Calibration standards are used to establish a calibration curve or instrument response factor.
<b>Calibration verification</b>	Analyzing a standard as a sample to confirm that the test instrument remains calibrated.
<b>Chemical waste</b>	Liquid or solid chemicals that are no longer industrially useful.
<b>Chronological bracket</b>	Verifying calibration before and after the measurement of environmental samples.
<b>Comparability</b>	Expresses the statistical confidence with which one data set can be compared to another.
<b>Confidence level</b>	The statistical probability associated with an interval of variance. Usually expressed as percent probability. The result being tested is significant if the calculated probability is greater than 90 percent and is highly significant if the probability is greater than 99 percent.
<b>Continuing calibration standard</b>	A standard analyzed during a measurement process to verify the accuracy of a calibration curve or other instrument calibration.
<b>Continuing calibration verification</b>	Analysis of a standard as if it were a sample to check the status of the test instrument calibration.
<b>Creel census</b>	An assessment of the fish consumption by human populations based on a statistical survey of fish landings by sport and subsistence catches.
<b>Data quality</b>	The features and characteristics of a set of data that determine its suitability for a given purpose. Examples of data quality include accuracy, precision, sensitivity, representativeness and comparability.
<b>Data quality objectives</b>	A set of specifications established for an intended use of a set of data.
<b>Data validation</b>	An audit in which data are evaluated according to predetermined validation criteria established as data quality objectives.
<b>Detection limit</b>	The smallest amount of an analyte that can be measured with a stated probability of significance.
<b>D-frame dip net</b>	Pole with a No.30 mesh bag attached to a "D-shaped" frame used for the collection of aquatic invertebrates.
<b>Drinking water</b>	Includes finished (treated) or raw source water designated as potable water. Drinking water sources may originate from surface or ground water.

## Glossary

<b>Environmental sample</b>	Any sample from a natural or other source that is reasonably expected to contribute pollution to or receive pollution from ground waters or surface waters of the state
<b>Equipment blank</b>	Quality control blanks prepared on-site during sampling by pouring analyte-free water through decontaminated field equipment into appropriate sample containers for each matrix and analyte group of interest. Equipment blanks are chemically preserved, stored, transported and analyzed with the collected field samples.
<b>External</b>	Refers to operations, personnel, documents and protocols from a party that is separate from or outside the specified organization.
<b>Field blanks</b>	Quality control blanks prepared on-site during sampling by pouring analyte-free water into appropriate sample containers for each analyte group of interest. Field blanks are chemically preserved, stored, transported and analyzed with the collected field samples.
<b>Field spike</b>	An environmental sample fortified to a known and validated concentration in the field during sampling. These quality control samples are sometimes submitted as blind samples to the analyzing laboratory.
<b>Frotus</b>	A double rake-head with a line attached and used for collecting submerged aquatic vegetation.
<b>Groundwater</b>	Includes all waters found below ground in confined or unconfined aquifers.
<b>Hester-Dendy artificial substrate (HD)</b>	Artificial substrate of known surface area used for the collection of invertebrates over a known amount of time.
<b>Hydrophobic</b>	A hydrophobic or lipophilic chemical having low water solubility and correspondingly high solubility in lipids or nonpolar solvents.
<b>Initial Calibration Verification (ICV)</b>	Calibration verification immediately following initial calibration.
<b>Instrument detection limit</b>	The smallest amount of an analyte of interest that generates an instrument response (signal) under prescribed conditions such that the magnitude of the signal is larger than the absolute uncertainty (error) associated with the signal.
<b>Intensive study</b>	A study of the temporal and spatial variability of specific contaminants found in the tissues of aquatic organisms living in a body of water impacted by pollution.
<b>Interference</b>	Any substance in a sample that fortifies or diminishes the amount of an analyte or otherwise affects the ability to detect and quantify an analyte in the sample.
<b>Internal</b>	Refers to operations, personnel, documents and protocols within the specified organization.

## Glossary

<b>Internal standard</b>	A compound having similar chemical characteristics to the compounds of interest but which is not normally found in the environment or does not interfere with the compounds of interest. A known and specified concentration of the standard is added to each sample prior to analyses. The concentration in the sample is based on the response of the internal standard relative to that of the calibration standard and the compound in the standard.
<b>Legal or evidentiary chain of custody</b>	A sample custody protocol in which all personnel, time intervals and supporting activities associated with the collection, possession, handling, processing, analysis, transport, storage and disposal of a specific sample are documented.
<b>Method blank</b>	A blank of an appropriate analyte-free matrix that is processed (digested, extracted, etc.) and analyzed with a specified sample set.
<b>Method detection limit</b>	The smallest amount of an analyte that can be analyzed by a given measurement system under specified conditions of sample processing and analysis and reported with a 99% confidence that the concentration of the analyte in the sample is greater than zero.
<b>Parameter</b>	For the purposes of the DEP SOPs, any measured quantity not reported in units of concentration.
<b>Parent sample</b>	A sample from which aliquots or subsamples are taken for processing or testing purposes.
<b>Performance audit</b>	An audit where quantitative data are independently obtained for comparison with routinely obtained data in a measurement system. Examples of these audits are EPA performance evaluation programs, commercial performance evaluation programs, split sampling programs involving at least two laboratories and/or sampling organizations and blind samples.
<b>Performance evaluation samples</b>	A sample submitted for analysis whose composition and concentration are known to the submitter but unknown to the analyst. Also known as a blind sample.
<b>Periphytometer</b>	Artificial substrate of known surface area used for collection of algae (specifically periphyton) over a known amount of time.
<b>Periphyton</b>	Aquatic algae attached to natural or artificial substrates.
<b>Practical quantitation limit</b>	The smallest concentration of an analyte that can be reported with an associated precision. DEP defines a practical quantitation limit as: $PQL = 4 \times MDL$ .
<b>Precision</b>	A measure of mutual agreement among individual measurements of a parameter or an analyte, usually under prescribed similar conditions. Precision is best expressed in terms of the standard deviation. Various measures of precision are used depending upon the "prescribed similar conditions".

## Glossary

<b>Project audit</b>	An independent review of all sampling and analytical documentation associated with a specific project or event in order to determine if the resulting data are valid and acceptable according to preestablished validation criteria and other data quality objectives. Enough documentation must be available so that a reviewer is able to reconstruct the history of a sample from time of sample collection (or sample container acquisition) through final results and sample disposal.
<b>Quality assurance</b>	The system of management activities and quality control procedures implemented to produce and evaluate data according to preestablished data quality objectives.
<b>Quality assurance plans</b>	An orderly assembly of detailed and specific procedures that delineates how data of known and accepted quality are produced.
<b>Quality assurance project plans</b>	A QA plan written for a specific project outlining data quality objectives, sampling and analytical protocols and QC measures needed to satisfy the intended uses of the data.
<b>Quality control</b>	The system of measurement activities used to document and control the quality of data so that it meets the needs of data users as specified by preestablished data quality objectives.
<b>Quality control check sample</b>	A sample obtained from an independent source for which the level of an analyte has been validated or certified. Also known as a reference material. The sample is prepared and analyzed with a sample set of similar matrix. If the sample has been obtained from the National Institute of Standards and Technology, it is referred to as a Standard Reference Material.
<b>Quality control check standards</b>	Certified and traceable standard solutions or purified materials from a source other than routine calibration standards used to check the accuracy of a calibration.
<b>Quality control checks</b>	Standards or known samples from an independent source that are analyzed at a specified frequency.
<b>Quantitative Bracket</b>	Standards used for calibration or calibration verification that encompass the range of environmental samples.
<b>Reagent blank</b>	An aliquot of analyte-free water or solvent that is analyzed with a sample set.
<b>Reagent spike</b>	Samples of an appropriate analyte-free matrix (deionized water, sand, soil, etc.) that are fortified to a known and validated concentration of analyte(s) before sample preparation and subsequent analysis.
<b>Reagent water</b>	A sample of water that conforms to ASTM grades II, III or IV.

## Glossary

<b>Replicate sample</b>	Samples that have been collected at the same time from the same source (field replicates) or aliquots of the same sample that are prepared and analyzed at the same time (laboratory replicates). Duplicate samples are one type of replicate sample. The analytical results from replicates are used to determine the precision of a system. If the concentration of analytes in the sample are below detectable limits, duplicate spike samples may be used to determine precision. Blind replicates (or duplicates) are replicates that have been collected (field replicates) or prepared (laboratory replicates) and are analyzed as separate samples whose replicate nature remains unknown to the analyst or organization.
<b>Representativeness</b>	Expresses the degree to which data for a sampled source accurately and precisely represent a characteristic or variation of the sampled source in terms of a measured analyte or parameter.
<b>Research quality assurance plan</b>	A quality assurance project plan written for research activities where non-standard procedures are used.
<b>Riparian buffer zone</b>	Land directly adjacent to a water body.
<b>Sample custody</b>	All records and documentation that trace sample possession, handling and associated supporting activities from the point of sample collection through transport, storage, processing, analysis and disposal of the sample.
<b>Sample matrix</b>	The natural or artificial medium from which a sample is collected. For the purposes of the DEP SOPs, a matrix is categorized in terms of the sample source and associated collection technique. See Table FA 1000-1.
<b>Sample matrix spike</b>	An environmental sample fortified to a known and validated concentration of analyte(s) before sample preparation and subsequent analysis.
<b>Sampling Kit</b>	A set of sampling accessories that has been assembled for a specified use or project. Examples of sampling accessories include: sample containers, sampling equipment, chemical preservatives, trip blanks, reagent transfer implements (e.g., disposable pipets), calibration standards, indicator papers (e.g., pH paper), reagents, etc.
<b>Screening study</b>	A study where a body of water is being surveyed for the presence of contaminants in the tissues of aquatic organisms without prior knowledge of their presence.
<b>Secchi disk</b>	A large round disk with an alternating black and white pattern used to determine visibility in lakes. The disk is lowered into the water column until the observer can no longer see the pattern.
<b>Sediment</b>	The unconsolidated solid matrix occurring immediately beneath any surface water body. The surface water body may be present part or all of the time.

## Glossary

<b>Spiked samples</b>	Any samples fortified with a known and validated concentration of analyte.
<b>Split samples</b>	Replicates of the same sample that are given to two independent laboratories for analysis.
<b>Stream order</b>	A method of classifying stream channels in a watershed. DEP uses Strahler's system where the uppermost channels (headwater streams with no tributaries) are considered first-order streams. The confluence of two first-order streams creates a second-order. Third-order streams start at the confluence of two second-order streams.
<b>Subsample</b>	Refers to any derivative obtained from a sample. Examples of subsamples include: aliquots, filtrates, digestates, eluates, fractions, extracts, reaction products, supernatants, etc.
<b>Surface water</b>	Includes fresh or saline waters from water bodies such as streams, canals, rivers, lakes, ponds, bays and estuaries (natural or manmade).
<b>Surrogate spikes</b>	Samples fortified with a compound having similar chemical characteristics to the analytes of interest, but which is not normally found in environmental samples. Known concentrations of these compounds are added to all samples in the set before sample preparation and subsequent analysis.
<b>System audit</b>	A qualitative on-site review and evaluation of a laboratory or field operation quality assurance system and physical facilities utilized for sampling, sample processing, calibration and measurement or analysis.
<b>Trip blank</b>	Trip blanks are only used for VOC samples. Blanks of VOC-free water are prepared by the organization providing sample containers for VOC collection. These blanks are transported to the site with the empty VOC sample containers and shipped to the analyzing laboratory in the same transport containers as the VOC samples. They remain unopened for the entire trip and are analyzed at the laboratory with the environmental VOC samples.
<b>Trophic level</b>	The different feeding relationships in an ecosystem that determine the route of energy flow and the pattern of chemical cycling.
<b>U.S. No. 30 mesh</b>	Standard U.S. 30 sieve size.
<b>Van Dorn bottle</b>	A water quality sampling device which allows for discrete water samples to be taken at various depths.
<b>Vascular plant</b>	A plant of higher order containing conducting tissues consisting primarily of xylem and phloem. These tissues are also known as vascular tissues.
<b>Wastewater</b>	Includes any influent or effluent associated with domestic or industrial waste treatment facilities.

## **FC 1000. CLEANING / DECONTAMINATION PROCEDURES**

### 1. PERFORMANCE CRITERIA

- 1.1. The cleaning/decontamination procedures must ensure that all equipment that contacts a sample during sample collection is free from the analytes of interest and constituents that would interfere with the analytes of interest.
- 1.2. The detergents and other cleaning supplies cannot contribute analytes of interest or interfering constituents unless these are effectively removed during a subsequent step in the cleaning procedure.
- 1.3. The effectiveness of any cleaning procedure (including all cleaning reagents) must be supported by equipment blanks with reported non-detected values.

The cleaning procedures outlined in this SOP are designed to meet the above-mentioned performance criteria. Alternative cleaning reagents or procedures may be used. However, the organization must be prepared to demonstrate through documentation (i.e., company-written protocols and analytical records) and historical data (i.e., absence of analytes of interest in equipment blanks) that it consistently meets these performance criteria. Field quality control measures (see FQ 1210) must support the use of alternative reagents or procedures.

### **FC 1001. *Cleaning Reagents***

Recommendations for the types and grades of various cleaning supplies are outlined below. The recommended reagent types or grades were selected to ensure that the cleaned equipment is free from any detectable contamination.

1. DETERGENTS: Use Luminox (or a non-phosphate solvent based equivalent), Liqui-Nox (or a non-phosphate equivalent) or Alconox (or equivalent). EPA recommends Luminox (or equivalent) since solvent rinses can be eliminated from the cleaning process. Liquinox (or equivalent) may be substituted (solvent rinses, when applicable, must be performed), and Alconox (or equivalent) may be substituted if the sampling equipment will not be used to collect phosphorus or phosphorus-containing compounds.

### 2. SOLVENTS

**Note: If the detergent Luminox (or equivalent) is used, solvent rinses are not required.**

- 2.1. Use pesticide grade isopropanol as the rinse solvent in routine equipment cleaning procedures. This grade of alcohol must be purchased from a laboratory supply vendor.
- 2.2. Other solvents, such as acetone or methanol, may be used as the final rinse solvent if they are pesticide grade. However, methanol is more toxic to the environment and acetone may be an analyte of interest for volatile organics.
  - 2.2.1. **Do not use** acetone if volatile organics are of interest.
- 2.3. Properly dispose of all wastes according to applicable regulations. Containerize all solvents (including rinsates) for on-site remediation or off-site disposal, as required.
- 2.4. Pre-clean equipment that is heavily contaminated (see FC 1120, section 3) with organic analytes with reagent grade acetone and hexane or other suitable solvents.
- 2.5. Use pesticide grade methylene chloride when cleaning sample containers.

2.6. Store all solvents away from potential sources of contamination (gas, copier supplies, etc.).

### 3. ANALYTE-FREE WATER SOURCES

3.1. Analyte-free water is water in which all analytes of interest and all interferences are below method detection limits.

3.2. Maintain documentation (such as results from equipment blanks) to demonstrate the reliability and purity of analyte-free water source(s).

3.3. The source of the water must meet the requirements of the analytical method and must be free from the analytes of interest. In general, the following water types are associated with specific analyte groups:

- Milli-Q (or equivalent polished water): suitable for all analyses.
- Organic-free: suitable for volatile and extractable organics.
- Deionized water: not suitable for volatile and extractable organics if the analytes of interest are present in concentrations that affect the result.
- Distilled water: not suitable for volatile and extractable organics, metals or ultra-trace metals.

3.4. Use analyte-free water for blank preparation and the final decontamination water rinse.

3.5. In order to minimize long-term storage and potential leaching problems, obtain or purchase analyte-free water just prior to the sampling event. If obtained from a source (such as a laboratory), fill the transport containers and use the contents for a single sampling event. Empty the transport container(s) at the end of the sampling event.

3.6. Discard any analyte-free water that is transferred to a dispensing container (such as a wash bottle) at the end of each sampling day.

### 4. ACIDS

4.1. Reagent Grade Nitric Acid: 10 - 15% (one volume concentrated nitric acid and five volumes deionized water).

4.1.1. Use for the acid rinse unless nitrogen components (e.g., nitrate, nitrite, etc.) are to be sampled.

4.1.2. If sampling for ultra-trace levels of metals, use an ultra-pure grade acid.

4.2. Reagent Grade Hydrochloric Acid: 10% hydrochloric acid (one volume concentrated hydrochloric and three volumes deionized water).

4.2.1. Use when nitrogen components are to be sampled.

4.3. If samples for both metals and the nitrogen-containing components (see FC 1001, section 4.1.1 above) are collected with the equipment, use the hydrochloric acid rinse, or thoroughly rinse with hydrochloric acid after a nitric acid rinse.

4.4. If sampling for ultra trace levels of metals, use an ultra-pure grade acid.

4.5. Freshly prepared acid solutions may be recycled during the sampling event or cleaning process. Dispose appropriately at the end of the sampling event, cleaning process or if acid is discolored or appears otherwise contaminated (e.g., floating particulates).

4.5.1. Transport only the quantity necessary to complete the sampling event.

- 4.6. Dispose of any unused acids according to FDEP and local ordinances.

**FC 1002.** *Reagent Storage Containers*

The contents of all containers must be clearly marked.

1. DETERGENTS: Store in the original container or in a high density polyethylene (HDPE) or polypropylene (PP) container.
2. SOLVENTS
  - 2.1. Store solvents to be used for cleaning or decontamination in the original container until use in the field. If transferred to another container for field use, the container must be either glass or Teflon.
  - 2.2. Use dispensing containers constructed of glass, Teflon, or stainless steel. Note: if stainless steel sprayers are used, any components (including gaskets and transfer lines) that contact the solvents must be constructed of inert materials.
3. ANALYTE-FREE WATER: Transport in containers appropriate to the type of water to be stored. If the water is commercially purchased (e.g., grocery store), use the original containers when transporting the water to the field. Containers made of glass, Teflon, polypropylene, or Polyethylene (PE) are acceptable.
  - 3.1. Use glass, Teflon, polypropylene or PE to transport organic-free sources of water on-site.
  - 3.2. Dispense water from containers made of glass, Teflon, PE or polypropylene.
  - 3.3. Do not store water in transport containers for more than three days before beginning a sampling event.
  - 3.4. Store and dispense acids using containers made of glass, Teflon, PE or polypropylene.

**FC 1003.** *General Requirements*

1. Before using any equipment, clean/decontaminate all sampling equipment (pumps, tubing, lanyards, split spoons, etc.) that are exposed to the sample.
  - 1.1. Before installing, clean (or obtain as certified precleaned) all equipment that is dedicated to a single sampling point and remains in contact with the sample medium (e.g., permanently installed groundwater pump (see FS 2220, section 3.3.4)).
  - 1.2. Clean this equipment any time it is removed for maintenance or repair.
  - 1.3. Replace dedicated tubing if discolored or damaged.
2. Clean all equipment in a designated area having a controlled environment (house, laboratory, or base of field operations) and transport to the field precleaned and ready to use, unless otherwise justified.
3. Rinse all equipment with water after use, even if it is to be field-cleaned for other sites. Rinse equipment used at contaminated sites or used to collect in-process (e.g., untreated or partially treated wastewater) samples immediately with water.
4. Whenever possible, transport sufficient clean equipment to the field so that an entire sampling event can be conducted without the need for cleaning equipment in the field.

5. Segregate equipment that is only used once (i.e., not cleaned in the field) from clean equipment and return to the in-house cleaning facility to be cleaned in a controlled environment.
6. Protect decontaminated field equipment (including well sounders) from environmental contamination by securely wrapping and sealing with one of the following:
  - 6.1. Aluminum foil (commercial grade is acceptable);
  - 6.2. Untreated butcher paper; or
  - 6.3. Clean, untreated, disposable plastic bags. Plastic bags may be used:
    - For all analyte groups except volatile and extractable organics;
    - For volatile and extractable organics, if the equipment is first wrapped in foil or butcher paper or if the equipment is completely dry.
7. Containerize all solvent rinsing wastes, detergent wastes and other chemical wastes requiring off-site or regulated disposal. Dispose of all wastes in conformance with applicable regulations.

## **FC 1100. Cleaning Sample Collection Equipment**

### **FC 1110. ON-SITE/IN-FIELD CLEANING**

1. Cleaning equipment on-site is not recommended because:
  - 1.1. Environmental conditions cannot be controlled.
  - 1.2. Wastes (solvents and acids) must be containerized for proper disposal.
2. If performed, follow the appropriate cleaning procedure as outlined in FC 1130. Ambient temperature water may be substituted in the hot, sudsy water bath, and hot water rinses.

**Note: Properly dispose of all solvents and acids.**

3. Rinse all equipment with water after use, even if it is to be field-cleaned for other sites. Rinse equipment used at contaminated sites or used to collect in-process (e.g., untreated or partially treated wastewater) samples immediately with water.

### **FC 1120. HEAVILY CONTAMINATED EQUIPMENT**

In order to avoid contaminating other samples, isolate heavily contaminated equipment from other equipment and thoroughly decontaminate the equipment before further use. Equipment is considered heavily contaminated if it:

- Has been used to collect samples from a source known to contain significantly higher levels than background;
  - Has been used to collect free product; or
  - Has been used to collect industrial products (e.g., pesticides or solvents) or their by-products.
1. Cleaning heavily contaminated equipment in the field is not recommended.
  2. ON-SITE PROCEDURES
    - 2.1. Protect all other equipment, personnel and samples from exposure by isolating the equipment immediately after use.

- 2.2. At a minimum, place the equipment in a tightly sealed untreated plastic bag.
  - 2.3. Do not store or ship the contaminated equipment next to clean, decontaminated equipment, unused sample containers, or filled sample containers.
  - 2.4. Transport the equipment back to the base of operations for thorough decontamination.
  - 2.5. If cleaning must occur in the field, and in order to document the effectiveness of the procedure, collect and analyze blanks on the cleaned equipment (see FQ 1000).
3. CLEANING PROCEDURES
- 3.1. If organic contamination cannot be readily removed with scrubbing and a detergent solution, prerinse equipment by thoroughly rinsing or soaking the equipment in acetone.
    - 3.1.1. Do not use solvent soaks or rinses if the material is clear acrylic.
    - 3.1.2. Use hexane only if preceded and followed by acetone.
  - 3.2. In extreme cases, it may be necessary to steam clean the field equipment before proceeding with routine cleaning procedures.
  - 3.3. After the solvent rinses (and/or steam cleaning), use the appropriate cleaning procedure (see FC 1130).
    - 3.3.1. Scrub, rather than soak all equipment with sudsy water.
    - 3.3.2. If high levels of metals are suspected and the equipment cannot be cleaned without acid rinsing, soak the equipment in the appropriate acid. Do not use stainless steel equipment when heavy metal contamination is suspected or present, since stainless steel cannot be exposed to prolonged acid soaks.
  - 3.4. If the field equipment cannot be cleaned utilizing these procedures, discard unless further cleaning with stronger solvents and/or oxidizing solutions is effective as evidenced by visual observation and blanks.
  - 3.5. Clearly mark or disable all discarded equipment to discourage use.

### **FC 1130. GENERAL CLEANING**

Follow these procedures when cleaning equipment under controlled conditions. See FC 1110 for modifications if cleaning is performed on-site. Check manufacturer's instructions for cleaning restrictions and/or recommendations.

### **FC 1131. Procedure for Teflon, Stainless Steel and Glass Sampling Equipment**

This procedure must be used when sampling for **ALL** analyte groups: extractable organics, metals, nutrients, etc. or if a single decontamination protocol is desired to clean all Teflon, stainless steel and glass equipment.

1. Rinse equipment with hot tap water.
2. Soak equipment in a hot, sudsy water solution (Liqui-Nox or equivalent - see FC 1001, section 1).
3. If necessary, use a brush to remove particulate matter or surface film.
4. Rinse thoroughly with hot tap water.

5. If samples for trace metals or inorganic analytes will be collected with the equipment and the equipment **is not** stainless steel, thoroughly rinse (wet all surfaces) with the appropriate acid solution (see FC 1001, section 4).
6. Rinse thoroughly with analyte-free water. Use enough water to ensure that all equipment surfaces are thoroughly flushed with water.
7. If samples for volatile or extractable organics will be collected, rinse with isopropanol. Wet equipment surfaces thoroughly with free-flowing solvent. Rinse thoroughly with analyte-free water (see FC 1001, section 3).
8. Allow to air dry. Wrap and seal according to FC 1003, section 6 as soon as the equipment is air-dried.
9. If isopropanol is used, the equipment may be air-dried without the final analyte-free water rinse (see FC 1131, section 8 above); however, **the equipment must be completely dry before wrapping or use.**
10. Wrap clean sampling equipment according to the procedure described in FC 1003, section 6.

**FC 1132.**     *General Cleaning Procedure for Plastic Sampling Equipment*

1. Rinse equipment with hot tap water.
2. Soak equipment in a hot, sudsy water solution (Liqui-Nox or equivalent - see FC 1001, section 1).
3. If necessary, use a brush to remove particulate matter or surface film.
4. Rinse thoroughly with hot tap water.
5. Thoroughly rinse (wet all surfaces) with the appropriate acid solution (see FC 1001, section 4).
6. Rinse thoroughly with analyte-free water. Use enough water to ensure that all equipment surfaces are thoroughly flushed with water. Allow to air dry as long as possible.
7. Wrap clean sampling equipment according to the procedure described in FC 1003, section 6.

**FC 1133.**     *Cleaning Procedure by Analyte Group*

See Table FC 1000-1 for the procedures to be used to decontaminate equipment based on construction of sampling equipment, and analyte groups to be sampled.

**FC 1140.**     **AUTOMATIC SAMPLERS, SAMPLING TRAINS AND BOTTLES**

1. When automatic samplers are deployed for extended time periods, clean the sampler using the following procedures when routine maintenance is performed. Inspect deployed samplers prior to each use. At a minimum, change the tubing if it has become discolored or has lost elasticity (FC 1140, section 2.3 below).
2. Clean all automatic samplers (such as ISCO) as follows:
  - 2.1. Wash the exterior and accessible interior portions of the automatic samplers (excluding the waterproof timing mechanisms) with laboratory detergent (see FC 1001, section 1) and rinse with tap water.

- 2.2. Clean the face of the timing case mechanisms with a clean, damp cloth.
- 2.3. Check all tubing (sample intake and pump tubing). Change the tubing every six months (if used frequently) or if it has become discolored (i.e., affected by mold and algae) or if it has lost its elasticity.
- 2.4. See FC 1160, section 4 for the procedures associated with cleaning the tubing in the pump head.
3. AUTOMATIC SAMPLER ROTARY FUNNEL AND DISTRIBUTOR
  - 3.1. Clean with hot sudsy water and a brush (see FC 1001, section 1 for appropriate detergent type).
  - 3.2. Rinse thoroughly with analyte-free water.
  - 3.3. Air dry.
  - 3.4. Replace in sampler.
4. SAMPLER METAL TUBE: Clean as outlined in FC 1160, section 5.
5. REUSABLE GLASS COMPOSITE SAMPLE CONTAINERS
  - 5.1. If containers are used to collect samples that contain oil, grease or other hard to remove materials, it may be necessary to rinse the container several times with reagent-grade acetone before the detergent wash. If material cannot be removed with acetone, discard the container.
  - 5.2. Wash containers following the procedure outlined in FC 1131 above. End with a final solvent rinse if organics are to be sampled.
  - 5.3. Invert containers to drain and air dry for at least 24 hours.
  - 5.4. Cap with aluminum foil, Teflon film or the decontaminated Teflon-lined lid.
  - 5.5. After use, rinse with water in the field, seal with aluminum foil to keep the interior of the container wet, and return to the laboratory or base of operations.
  - 5.6. **Do not recycle or reuse containers if:**
    - 5.6.1. They were used to collect in-process (i.e., untreated or partially treated) wastewater samples at industrial facilities;
    - 5.6.2. A visible film, scale or discoloration remains in the container after the cleaning procedures have been used; or
    - 5.6.3. The containers were used to collect samples at pesticide, herbicide or other chemical manufacturing facilities that produce toxic or noxious compounds. Such containers must be properly disposed of (preferably at the facility) at the conclusion of the sampling activities.
    - 5.6.4. If the containers described above are reused, check no less than 10% of the cleaned containers for the analytes of interest **before** use. If found to be contaminated, (i.e., constituents of interest are found at method detection levels or higher), then **discard the containers.**
6. REUSABLE PLASTIC COMPOSITE SAMPLE CONTAINERS
  - 6.1. Follow FC 1132.

- 6.2. Inspect the containers. Determine if the containers can be reused by the criteria in FC 1140, section 5 above.
7. GLASS SEQUENTIAL SAMPLE BOTTLES FOR AUTOMATIC SAMPLER BASED FOR SEQUENTIAL MODE
  - 7.1. Clean glass sequential sample bottles to be used for collecting inorganic samples by using a laboratory dishwasher (see FC 1140, sections 7.1.1 through 7.1.3 below) or manually following the procedures in FC 1131.
    - 7.1.1. Rinse with appropriate acid solution (see FC 1001, section 4).
    - 7.1.2. Rinse thoroughly with tap water.
    - 7.1.3. Wash in dishwasher at wash cycle, using laboratory detergent cycle, followed by tap and analyte-free water rinse cycles.
  - 7.2. Replace bottles in covered, automatic sampler base; cover with aluminum foil for storage.
  - 7.3. Rinse bottles in the field with water as soon as possible after sampling event.
8. Glass Sequential Sample Bottles (Automatic Sampler based for Sequential Mode) to be used for Collecting Samples for Organic Compounds
  - 8.1. Use cleaning procedures outlined in FC 1131. Allow containers to thoroughly air dry before use.
  - 8.2. Replace bottles in covered, automatic sampler base; cover with aluminum foil for storage.
9. BOTTLE SIPHONS USED TO TRANSFER SAMPLES FROM COMPOSITE CONTAINERS
  - 9.1. Rinse tubing with solvent and dry overnight in a drying oven.
  - 9.2. Cap ends with aluminum foil and/or Teflon film for storage.
  - 9.3. Seal in plastic for storage and transport.
  - 9.4. Flush siphon thoroughly with sample before use.
10. REUSABLE TEFLON COMPOSITE MIXER RODS
  - 10.1. Follow procedures outlined in FC 1131.
  - 10.2. Wrap in aluminum foil for storage.

## **FC 1150. FILTRATION EQUIPMENT**

1. Dissolved Constituents using in-line, Molded and Disposable Filter Units
  - 1.1. Peristaltic Pump
    - 1.1.1. Clean the pump following procedures in FC 1170, section 2.2.
    - 1.1.2. Clean the pump head tubing following FC 1160, section 4.
    - 1.1.3. If Teflon tubing is used, clean following the procedures in FC 1160, section 3.
    - 1.1.4. Clean other tubing types such as polyethylene according to the appropriate procedures listed in FC 1160, section 7.
  - 1.2. Other Equipment Types (e.g., pressurized Teflon bailer)

- 1.2.1. Follow the appropriate cleaning regimen specified in FC 1131 through FC 1132 for other types of equipment that utilize in-line, molded and disposable filters.
2. Dissolved Constituents using Non-disposable Filtration Units (e.g., syringes, "tripod assembly")
  - 2.1. Stainless Steel or Glass Units
    - 2.1.1. Follow FC 1131, assembling and applying pressure to the apparatus after each rinse step (water and acid) to drive rinsing solution through the porous filter holder in the bottom of the apparatus.
    - 2.1.2. Remove and clean any transfer tubing according to the appropriate cleaning procedures (see FC 1160).
    - 2.1.3. Assemble the unit and cap both the pressure inlet and sample discharge lines (or whole unit if a syringe) with aluminum foil to prevent contamination during storage.
    - 2.1.4. If the unit will **not** be used to filter volatile or extractable organics, seal the unit in an untreated plastic bag to prevent contamination.
  - 2.2. Reusable In-Line Filter Holders
    - 2.2.1. Clean, using FC 1131, (if Teflon, glass or stainless steel) or FC 1132 (if plastic) assembling and applying pressure to the apparatus after each rinse step (water and acid) to drive rinsing solution through the porous filter holder in the bottom of the apparatus.
    - 2.2.2. Assemble the unit and wrap with aluminum foil to prevent contamination during storage.
    - 2.2.3. If the unit will **not** be used to filter volatile or extractable organics, seal the unit in an untreated plastic bag to prevent contamination.
3. FILTERS
  - 3.1. Do not clean filters. Instructions for rinsing the filters prior to use are discussed in the applicable sampling SOPs (FS 2000 - FS 8000).

## **FC 1160. SAMPLE TUBING DECONTAMINATION**

1. Check tubing:
  - 1.1. For discoloration: Remove discolored tubing from use until it can be cleaned. If the discoloration cannot be removed, discard the tubing.
  - 1.2. For elasticity (if used in a peristaltic-type pump): Discard any tubing that has lost its elasticity.
2. Transport all tubing to the field in precut, **precleaned** sections.
3. TEFLON, POLYETHYLENE AND POLYPROPYLENE TUBING
  - 3.1. New Tubing: Follow this procedure unless the manufacturer/supplier provides certification that the tubing is clean.
    - 3.1.1. Teflon
      - 3.1.1.1. Rinse outside of tubing with pesticide-grade solvent (see FC 1001, section 2).

- 3.1.1.2. Flush inside of tubing with pesticide-grade solvent.
- 3.1.1.3. Dry overnight in drying oven or equivalent (zero air, nitrogen, etc.).

3.1.2. Polyethylene and Polypropylene

- 3.1.2.1. Clean the exterior and interior of the tubing by soaking in hot, sudsy water.
- 3.1.2.2. Thoroughly rinse the exterior and interior of the tubing with tap water, followed by analyte-free water.

3.2. Reused Tubing

Use the following procedure for in-lab cleaning. **Field cleaning is not recommended:**

- 3.2.1. Clean the exterior of the tubing by soaking in hot, sudsy water (see FC 1001, section 1) in a stainless steel sink (or equivalent non-contaminating material). Use a brush to remove any particulates, if necessary.
- 3.2.2. Use a small bottle brush and clean the inside of the tubing ends where the barbs are to be inserted or cut 1-2 inches from the ends of the tubing after cleaning.
- 3.2.3. Rinse tubing exterior and ends liberally with tap water.
- 3.2.4. Rinse tubing surfaces and ends with the appropriate acid solution (see FC 1001, section 4), tap water, isopropanol (see FC 1001, section 2), and finally analyte-free water.
  - 3.2.4.1. Note: Eliminate the isopropanol rinse for polyethylene or polypropylene tubing.
- 3.2.5. Place tubing on fresh aluminum foil or clean polyethylene sheeting. Connect all of the precut lengths of tubing with Teflon inserts or barbs.
- 3.2.6. Cleaning configuration:
  - 3.2.6.1. Place cleaning reagents: [sudsy water (see FC 1001, section 1); acid (see FC 1001, section 4); isopropanol (see FC 1001, section 2)] in an appropriately cleaned container (2-liter glass jar is recommended).
  - 3.2.6.2. Place one end of the Teflon tubing into the cleaning solution.
  - 3.2.6.3. Attach the other end of the Teflon tubing set to the influent end of a pump.
  - 3.2.6.4. Recycle the effluent from the pump by connecting a length of Teflon tubing from the effluent to the glass jar with the cleaning reagents.
  - 3.2.6.5. Recycling as described above may be done for all reagents listed in FC 1160, section 3.2.6.1 above, **except** the final isopropanol rinse and the final analyte-free water rinse. Disconnect the tubing between the effluent end of the pump and the jar of cleaning reagents.
  - 3.2.6.6. Containerize isopropanol in a waste container for proper disposal.
  - 3.2.6.7. Analyte-free water may be discarded down the drain.
- 3.2.7. Using the above configuration described in FS 1160, section 3.2.6 above:
  - 3.2.7.1. Pump hot, sudsy water through the connected lengths. Allow the pump to run long enough to pump at least three complete tubing volumes through the tubing set.

3.2.7.2. Using the same procedure, successively pump tap water, the acid solution(s), tap water, isopropanol, and finally analyte-free water through the system.

3.2.7.3. Leave the Teflon inserts or barbs between the precut lengths and cap or connect the remaining ends.

3.2.8. After the interior has been cleaned as described in FC 1160, section 3.2.7 above, rinse the exterior of the tubing with analyte-free water.

3.2.9. Wrap the connected lengths in aluminum foil or untreated butcher paper and store in a clean, dry area until use.

#### 4. Flexible Tubing used in Pump Heads of Automatic Samplers and other Peristaltic Pumps

Replace tubing after each sampling point if samples are collected through the tubing. Unless the pump is deployed to collect samples from the same location over a long period of time, remove and wash the tubing after each sampling event (see FC 1140, section 1).

4.1. Flush tubing with hot tap water then sudsy water (see FC 1001, section 1).

4.2. Rinse thoroughly with hot tap water.

4.3. Rinse thoroughly with analyte-free water.

4.4. If used to collect metals samples, flush the tubing with an appropriate acid solution (see FC 1001, section 4), followed by thorough rinsing with analyte-free water. If used to collect both metals and nitrogen components use hydrochloric acid (see FC 1001, section 4.1.1).

4.5. Install tubing in peristaltic pump or automatic sampler.

4.6. Cap both ends with aluminum foil or equivalent.

**Note: Change tubing at specified frequencies as part of routine preventative maintenance.**

#### 5. STAINLESS STEEL TUBING

Clean the exterior and interior of stainless steel tubing as follows:

5.1. Using sudsy water (see FC 1001, section 1), scrub the interior and exterior surfaces.

5.2. Rinse with hot tap water.

5.3. Rinse with analyte-free water.

5.4. If volatile or extractable organics are to be sampled, rinse all surfaces with isopropanol (see FC 1001, section 2). Use enough solvent to wet all surfaces with free flowing solvent.

5.5. Allow to air dry or thoroughly rinse with analyte-free water.

#### 6. GLASS TUBING

6.1. Use new glass tubing.

6.2. If volatile or extractable organics are to be sampled, rinse with isopropanol (see FC 1001, section 2).

6.3. Air dry for at least 24 hours.

6.4. Wrap in aluminum foil or untreated butcher paper to prevent contamination during storage.

6.5. Discard tubing after use.

7. MISCELLANEOUS NON-INERT TUBING TYPES (TYGON, RUBBER, PVC, ETC.)

7.1. New Tubing

7.1.1. As a general rule, new tubing may be used without preliminary cleaning.

7.1.2. Protect new tubing from potential environmental contamination by wrapping in aluminum foil and sealing in untreated plastic bags or keep in the original sealed packaging until use.

7.1.3. If new tubing is exposed to potential contamination, rinse the exterior and interior tubing surfaces with hot tap water followed by a thorough rinse with analyte-free water.

7.1.4. If new tubing is to be used to collect samples, thoroughly rinse the tubing with sample water (i.e., pump sample water through the tubing) before collecting samples.

7.2. Reused Tubing

7.2.1. Flush tubing with sudsy solution of hot tap water and laboratory detergent (see FC 1001, section 1).

7.2.2. Rinse exterior and interior thoroughly with hot tap water.

7.2.3. Rinse exterior and interior thoroughly with analyte-free water.

7.2.4. If used to collect only metals samples, flush the tubing with nitric acid (see FC 1001, section 4.1), followed by a thorough rinse with analyte-free water.

7.2.5. If used to collect metals and nitrogen-containing compounds, see FC 1001, section 4.3.

7.2.6. Cap ends in aluminum foil and store in clean, untreated plastic bags to prevent contamination during storage and transport.

**FC 1170. PUMPS**

1. SUBMERSIBLE PUMPS

1.1. Pumps used for Purging and Sampling Metals and/or Volatile and Extractable Organics

1.1.1. Construction of pump body and internal mechanisms (bladders, impellers, etc.), including seals and connections, must follow Tables FS 1000-1, FS 1000-2 and FS 1000-3.

1.1.2. Tubing material must follow Tables FS 1000-1, FS 1000-2 and FS 1000-3.

1.1.3. Clean pump exterior following FC 1132. Note: omit the solvent rinse if the pump body is constructed of plastic (e.g., ABS, PVC, etc.).

1.1.4. Clean the pump internal cavity and mechanism as follows:

1.1.4.1. If used only for purging, thoroughly flush the pump with water before purging the next well.

1.1.4.2. When used for purging and sampling, completely disassemble the pump (if practical) and decontaminate between each well.

1.1.4.3. When used for purging and sampling and the pump cannot be (practicably) disassembled, then clean the internal cavity/mechanism by pumping

several gallons of sudsy water (see FC 1001, section 1), followed by several gallons of tap water, and finally, several gallons of analyte-free water.

1.1.4.4. If multiple sampling points are located in an area that is not accessible by a vehicle, and it is difficult to return to the vehicle for cleaning or to transport all cleaning materials to the staging location, at a minimum thoroughly rinse the pump with water.

1.1.5. Refer to FC 1160, section 3 to clean Teflon tubing.

1.1.6. Refer to FC 1160, section 5 for stainless steel tubing.

1.1.7. Clean other types of tubing according to FC 1160, sections 6 and 7.

1.2. Pumps used for Purging and Sampling all Analytes except Metals, Volatile and Extractable Organics

1.2.1. Pump construction: no restrictions.

1.2.2. Pump tubing material: no restrictions.

1.2.3. Scrub the exterior of the pump with appropriate metal-free, phosphate-free or ammonia-free detergent solution.

1.2.4. Rinse the exterior with tap water and analyte-free water.

1.2.5. Rinse the interior of the pump and tubing by pumping tap or analyte-free water through the system using a clean bucket or drum.

2. ABOVE-GROUND PUMPS USED FOR PURGING AND SAMPLING

2.1. Pumps used only for Purging

2.1.1. The exterior of the pump must be free of oil and grease.

2.1.2. Select tubing according to Tables FS 1000-1, FS 1000-2 and FS 1000-3.

2.1.3. Clean the tubing that contacts the formation water according to the appropriate protocol for construction materials specified in FC 1160.

2.2. Pumps used for Sampling

2.2.1. Clean the exterior of the pump with a detergent solution followed by a tap water rinse. Use clean cloths or unbleached paper towels that have been moistened with the appropriate solution to wipe down the pump.

2.2.2. Select tubing according to Tables FS 1000-1, FS 1000-2 and FS 1000-3.

2.2.3. Clean the tubing that contacts the formation water according to the appropriate protocol for construction materials specified in FC 1160.

**FC 1180. ANALYTE-FREE WATER CONTAINERS**

This section pertains to containers that are purchased to transport, store and dispense analyte-free water. It does not apply to water that has been purchased in containers. See FC 1002, section 3 for appropriate construction materials.

1. NEW CONTAINERS

1.1. Wash containers and caps according to FC 1131, omitting the solvent rinse if plastic (polyethylene or polypropylene) containers are being cleaned.

1.2. Cap with Teflon film or the bottle cap. The bottle cap must be composed of the same material as the container and cannot be lined.

2. REUSED CONTAINERS

2.1. Immediately after emptying, cap with aluminum foil, Teflon film or the container cap.

2.2. Wash the exterior of the container with lab-grade detergent solution (see FC 1001, section 1) and rinse with analyte-free water.

2.3. Rinse the interior thoroughly with analyte-free water.

2.4. Invert and allow to drain and dry.

**FC 1190. ICE CHESTS AND SHIPPING CONTAINERS**

1. Wash the exterior and interior of all ice chests with laboratory detergent (see FC 1001, section 1) after each use.

2. Rinse with tap water and air dry before storing.

3. If the ice chest becomes severely contaminated with concentrated waste or other toxic or hazardous materials clean as thoroughly as possible, render unusable, and properly dispose.

**FC 1200. Field Instruments and Drilling Equipment**

**FC 1210. FIELD INSTRUMENTS (TAPES, METERS, ETC.)**

Follow manufacturer's recommendations for cleaning instruments. At a minimum:

1. Wipe down equipment body, probes, and cables with lab-grade detergent solution (see FC 1001, section 1). Check manufacturer's instructions for recommendations and/or restrictions on cleaning.

2. Rinse thoroughly with tap water.

3. Rinse thoroughly with analyte-free water.

4. Store equipment according to the manufacturer's recommendation or wrap equipment in aluminum foil, untreated butcher paper or untreated plastic bags to eliminate potential environmental contamination.

**FC 1220. SOIL BORING EQUIPMENT**

This section pertains only to equipment that is not used to collect samples. Clean split spoons, bucket augers and other sampling devices according to FC 1131.

1. Remove oil, grease, and hydraulic fluid from the exterior of the engine and power head, auger stems, bits and other associated equipment with a power washer or steam jenny or wash by hand with a brush and sudsy waster (no degreasers).

2. Rinse thoroughly with tap water.

**FC 1230. WELL CASING CLEANING**

These are recommended procedures for cleaning well casing and riser pipes. Use procedures specified by a FDEP contract, order, permit, or rule, if different or more stringent than the procedures outlined below.

1. FDEP recommends only using casing that is designed for subsurface environmental groundwater monitoring.
2. Casing that has been contaminated with grease, hydraulic fluid, petroleum fuel, etc. may require additional cleaning or deemed unusable.
3. All casings and riser pipes should be cleaned before installation, unless the casing is received wrapped and ready for installation:
  - 3.1. Steam clean all casings and riser pipes except PVC. Steam cleaning criteria shall meet the following: water pressure - 2500 psi; water temperature - 200°F.
  - 3.2. Rinse thoroughly with tap (potable) water. This tap water must be free of the analytes of interest.

## **FC 1300. Sample Containers**

### **FC 1310. OBTAINING CLEAN CONTAINERS**

1. Obtain clean sample containers in one of three ways:
  - 1.1. From commercial vendors as precleaned containers. The cleaning grades must meet EPA analyte specific requirements. Keep all records for these containers (lot numbers, certification statements, date of receipt, etc.) and document the container's intended uses;
  - 1.2. From internal groups within the organization that are responsible for cleaning and maintaining containers according to the procedures outlined in FC 1320; or
  - 1.3. From a subcontracted laboratory that is accredited under the National Environmental Laboratory Accreditation Program (NELAP).
    - 1.3.1. The contractor must verify that the laboratory follows the container cleaning procedures outlined in FC 1320.
    - 1.3.2. If the laboratory cleaning procedures are different, the contractor must require that the laboratory use the following cleaning procedures or provide documentation and historical records to show that their in-house procedure produces containers that are free from the analytes of interest.

### **FC 1320. CONTAINER CLEANING PROCEDURES**

1. Refer to Table FC 1000-2. Follow the cleaning steps in the order specified in the chart.
2. Cleaning procedures that are different from those outlined in FC 1320 may be used as long as blanks collected in the containers are free from the analytes of interest and any analytical interferences and the cleaning procedures are supported by historical and continuing documentation.
3. Inspect all containers before cleaning.
  - 3.1. **Do not recycle or reuse containers if:**
    - 3.1.1. Containers were used to collect in-process (i.e., untreated or partially treated) wastewater samples at industrial facilities;
    - 3.1.2. A visible film, scale or discoloration remains in the container after the cleaning procedures have been used; or

3.1.3. Containers were used to collect samples at pesticide, herbicide or other chemical manufacturing facilities that produce toxic or noxious compounds. Such containers shall be properly disposed of (preferably at the facility) at the conclusion of the sampling activities.

3.1.4. If the containers described above are reused, check no less than 10% of the cleaned containers for the analytes of interest before use. If found to be contaminated (i.e., analytes of interest are found at MDL levels or higher), discard the containers.

## **FC 1400. Documentation**

Document cleaning procedures described below for the indicated activities. See FD 1000 for additional information about required records and retention of documents.

### **FC 1410. FIELD EQUIPMENT**

#### 1. IN-FIELD CLEANING

1.1. Initially identify the procedures that are used to clean equipment in the field by SOP numbers and dates of usage.

1.2. Record the date and time that equipment was cleaned.

#### 2. IN-HOUSE CLEANING

2.1. Retain any cleaning certificates, whether from a laboratory or commercial vendor.

2.2. Identify the procedure(s) that are used to clean equipment by the SOP number and dates of usage.

2.3. Record the date that the equipment was cleaned.

### **FC 1420. SAMPLE CONTAINERS**

1. Organizations that order precleaned containers must retain the packing slips, and lot numbers of each shipment, any certification statements provided by the vendor and the vendor cleaning procedures.

2. Organizations that clean containers must maintain permanent records of the following:

2.1. Procedure(s) used to clean containers by SOP number and dates of usage.

2.2. If containers are certified clean by the laboratory the laboratory must record:

- Type of container;
- Date cleaned;
- SOP used;
- Person responsible for cleaning;
- Lot number (date of cleaning may be used) of the batch of containers that were cleaned using the same reagent lots and the same procedure;
- The results of quality control tests that were run on lot numbers; and
- Any additional cleaning or problems that were encountered with a specific lot.

**FC 1430. REAGENTS AND OTHER CLEANING SUPPLIES**

Maintain a record of the lot number with the inclusive dates of use for all acids, solvents, and other cleaning supplies.

**Appendix FC 1000**  
**Tables, Figures and Forms**

Table FC 1000-1 Procedures for Decontamination at the Base of Operations or On-site

Table FC 1000-2 Container Cleaning Procedures

**Table FC 1000-1  
Procedures for Decontamination at the Base of Operations or On-Site**

Construction Material	Analyte Group Sampled	SOP Reference	Base of Operations	On-Site
Teflon or Glass	All	FC 1131	Follow as written	May substitute ambient temperature water for the hot water rinses and hot detergent solution
	Extractable & Volatile Organics Petroleum Hydrocarbons		May omit acid rinse	May substitute ambient temperature water for the hot water rinses and hot detergent solution May omit acid rinse
	Metals Radionuclides For ultra trace metals, refer to FS 8200		May omit solvent rinse	May substitute ambient temperature water for the hot water rinses and hot detergent solution May omit solvent rinse
	Inorganic Nonmetallics Physical & Aggregate Properties Aggregate Organics Biologicals Volatile Inorganics		May omit solvent rinse	Rinse several times with water Rinse several times with sample water from the next sampling location
	Microbiological – Viruses Microbiological - Bacteria		Omit solvent and acid rinses	Rinse several times with water Rinse several times with sample water from the next sampling location
Metallic (stainless steel, brass, etc.)	All	FC 1131	Omit the acid rinse	May substitute ambient temperature water for the hot water rinses and hot detergent solution Omit the acid rinse
	Extractable & Volatile Organics Petroleum Hydrocarbons		Omit the acid rinse May omit the solvent rinse	May substitute ambient temperature water for the hot water rinses and hot detergent solution Omit the acid rinse May omit the solvent rinse
	Metals Radionuclides		Omit solvent rinse May omit the acid rinse	Rinse several times with water Rinse several times with sample water from the next sampling location
	Inorganic Nonmetallics Physical & Aggregate Properties Aggregate Organics Biologicals Volatile Inorganics			

**Table FC 1000-1  
Procedures for Decontamination at the Base of Operations or On-Site**

<b>Construction Material</b>	<b>Analyte Group Sampled</b>	<b>SOP Reference</b>	<b>Base of Operations</b>	<b>On-Site</b>
	Microbiological – Viruses Microbiological - Bacteria		Omit solvent and acid rinses	Rinse several times with water Rinse several times with sample water from the next sampling location
Plastic (Polyethylene, polypropylene, PVC, silicone, acrylic	Volatile and Extractable Organics;	FC 1132	Follow as written.	May substitute ambient temperature water for the hot water rinses and hot detergent solution
	Inorganic Nonmetallics Physical & Aggregate Properties		May omit the acid rinse	Rinse several times with water Rinse several times with sample water from the next sampling location
	Aggregate Organics Biologicals Volatile Inorganics		Omit acid rinse	Rinse several times with water Rinse several times with sample water from the next sampling location
	Microbiological – Viruses Microbiological - Bacteria			Rinse several times with water Rinse several times with sample water from the next sampling location

<sup>1</sup> Do not use glass if collecting samples for boron or silica.

**Table FC 1000-2  
 Container Cleaning Procedures**

ANALYSIS / ANALYTE GROUP	CLEANING STEPS See Description Below
Extractable Organics	1, 2, 4, 6 (not required if Luminox (or equivalent is used), (5 and 7 optional), 11
Volatile Organics	1, 2, 4, (6 optional, methanol only), 7
Metals	1, 2, 3, 4, 8, 11 ** **Procedures to clean containers for ultra-trace metals are found in FS 8200
Inorganic Nonmetallics, Radionuclides, Physical and Aggregate Properties, Aggregate Inorganics, and Volatile Inorganics	1, 2, 3*, 4, 8, 11 * For nutrients, replace nitric acid with hydrochloric acid, or use a hydrochloric acid rinse after the nitric acid rinse. See FC 1001, section 4
Petroleum Hydrocarbons, and Oil and Grease	1, 2, 3, 4, (5, 6, 7 optional), 11
Microbiological (all)	1, 2, 4, 8, 9, 11
Toxicity Tests (Includes Bioassays)	1, 2, 10, 2, 4, 6.1, (10 optional), 11

**NOTE:** Steps 1 and 2 may be omitted when cleaning new, uncertified containers.

1. Wash with hot tap water and a brush using a suitable laboratory-grade detergent:
  - 1.1. Volatile and Extractable Organics, Petroleum Hydrocarbon, Oil and Grease: Luminox, Liqui-Nox, Alconox or equivalent;
  - 1.2. Inorganic nonmetallics: Liqui-Nox or equivalent;
  - 1.3. Metals: Liqui-Nox, Acationox, Micro or equivalents;
  - 1.4. Microbiologicals (all): Must pass an inhibitory residue test.
2. Rinse thoroughly with hot tap water.
3. Rinse with 10% nitric acid solution.
4. Rinse thoroughly with analyte-free water (deionized or better).
5. Rinse thoroughly with pesticide-grade methylene chloride.
6. Rinse thoroughly with pesticide-grade isopropanol, acetone or methanol.
  - 6.1. For bioassays, use only acetone, and only when containers are glass.
7. Oven dry at 103°C to 125°C for at least 1 hour.

**Table FC 1000-2**  
**Container Cleaning Procedures**

- 7.1. VOC vials and containers must remain in the oven in a contaminant-free environment until needed. They should be capped in a contaminant-free environment just prior to dispatch to the field.
8. Invert and air-dry in a contaminant-free environment.
9. Sterilize containers:
  - 9.1. Plastic: 60 min at 170°C, loosen caps to prevent distortion.
  - 9.2. Glass: 15 min at 121°C.
10. Rinse with 10% hydrochloric acid followed by a sodium bicarbonate solution.
11. Cap tightly and store in a contaminant-free environment until use. Do not use glass if collecting samples for boron or silica.

## ***FD 1000. DOCUMENTATION PROCEDURES***

### 1. INTRODUCTION:

1.1. For the creation of clear, accurate and methodical records to document all field activities affecting sample data, implement the following standard operating procedures for sample collection, sample handling and field-testing activities.

### 2. SCOPE AND APPLICABILITY

2.1. This SOP provides a detailed listing of the information required for documentation of all sampling procedures and field testing.

2.2. Refer to the associated sampling or field testing SOP for any requirements for the chronological or sequential documentation of data.

### 3. QUALITY ASSURANCE

3.1. Implement review procedures to monitor and verify accurate manual and automated data entry and recordkeeping for all documentation tasks outlined in this SOP.

## **FD 1100. Universal Documentation Requirements**

Incorporate efficient archival design and concise documentation schemes for all record systems. Ensure that the history of a sample is clearly evident in the retained records and documentation and can be independently reconstructed.

### 1. CRITERIA FOR ALL DOCUMENTS

1.1. Keep all applicable documentation available for inspection. Keep all original data and records as well as reduced or manipulated forms of the original data or records.

1.1.1. Authorized representatives of DEP have the legal right to inspect and request copies of any records using paper, electronic media, or other media during any DEP audit of physical facilities or on-site sampling events, and for any data validations conducted for applicable project data submitted to DEP.

1.2. Record enough information so that clarifications, interpretations, or explanations of the data are not required from the originator of the documentation.

1.3. Clearly indicate the nature and intent of all documentation and all record entries.

1.4. Link citations to SOPs and other documents by the complete name, reference or publication number, revision number, and revision date for the cited document, when applicable. Also assign this information to internally generated SOPs.

1.5. Retain copies of all revisions of all cited documents as part of the documentation archives.

### 2. PROCEDURES

2.1. Sign, initial or encode all documentation entries made to paper, electronic or other records with a link indicating the name and responsibility of the author making the data entry, clearly indicating the reason for the signature, initials or code (e.g., "sampled by"; "released by"; "prepared by"; "reviewed by").

2.2. In order to abbreviate record entries, make references to procedures written in internal SOPs or methodology and procedures promulgated by external sources.

DEP-SOP-001/01  
FD 1000 Documentation Procedures

2.2.1. Document the intent to use SOPs other than the DEP SOPs, or to use allowable modifications to the DEP SOPs by recording the effective date of use for all such SOPs or modifications.

2.2.1.1. Retain any correspondence with DEP regarding approval to use alternative procedures for any projects.

2.2.2. Authorize all internal SOPs with the signatures of the quality assurance officer(s) and manager(s) responsible for implementation of the SOPs. Record the dates of signature.

2.3. Employ straightforward archiving of records to facilitate documentation tracking and retrieval of all current and archived records for purposes of inspection, verification, and historical reconstruction of all procedures and measurement data.

2.4. Keep copies or originals of all documentation, including documentation sent to or received from external parties.

2.5. Use waterproof ink for all paper documentation.

2.6. Do not erase or obliterate entry errors on paper records. Make corrections by marking a line through the error so that it is still legible. Initial or sign the marked error and its correction.

2.7. Maintain electronic audit trails for all edited electronic records, if possible. Utilize software that allows tracking of users and data edits, if available. Software that prompts the user to double-check edits before execution is also preferred. See FD 1200.

2.8. Clearly link all documentation associated with a sample or measurement. Make cross-references to specific documentation when necessary.

2.9. Link final reports, data summaries, or other condensed versions of data to the original sample data, including those prepared by external parties.

### 3. RETENTION REQUIREMENTS

3.1. Per the DEP QA Rule, 62-160.220 & .340, F.A.C., keep all documentation archives for a minimum of 5 years after the date of project completion or permit cycle unless otherwise specified in a Department contract, order, permit, or Title 62 rules.

## **FD 1200. Electronic Documentation**

Handle electronic (digital) data as with any data according to applicable provisions of FD 1100.

### 1. RETENTION OF AUTOMATIC DATA RECORDING PRODUCTS

1.1. For data not directly read from the instrument display and manually recorded, retain all products or outputs from automatic data recording devices, such as strip chart recorders, integrators, data loggers, field measurement devices, computers, etc. Store records in electronic, magnetic, optical, or paper form, as necessary.

1.1.1. Retain all original, raw output data. Ensure archiving of these data prior to subsequent reduction or other manipulation of the data.

1.2. Identify output records as to purpose, analysis date and time, field sample identification number, etc. Maintain clear linkage with the associated sample, other data source or measured medium and specific instrument used to make the measurement.

### 2. ELECTRONIC DATA SECURITY

DEP-SOP-001/01  
FD 1000 Documentation Procedures

- 2.1. Control levels of access to electronic data systems as required to maintain system security and to prevent unauthorized editing of data.
  - 2.2. Do not alter raw instrumentation data or original manual data records in any fashion without retention of the original raw data.
  - 2.3. Maintain secure computer networks and appropriate virus protection as warranted for each system design.
3. ELECTRONIC DATA STORAGE AND DOCUMENTATION
- 3.1. Store all electronic, magnetic, and optical media for easy retrieval of records.
    - 3.1.1. Ensure that all records can be printed to paper if needed for audit or verification purposes.
    - 3.1.2. If it is anticipated that the documentation archive will become unreadable due to obsolescence of a particular storage technology, retain a paper archive of the data or transfer to other suitable media.
  - 3.2. For easy retrieval of records, link all stored data to the associated sample data or other data source.
  - 3.3. Back up all data at a copy rate commensurate with the level of vulnerability of the data. Consider replicating all original data as soon as possible after origination.
4. SOFTWARE VERIFICATION
- 4.1. Ensure that any software used to perform automatic calculations conforms to required formulas or protocols.
  - 4.2. Document all software problems and their resolution in detail, where these problems have irretrievably affected data records or linkage. Record the calendar date, time, responsible personnel, and relevant technical details of all affected data and software files. Note all software changes, updates, installations, etc. per the above concerns. File and link all associated service records supplied by vendors or other service personnel.
5. PROTECTION OF EQUIPMENT AND STORAGE MEDIA
- 5.1. Place stationary computers, instrumentation, and peripheral devices in locations of controlled temperature and humidity and away from areas where the potential for fluid leaks, fire, falling objects, or other hazards may exist. In the field, protect portable equipment from weather, excess heat or freezing, storage in closed vehicles, spillage from reagents and samples, etc.
  - 5.2. Protect storage media from deteriorating conditions such as temperature, humidity, magnetic fields, or other environmental hazards as above.
6. ELECTRONIC SIGNATURES – Documents signed with electronic signatures must be consistent with the requirements of 62-160.405, F.A.C.:
- 6.1. the integrity of the electronic signature can be assured;
  - 6.2. the signature is unique to the individual;
  - 6.3. the organization using electronic signatures has written policies for the generation and use of electronic signatures; and
  - 6.4. the organization using electronic signatures has written procedures for ensuring the security, confidentiality, integrity and auditability of each signature.

## **FD 1300. Documentation Using Other Media**

### 1. UNIVERSAL REQUIREMENTS

1.1. Handle documentation prepared using other media according to FD 1100.

### 2. PROTECTION OF STORED MEDIA

2.1. Store media such as photographs, photographic negatives, microfilm, videotape, etc. under conditions generally prescribed for these media by manufacturers and conducive to long-term storage and protection from deterioration. See also FD 1200, section 5, above.

## ***FD 2000. DOCUMENTATION OF CLEANED EQUIPMENT, SAMPLE CONTAINERS, REAGENTS AND SUPPLIES***

When providing sample containers, preservation reagents, analyte-free water or sampling equipment, document certain aspects of these preparations.

### 1. EQUIPMENT CLEANING DOCUMENTATION

1.1. Document all cleaning procedures by stepwise description in an internal SOP if cleaning procedures in the DEP SOP have been modified for use. Alternatively, cite the DEP SOP procedures in the cleaning record for the applicable equipment.

1.2. Record the date of cleaning.

1.2.1. If items are cleaned in the field during sampling activities for a site, document the date and time when the affected equipment was cleaned. Link this information with the site and the cleaning location at the site.

1.3. Retain or make accessible any certificates of cleanliness issued by vendors supplying cleaned equipment or sample containers.

1.3.1. Retain from the vendor or document for internal cleaning the following information for sample containers, as applicable:

- Packing slip and cleanliness certificates from vendors
- Container types and intended uses
- Lot numbers or other designations for groups of containers cleaned together using the same reagents and procedures
- Dates of cleaning
- Cleaning procedures or reference to internal cleaning SOPs or DEP SOPs
- Cleaning personnel names
- Results of quality control analyses associated with container lots
- Comments about problems or other information associated with container lots

### 2. SAMPLING KIT DOCUMENTATION

If supplied to a party other than internal staff, transmit to the recipient the following information pertaining to sampling equipment or other implements, sample containers, reagent containers, analyte-free water containers, reagents or analyte-free water supplied to the recipient.

DEP-SOP-001/01  
FD 1000 Documentation Procedures

- Quantity, description and material composition of all containers, container caps or closures or liners for caps or closures
  - Intended application for each sample container type indicated by approved analytical method or analyte group(s)
  - Type, lot number, amount and concentration of preservative added to clean sample containers and/or shipped as additional preservative
  - Intended use for any additional preservatives or reagents provided
  - Description of any analyte-free water (i.e., deionized, organic-free, etc.)
  - Date of analyte-free water containerization
  - Date of sampling kit preparation
  - Description and material composition of all reagent transfer implements (e.g., pipets) shipped in the sampling kit and the analyte groups for which the implements have been cleaned or supplied
  - Quantity, description and material composition of all sampling equipment and pump tubing (including equipment supplied for filtration) and the analyte groups for which the equipment has been cleaned or supplied
  - Tare weight of VOC vials, as applicable (this item is necessary when EPA 5035 VOC sample vials are provided for soil samples)
3. DOCUMENTATION FOR REAGENTS AND OTHER CHEMICALS
- 3.1. Keep a record of the lot numbers and inclusive dates of use for all reagents, detergents, solvents and other chemicals used for cleaning and sample preservation.
- 3.1.1. See FD 4000 below for documentation requirements for reagents used for field testing.

## ***FD 3000. DOCUMENTATION OF EQUIPMENT MAINTENANCE***

1. Log all maintenance and repair performed for each instrument unit, including routine cleaning procedures, corrective actions performed during calibrations or verifications, and solution or parts replacement for instrument probes.
  - 1.1. Include the calendar date for the procedures performed.
  - 1.2. Record names of personnel performing the maintenance or repair tasks.
    - 1.2.1. Describe any malfunctions necessitating repair or service.
2. 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.
3. Retain vendor service records for all affected instruments.
4. Record the following for rented equipment:

- Rental date(s)
  - Equipment type and model or inventory number or other description
5. Retain the manufacturer's operating and maintenance instructions.

## ***FD 4000. DOCUMENTATION FOR CALIBRATION OF FIELD-TESTING INSTRUMENTS AND FIELD ANALYSES***

Document acceptable instrument or measuring system calibration for each field test or analysis of a sample or other measurement medium.

### **FD 4100. General Documentation for all Field Testing**

1. STANDARD AND REAGENT DOCUMENTATION: Document information about standards and reagents used for calibrations, verifications, and sample measurements.
  - 1.1. Note the date of receipt, the expiration date and the date of first use for all standards and reagents.
    - 1.1.1. Document acceptable verification of any standard used after its expiration date.
  - 1.2. Record the concentration or other value for the standard in the appropriate measurement units.
    - 1.2.1. Note vendor catalog number and description for preformulated solutions as well as for neat liquids and powdered standards.
    - 1.2.2. Retain vendor assay specifications for standards as part of the calibration record.
      - 1.2.2.1. Record the grade of standard or reagent used.
  - 1.3. When formulated in-house, document all calculations used to formulate calibration standards.
    - 1.3.1. Record the date of preparation for all in-house formulations.
  - 1.4. Describe or cite the procedure(s) used to prepare any standards in-house (DEP SOP or internal SOP).
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.
  - 2.1. Retain vendor certifications of all factory-calibrated instrumentation.
  - 2.2. Designate the identity of specific instrumentation in the documentation with a unique description or code for each instrument unit used.
    - 2.2.1. Record manufacturer name, model number, and identifying number such as a serial number for each instrument unit.
  - 2.3. Record the time and date of all initial calibrations and all calibration verifications.
  - 2.4. Record the instrument reading (value in appropriate measurement units) of all calibration verifications.
  - 2.5. Record the name of the analyst(s) performing the calibration or verification.

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 1 above

2.7. Retain manufacturers' instrument specifications.

2.8. Document whether successful initial calibration occurred.

2.9. Document whether each calibration verification passed or failed.

2.10. Document, according to records requirements of FD 3000, any corrective actions taken to modify instrument performance.

2.10.1. Document date and time of any corrective actions.

2.10.2. Note any incidence of discontinuation of use of the instrument due to calibration failure.

2.11. Describe or cite the specific calibration or verification procedure performed (DEP SOP or internal SOP).

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
- "J" data qualifier code for estimated measurement or test sample value
- Reporting units for the measurement
- Initials or name of analyst performing the measurement
- Unique identification of the specific instrument unit used for the test (see 2.2 above)

## ***FD 5000. DOCUMENTATION OF SAMPLE COLLECTION, PRESERVATION AND TRANSPORT***

Follow these procedures for all samples. See FD 5100 - FD 5427 below for additional documentation for specific sampling activities. See example Forms in FD 9000 below for example formats for documenting specific sampling and testing procedures.

### **1. SAMPLE IDENTIFICATION REQUIREMENTS**

1.1. Ensure that labels are waterproof and will not disintegrate or detach from the sample container when wet, especially under conditions of extended submersion in ice water typically accumulating in ice chests or other transport containers.

DEP-SOP-001/01  
FD 1000 Documentation Procedures

1.2. Label or tag each sample container with a unique field identification code that adequately distinguishes each sample according to the following criteria. The code must adequately link the sample container with all of the information about the sample contained in the permanent field record.

1.2.1. Link the unique field identification code to the sample source or sampling point identification, the date of sample collection, the time of sample collection (for maximum holding times equal to or less than 48 hours), the analytes of interest and the preservation technique.

1.2.2. Label or tag each sample container for the following types of samples with a unique field identification code:

- Quality control samples such as duplicate samples, other replicate samples or split samples collected for the same analyte or group of analytes
- Field samples or quality control samples collected using a different sample collection technique for the same analyte or group of analytes (for example, if both a bailer and a pump are used to collect samples for metals analysis, label the bailer sample to distinguish it from the pump sample)

1.2.3. The color, size, shape, or material composition of sample containers and caps cannot substitute for the information required in 1.2.1. – 1.2.2. Above.

1.2.4. The unique field identification code and any other information included on the container label or tag must allow the analyzing laboratory to independently determine the sample collection date, the sample collection time (for maximum holding times  $\leq$  48 hours), the sample preservation and the analytical tests to be performed on each container or group of containers.

1.3. Attach the label or tag so that it does not contact any portion of the sample that is removed or poured from the container.

1.4. Record the unique field identification code on all other documentation associated with the specific sample container or group of containers.

2. GENERAL REQUIREMENTS FOR SAMPLING DOCUMENTATION: Record the following information for all sampling:

2.1. Names of all sampling team personnel on site during sampling

2.2. Date and time of sample collection (indicate hours and minutes)

2.2.1. Use 24-hour clock time or indicate A.M. and P.M.

2.2.2. Note the exact time of collection for individual sample containers for time-sensitive analyses with a maximum holding time of 48 hours or less.

2.3. Ambient field conditions, to include, but not limited to information such as weather, tides, etc.

2.4. Comments about samples or conditions associated with the sample source (e.g., turbidity, sulfide odor, insufficient amount of sample collected)

2.5. Specific description of sample location, including site name and address

2.5.1. Describe the specific sampling point (e.g., monitoring well identification number, outfall number, station number, etc.).

2.5.2. Determine latitude and longitude of sampling source location (if required).

DEP-SOP-001/01  
FD 1000 Documentation Procedures

- 2.5.3. Locate sampling points on scaled maps or drawings where applicable.
  - 2.6. Record the unique field identification code for each sample container and parameters to be analyzed, per section 1 above. The code must adequately link the sample container or group of containers with all of the information about the sample contained in the permanent field record.
  - 2.7. Number of containers collected for each unique field identification code
  - 2.8. Matrix sampled
  - 2.9. Type of field sample collected, such as grab, composite or other applicable designation.
  - 2.10. Field-testing measurement data:
    - 2.10.1. See FD 4000 above for specific details.
  - 2.11. Calibration records for field-testing equipment
    - 2.11.1. See FD 4000 above for specific details.
  - 2.12. Preservation for each container
    - 2.12.1. Indicate whether samples are chemically preserved on-site by the sampling team or, alternatively, were collected in prepreserved (predosed) containers.
    - 2.12.2. Indication of any tests performed in the field to determine the presence of analytical interferences in the sample.
    - 2.12.3. Indication of any treatments of samples performed in the field to eliminate or minimize analytical interferences in the sample.
    - 2.12.4. See FD 5100, section 1.
  - 2.13. Purging and sampling equipment used, including the material composition of the equipment and any expendable items such as tubing.
  - 2.14. Types, number, collection location and collection sequence of quality control samples
    - 2.14.1. Include a list of equipment that was rinsed to collect any equipment blanks.
  - 2.15. Use of fuel powered vehicles and equipment
  - 2.16. Number of subsamples and amount of each subsample in any composite samples
    - 2.16.1. Include sufficient location information for the composite subsamples per 2.4 above.
  - 2.17. Depth of all samples or subsamples
  - 2.18. Signature(s) or initials of sampler(s)
3. SAMPLE TRANSMITTAL RECORDS: Transmit the following information to the analytical laboratory or other receiving party. Link transmittal records with a given project and retain all transmittal records.
- Site name and address – Note: Client code is acceptable if samples are considered sensitive information and if the field records clearly trace the code to a specified site and address.
  - Date and time of sample collection

DEP-SOP-001/01  
FD 1000 Documentation Procedures

- Name of sampler responsible for sample transmittal
- Unique field identification codes for each sample container
- Total number of samples
- Required analyses
- Preservation protocol
- Comments about sample or sample conditions
- Identification of common carrier (if used)

4. SAMPLE TRANSPORT

4.1. If shipping transmittal forms in the transport containers with the samples, place the forms in a waterproof enclosure and seal.

4.2. For common carrier shipping, seal transport containers securely with strapping tape or other means to prevent lids from accidentally opening.

4.2.1. Keep all shipping bills from common carriers with archived transmittal records.

5. ANCILLARY FIELD RECORDS: Link any miscellaneous or ancillary records (photographs, videotapes, maps, etc.) to specific sampling events such that these records are easily traceable in the data archives associated with the project, sampling date and sample source(s).

## **FD 5100. Documentation Specific To Aqueous Chemistry Sampling**

1. SAMPLE PRESERVATION: Document preservation of all samples according to the following instructions.

1.1. List the chemical preservatives added to the sample.

1.2. Record the results of pH verification performed in the field, including the pH value of the sample (if applicable). Note any observations about changes in the sample as a result of adding preservative to the sample or mixing the sample with the preservative.

1.3. Record the amount of preservative added to samples and the amount of any additional preservative added. The amount dosed into sample containers supplied with premeasured preservatives must also be recorded.

1.3.1. For documentation of procedures for preservation for routine samples, cite DEP SOPs or internal SOPs for this information.

1.3.2. Record instances of deviation from preservation protocols found in SOPs when non-routine or problematic samples are collected.

1.4. Record the use of ice or other cooling method, when applicable.

2. GROUNDWATER SAMPLING

2.1. Record or establish a documentation link to the following information for all samples. See section 3 below for in-place plumbing:

- Well casing composition and diameter of well casing
- A description of the process and the data used to design the well

DEP-SOP-001/01  
FD 1000 Documentation Procedures

- The equipment and procedure used to install the well
  - The well development procedure
  - Pertinent lithologic or hydrogeologic information
  - Ambient conditions at the wellhead or sampling point that are potential sources of unrepresentative sample contamination
  - Water table depth and well depth
  - Calculations used to determine purge volume
  - Total amount of water purged
  - Date well was purged
  - Purging equipment used
  - Sampling equipment used
  - Well diameter
  - Total depth of well
  - Depth to groundwater
  - Volume of water in the well
  - Purging method
  - Placement depth of tubing or pump intake
  - Depth and length of screened interval
  - Times for beginning and ending of purging
  - Total volume purged
  - Times of stabilization parameter measurements
  - Purging rate, including any changes in rate
  - Temperature measurements
  - pH measurements
  - Specific conductance measurements
  - Dissolved oxygen measurements
  - Turbidity measurements
  - Site or monitoring well conditions impacting observed dissolved oxygen and turbidity measurements
  - Color of groundwater
  - Odor of groundwater
- 2.2. Record the following for Water Level and Purge Volume Determination (FS 2211):
- Depth to groundwater
  - Total depth of well

DEP-SOP-001/01  
FD 1000 Documentation Procedures

- Length of water column
- Well diameter
- Volume of water in the well
- Volume of pump
- Tubing diameter
- Length of tubing
- Volume of flow cell
- Volume in the pumping system

2.3. Record the following for Well Purging (FS 2212)

- Calculations for pumping rates, including any changes in rates
- Flow meter readings
- Volume of water purged
- Placement depth of tubing or pump intake
- Depth and length of screened interval
- Time needed to purge one (1) well volume or purging equipment volume
- Well volumes or purging equipment volumes purged
- Temperature measurements
- pH measurements
- Specific conductance measurements
- Dissolved oxygen measurements
- Turbidity measurements
- Purging rate, including any changes in rate
- Drawdown in the well

3. IN-PLACE PLUMBING SOURCES INCLUDING DRINKING WATER SYSTEMS

3.1. Record the following for all samples:

- Plumbing and tap material construction (if known)
- Flow rate at which well was purged
- Amount of time well was allowed to purge
- Flow rate at time of sample collection
- Public water system identification number (if applicable)
- Name and address of water supply system and an emergency phone number for notification of sample results (if applicable)

4. SURFACE WATER SAMPLING

- Sample collection depth

DEP-SOP-001/01  
FD 1000 Documentation Procedures

- Beginning and ending times (24 hr) for timed composite sampling
- Type of composite (e.g., flow-proportioned, continuous, etc.)

5. WASTEWATER SAMPLING

- Beginning and ending times (24 hr) for timed composite sampling
- Type of composite (e.g. flow-proportioned, continuous, etc.)

**FD 5120. RECORDS FOR NON-AQUEOUS ENVIRONMENTAL SAMPLES**

Document the following information for all samples when using the indicated procedures.

**FD 5130. DOCUMENTATION SPECIFIC TO SOIL SAMPLING (FS 3000)**

1. GENERAL SOIL SAMPLING

- Sample collection depth
- Areal location of sample
- Sample collection device

2. Sampling for Volatile Organic Compounds (VOC) per EPA Method 5035

- Tare weight of VOC sample vial (if applicable)
- Weight of sample (if applicable)

**FD 5140. DOCUMENTATION SPECIFIC TO SEDIMENT SAMPLING (FS 4000)**

1. General Sediment Sampling

- Sample collection depth
- Areal location of sample
- Sample collection device

2. Sampling for Volatile Organic Compounds (VOC) per EPA Method 5035

- Tare weight of VOC sample vial (if applicable)
- Weight of sample (if applicable)

**FD 5200. Documentation Specific to Waste Sampling (FS 5000)**

1. DRUM SAMPLING

1.1. Record the following information for each drum:

- Type of drum and description of contents
- Drum number, if applicable
- Terrain and drainage condition
- Shape, size and dimensions of drum
- Label wording or other markings

DEP-SOP-001/01  
FD 1000 Documentation Procedures

- Dimensional extent of leaks or spills associated with the drum
- Drum location (or location map)

1.2. Record the following information for the drum sample(s):

- Description of phases, colors, crystals, powders, sludges, etc.
- Stratified layers sampled, including aliquot amounts for composites, if applicable

1.3. Record the following for field testing results on opened drums and drum samples:

- Background readings for OVA meters
- Sample readings for OVA meters
- Type of OVA probe
- Radiation background reading and sample radiation reading
- Type of radiation monitor used
- Oxygen and LEL readings from container opening
- Water reactivity results
- Specific gravity
- PCB test results
- Water solubility results
- pH of aqueous wastes
- Results of chemical test strips
- Ignitability results
- Results of other chemical hazard test kits
- Miscellaneous comments for any tests

2. Documentation for Tanks

2.1. Record the following information for the tank:

- Type of tank, tank design and material of construction of tank
- Description of tank contents and markings
- Tank number or other designation, if applicable
- Terrain and drainage condition
- Shape, size and dimensions of tank
- Label or placard wording or other markings
- Dimensional extent of leaks or spills associated with the tank
- Tank location (or location map)

2.2. Record the following information for the tank sample(s):

- Description of phases, colors, crystals, powders, sludges, etc.

DEP-SOP-001/01  
FD 1000 Documentation Procedures

- Stratified layers sampled, including aliquot amounts for composites, if applicable
- 2.3. Record the following for field testing results on opened tanks and tank samples:

- Background readings for OVA meters
- Sample readings for OVA meters
- Type of OVA probe
- Radiation background reading and sample radiation reading
- Type of radiation monitor used
- Oxygen and LEL level from container opening
- Water reactivity results
- Specific gravity
- PCB test results
- Water solubility results
- pH of aqueous wastes
- Results of chemical test strips
- Ignitability results
- Results of other chemical hazard test kits
- Miscellaneous comments for any tests

3. DOCUMENTATION FOR WASTE LEACHATE AND WASTE SUMP SAMPLES

3.1. Document information specific to leachate and sump sampling according to the documentation requirements for the respective DEP SOPs employed to collect samples (FS 2100, FS 2200, FS 4000, FS 5100 and FS 5200).

4. DOCUMENTATION FOR WASTE PILE SAMPLES

4.1. Document information specific to waste pile sampling according to associated regulatory requirements for the project.

5. DOCUMENTATION FOR WASTE IMPOUNDMENT AND WASTE LAGOON SAMPLES

5.1. Document information specific to impoundment and lagoon sampling according to the documentation requirements for the respective DEP SOPs employed to collect samples (FS 2100, FS 4000, FS 5100, and FS 5200).

## **FD 5300. Documentation for Biological Sampling**

The following SOP sections list required documentation items for specific biological sampling procedures, as indicated.

### **FD 5310. DOCUMENTATION FOR BIOLOGICAL AQUATIC HABITAT CHARACTERIZATION**

Minimum documentation required for biological habitat characterization and sampling is listed below according to requirements as specified in the indicated sampling and field-testing DEP SOPs.

**FD 5311.** *Physical/Chemical Characterization for Biological Sampling (FT 3001)*

1. Record the following information or use the Physical/Chemical Characterization Field Sheet (Form FD 9000-3):

- Submitting agency code
- Submitting agency name
- STORET station number
- Sample date
- Sample location including county
- Field identification
- Receiving body of water
- Time of sampling
- Percentage of land-use types in the watershed that drain to the site
- Potential for erosion within the portion of the watershed that affects the site
- Local non-point-source pollution potential and obvious sources
- Typical width of 100-meter section of river or stream
- Size of the system or the size of the sample area within the system (lake, wetland, or estuary)
- Three measurements of water depth across the typical width transect
- Three measurements of water velocity, one at each of the locations where water depth was measured
- Vegetated riparian buffer zone width on each side of the stream or river or at the least buffered point of the lake, wetland or estuary
- Presence of artificial channelization in the vicinity of the sampling location (stream or river)
- Description of state of recovery from artificial channelization
- Presence or absence of impoundments in the area of the sampling location
- Vertical distance from the current water level to the peak overflow level
- Distance of the high water mark above the stream bed
- Observed water depth at high water mark location
- Percentage range that best describes the degree of shading in the sampling area
- Any odors associated with the bottom sediments
- Presence or absence of oils in the sediment
- Any deposits in the area, including the degree of smothering by sand or silt
- Depth of each water quality measurement
- Temperature

DEP-SOP-001/01  
FD 1000 Documentation Procedures

- pH
- Dissolved oxygen
- Specific conductance
- Salinity
- Secchi depth
- Type of aquatic system sampled
- Stream magnitude (order designation)
- Description of any noticeable water odors
- Term that best describes the relative coverage of any oil on the water surface
- Term that best describes the amount of turbidity in the water
- Term that best describes the color of the water
- Weather conditions during the time of sampling
- Any other conditions/observations that are helpful in characterizing the site
- Relative abundances of periphyton, fish, aquatic macrophytes and iron/sulfur bacteria
- List and map of dominant vegetation observed
- Sampling team designation
- Signature(s) of sampler(s)
- Signature date

2. For streams and rivers, draw a grid sketch of the site (optionally use Form FD 9000-4), showing the location and amount of each substrate type (as observed by sight or touch). Using the grid sketch, count the number of grid spaces for each substrate type. Divide each of these numbers by the total number of grid spaces contained within the site sketch. Record this percent coverage value for each substrate type. If the substrates are sampled, record the number of times each substrate is sampled by an indicated method.

3. For lakes, divide the site map into twelve sections and note visual markers that will assist in distinguishing those sections.

4. Photographs of the sampling area are also useful tools for documenting habitat conditions and identifying station location.

**FD 5312.** *Stream and River Biological Habitat Assessment Records (FT 3100)*

1. Record the following information or use Form FD 9000-5, Stream/River Habitat Assessment Field Sheet:

- Submitting organization name and/or code
- STORET station number
- Assessment date
- Sampling location including county
- Field identification

DEP-SOP-001/01  
FD 1000 Documentation Procedures

- Receiving body of water
  - Time of sampling upon arrival at the site
2. Additionally record the following:
- Substrate diversity score
  - Substrate availability score
  - Water velocity score
  - Habitat smothering score
  - Artificial channelization score
  - Bank stability score for each bank
  - Riparian buffer zone width score for each bank
  - Riparian zone vegetation quality score for each bank
  - Primary habitat components score
  - Secondary habitat components score
  - Habitat assessment total score
  - Additional comments and observations
  - Signatures
3. Record the following information or use Form FD 9000-4, Stream/River Habitat Sketch Sheet for each 100-meter segment assessed.
- Link to the waterbody name, location of 100-meter segment, analyst name(s) and date of the assessment
  - Code, symbol or icon used to map each substrate observed in the segment
  - Proportionate sketch or map of the abundance of each habitat (substrate) observed in the 100-meter segment, oriented to the direction of flow
  - Location of velocity measurements taken within the segment
  - Location of habitats smothered by sand or silt
  - Location of unstable, eroding banks
  - Locations along the segment where the natural, riparian vegetation is altered or eliminated
  - Plant taxa observed
  - Additional notes and observations

**FD 5313.**     *Lake Biological Habitat Assessment Records (FT 3200)*

1. Document the following information or use the Lake Habitat Assessment Field Sheet (Form FD 9000-6):
- STORET station number

DEP-SOP-001/01  
FD 1000 Documentation Procedures

- Sampling date
- Sampling location including lake name
- Eco-region
- Field identification number
- County name
- Lake size
- Features observed
- Description of the hydrology of the system (water residence time)
- Lake water color
- Secchi depth score
- Vegetation quality score
- Stormwater inputs score
- Bottom substrate quality score
- Lakeside adverse human alterations score
- Upland buffer zone score
- Adverse watershed land use score
- Habitat assessment total score
- Additional comments and observations
- Name and Signature of analyst

**FD 5320.     **BIOLOGICAL AQUATIC COMMUNITY SAMPLING RECORDS (FS 7000)****

Minimum documentation required for biological sampling for procedures described in FS 7000 is listed below according to requirements as specified in the indicated sampling DEP SOPs.

**FD 5321.     *Periphyton Sampling Records (FS 7200)***

For each sample, record the following:

- Station sampled
- Date collected

**FD 5322.     *Qualitative Periphyton Sampling Records (FS 7220)***

Complete the Physical/Chemical Characterization Field Sheet (Form FD 9000-3), Stream/River Habitat Sketch Sheet (Form FD 9000-4) or site map and Stream/River Habitat Assessment Field Sheet (Form FD 9000-5), as appropriate for the water body sampled (see FT 3000 – FT 3100). Other customized formats may be used to record the information prompted on the above forms.

**FD 5323.**     *Rapid Periphyton Survey Records (FS 7230)*

For each 100-meter reach surveyed, record the following information or use Form FD 9000-8, Rapid Periphyton Survey Field Sheet:

- Site or waterbody name
- Survey date
- Name(s) of analyst(s)
- Transect mark number (10-meter segment within the 100-meter reach)
- Transect point (1 – 9)
- Algae sample collected
- Algal thickness rank (per FS 7230 procedure)
- Algae type
- Canopy cover (per FS 7230 procedure)
- Bottom visibility
- Water color
- Additional comments or observations

**FD 5324.**     *Lake Vegetation Index Records (FS 7310)*

Record the following information or use Form FD 9000-7, Lake Vegetation Index Data Field Sheet:

- Waterbody name
- Assessment or sampling date
- County name
- Name of analyst(s)
- STORET station number
- Signature(s) of analyst(s)
- Lake water level
- Presence of algal mats
- Lake units sampled (12-sector procedure per FS 7310)
- Taxa observed in each selected unit
- Dominant and co-dominant taxa in each unit
- Taxa collected for further identification
- Approximate water depth for each taxon collected

**FD 5325.**     *Rapid Bioassessment (Biorecon) Records (FS 7410)*

Record the following information or use the Biorecon Field Sheet (Form FD 9000-1).

DEP-SOP-001/01  
FD 1000 Documentation Procedures

- STORET station number
- Location, including latitude and longitude
- Watershed or basin name
- Family or genus of all organisms from all material in all four dipnet sweeps
- Total taxa tallies
- Taxa richness, Ephemeroptera taxa, Trichoptera taxa, Long-lived taxa, Clinger taxa, and Sensitive taxa
- Abundance code for each taxon
- Name(s) of analysts collecting and sorting samples
- Habitat types (substrates) sampled
- Name(s) of analyst(s) performing quality control
- Signatures
- Collection date and time

**FD 5326.**     *Stream Condition Index (D-frame Dipnet) Sampling Records (FS 7420)*

1. Complete the Physical/Chemical Characterization Field Sheet (Form FD 9000-3), Stream/River Habitat Sketch Sheet (Form FD 9000-4) or site map and Stream/River Habitat Assessment Field Sheet (Form FD 9000-5) forms appropriate for the water body sampled (see FT 3000 – FT 3400). Other customized formats may be used to record the information prompted on the above forms.
2. Record the following for each sample:
  - Number of sweeps for each habitat
  - Number of containers per sample

**FD 5327.**     *Sediment Core Biological Grab Sampling Records (FS 7440)*

Record the sampling location of site grab core samples.

**FD 5328.**     *Sediment Dredge Biological Grab Sampling Records (FS 7450)*

Record the sampling location of site grab dredge samples.

**FD 5329.**     *Lake Condition Index (Lake Composite) Sediment Dredge Biological Grab Sampling Records (FS 7460)*

Record the following or use DEP Form FD 9000-2 (Composite Lake Sampling Sheet):

- Sampling date
- Lake name
- Sampling equipment used
- Comments and observations

- Dredge drop number (1 – 12)
- Sampling depth for each drop number
- Sampling location of site grab dredge sample for each drop (include lake sector map)
- Sediment type(s) in grab dredge sample for each drop
- Location of any water quality measurements

## ***FD 6000. QUALITY CONTROL DOCUMENTATION***

1. Document all field quality control samples in the permanent field records.
2. At a minimum, record the following information:
  - The type, time and date that the quality control sample was collected; and
  - The preservative(s) (premeasured or added amount) and preservation checks performed.
3. If blanks are collected/prepared by the field organization, maintain records of the following:
  - Type of analyte-free water used;
  - Source of analyte-free water (include lot number if commercially purchased);
  - A list of the sampling equipment used to prepare the blank.

If items above are specified in an internal SOP, you may reference the SOP number and revision date in the field notes. Note any deviations to the procedure in the field notes.

4. For trip blanks, record the following:
  - Date and time of preparation
  - Storage conditions prior to release to the sample collecting organization
  - Type of analyte-free water used
  - Source and lot number (if applicable) of analyte-free water
  - 4.1. Include trip blank information in the sampling kit documentation per FD 2000, section 2.
5. For duplicates, record the technique that was used to collect the sample.
6. For split samples, identify the method used to collect the samples and the source(s) of the sample containers and preservatives.

## ***FD 7000. LEGAL OR EVIDENTIARY DOCUMENTATION***

1. Scope: 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, for example, unless evidentiary custody protocols are specifically mandated in a permit or other legal order or when required for enforcement actions.
2. General Procedural Instructions
  - 2.1. Follow applicable requirements in FD 1000 – FD 5000 for all evidence samples.

2.2. Establish and maintain the evidentiary integrity of samples and/or sample containers. Demonstrate that the samples and/or sample containers were handled and transferred in such a manner as to eliminate possible tampering.

2.2.1. Document and track all time periods and the physical possession and storage of sample containers and samples from point of origin through the final analytical result and sample disposal.

## **FD 7100. General Requirements for Evidentiary Documentation**

1. CHAIN OF CUSTODY RECORDS: Use the Chain-of-Custody (COC) records to establish an intact, contiguous record of the physical possession, storage, and disposal of sample containers, collected samples, sample aliquots, and sample extracts or digestates. For ease of discussion, the above-mentioned items are referred to as "samples".

1.1. Account for all time periods associated with the physical samples.

1.2. Include signatures of all individuals who physically handle the samples.

1.2.1. The signature of any individual on any record that is designated as part of the Chain-of-Custody is their assertion that they personally handled or processed the samples identified on the record.

1.2.2. Denote each signature with a short statement that describes the activity of the signatory (e.g., "sampled by", "received by", "relinquished by", etc.).

1.2.3. In order to simplify recordkeeping, minimize the number of people who physically handle the samples.

2. CONSOLIDATION OF RECORDS: The COC records need not be limited to a single form or document. However, limit the number of documents required to establish COC, where practical, by grouping information for related activities in a single record. For example, a sample transmittal form may contain both certain field information and the necessary transfer information and signatures for establishing delivery and receipt at the laboratory.

3. LIABILITY FOR CUSTODY DOCUMENTATION: Ensure appropriate personnel initiate and maintain sample chain-of-custody at specified times.

3.1. Begin legal chain-of-custody when the precleaned sample containers are dispatched to the field.

3.1.1. Omit the transmittal record for precleaned sample containers if the same party provides the containers and collects the samples.

3.2. Sign the COC record upon relinquishing the prepared sample kits or containers.

3.3. Sign the COC record upon receipt of the sample kits or containers.

3.4. Thereafter, ensure that all parties handling the samples maintain sample custody (i.e., relinquishing and receiving) and documentation until the samples or sampling kits are relinquished to a common carrier.

3.4.1. The common carrier should not sign COC forms.

3.4.2. Indicate the name of the common carrier in the COC record, when used. Retain shipping bills and related documents as part of the record.

3.4.3. Ensure that all other transferors and transferees releasing or accepting materials from the common carrier sign the custody record.

DEP-SOP-001/01  
FD 1000 Documentation Procedures

3.5. Chain-of-custody is relinquished by the party who seals the shipping container and is accepted by the party who opens it.

3.5.1. Indicate the date and time of sealing of the transport container for shipment.

3.5.2. See FD 7200, section 3 below regarding the use of custody seals.

4. SAMPLE SHIPPING OR TRANSPORTING

4.1. Affix tamper-indicating custody seals or evidence tape before shipping samples.

4.1.1. Seal sample container caps with tamper-indicating custody seals or evidence tape before packing for shipping or transport.

4.1.2. Seal sample transport or shipping containers with strapping tape and tamper-indicating custody seals or evidence tape.

4.1.3. If the same party collects then possesses (or securely stores), packs and transports the samples from time of collection, omit any use of custody seals or evidence tape.

4.2. Keep the COC forms with the samples during transport or shipment. Place the COC records in a waterproof closure inside the sealed ice chest or shipping container.

## **FD 7200. Required Documentation for Evidentiary Custody**

1. GENERAL CONTENT REQUIREMENTS: Document the following in COC tracking records by direct entry or linkage to other records:

- Time of day and calendar date of each transfer or handling procedure
- Signatures of transferors, transferees and other personnel handling samples
- Location of samples (if stored in a secured area)
- Description of all handling procedures performed on the samples for each time and date entry recorded above
- Storage conditions for the samples, including chemical preservation and refrigeration or other cooling
- Unique identification for all samples
- Final disposition of the physical samples
- Common carrier identity and related shipping documents

2. DOCUMENTATION CONTENT FOR SAMPLE TRANSMITTAL

Provide a Chain-of-Custody record for all evidentiary samples and subsamples that are transmitted or received by any party. Include the following information in the COC record of transmittal:

- Sampling site name and address
- Date and time of sample collection
- Unique field identification code for each sample source and each sample container
- Names of personnel collecting samples
- Signatures of all transferors and transferees

DEP-SOP-001/01  
FD 1000 Documentation Procedures

- Time of day and calendar date of all custody transfers
- Clear indication of number of sample containers
- Required analyses by approved method number or other description
- Common carrier usage
- Sample container/preservation kit documentation, if applicable

3. 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.

- 3.1. Place the seal so that the closure cannot be opened without breaking the seal.
- 3.2. Record the time, calendar date, and signatures of responsible personnel affixing and breaking all seals for each sample container and shipping container.
- 3.3. Affix new seals every time a seal is broken until continuation of evidentiary custody is no longer required.

### **FD 7300. Documenting Controlled Access to Evidence Samples**

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. See FS 1000 for additional discussion about procedures for handling evidence samples.

1. Limit the number of individuals who physically handle the samples as much as practicable.
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.
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.
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.

### **FD 7400. Documenting Disposal of Evidence Samples**

1. Dispose of the physical samples only with the concurrence of the affected legal authority, sample data user, and/or submitter/owner of the samples.
2. Record all conditions of disposal and retain correspondence between all parties concerning the final disposition of the physical samples.
3. Record the date of disposal, the nature of disposal (i.e., sample depleted, sample flushed into sewer, sample returned to client, etc.), and the name of the individual who performed the disposal. If samples are transferred to another party, document custody transfer in the same manner as other transfers (see FD 7000 – FD 7200).

## ***FD 8000. (RESERVED)***

## ***FD 9000. FORMS***

Forms to facilitate documentation of sampling, field-testing, and biological laboratory calculation activities are available on the Department's website. These forms are for unrestricted public use and are presented in example formats. *The use of these forms is not mandatory. However, **some** of the data elements and other information denoted by the form prompts comprise **required documentation** items. Not all required documentation is illustrated in the form examples.* Customize these forms as needed. These forms are available as separate document files. The following forms are incorporated into the indicated SOPs for convenience of use:

- Form FD 9000-1 Biorecon Field Sheet (FS 7000)
- Form FD 9000-2 Composite Lake Sampling Sheet for <1000 Acres (FS 7000)
- Form FD 9000-3 Physical/Chemical Characterization Field Sheet (FT 3000)
- Form FD 9000-4 Stream/River Habitat Sketch Sheet (FT 3000)
- Form FD 9000-5 Stream/River Habitat Assessment Field Sheet (FT 3000)
- Form FD 9000-6 Lake Habitat Assessment Field Sheet (FT 3000)
- Form FD 9000-7 Lake Vegetation Index Data Field Sheet (FS 7000)
- Form FD 9000-8 Rapid Periphyton Survey Field Sheet (FS 7000)

# **Department of Environmental Protection Standard Operating Procedures for Field Activities**

**DEP-SOP-001/01**



**FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION  
2600 BLAIR STONE ROAD  
TALLAHASSEE, FL 32399-2400**

**Bureau of Assessment and Restoration Support  
Standards and Assessment Section**

**March 31, 2008  
(Effective 12/3/08)**

## **FM 1000. FIELD PLANNING AND MOBILIZATION**

This SOP is advisory; however, the following procedures are designed as best management practices, for use as guidance for designing and implementing a field sampling program and when selecting a laboratory.

## **FM 2000. LABORATORY SCHEDULING**

### **FM 2100. Selecting a Laboratory**

#### 1. CONSUMER RESPONSIBILITIES

Each organization that uses laboratory services has certain responsibilities to ensure that the laboratory has the appropriate credentials and that the data are useable for the intended needs, and acceptable to DEP. A consumer's responsibilities include:

##### 1.1. Evaluating the Laboratory

1.1.1. Ensure that the laboratory has the proper credentials.

1.1.2. Ensure that the laboratory can produce data of a quality that will be acceptable to DEP.

1.2. Thinking in Terms of Quality not Dollars: A laboratory that produces data that are not acceptable to DEP usually means that the laboratory will need to repeat the work. It is more cost effective to select a laboratory that will meet the quality needs of the project even if that laboratory is not the lowest bidder.

1.3. Continuing Evaluation: In order to ensure that the laboratory provides data of a consistent quality, do not rely on just the initial evaluation of a laboratory. Other quality control measures will provide the ability to continuously evaluate the laboratory data quality.

1.4. Evaluating the Reported Data: Review the final laboratory reports against the original expectations and acceptable quality control measures.

1.5. Asking Questions: The consumer has the right to question laboratory results and receive a logical and clear response.

**An informed client increases the probability of quality data and data acceptability.**

### **FM 2110. IDENTIFYING LABORATORY NEEDS**

The consumer should be able to identify these critical needs before considering any laboratory:

1. The purpose for which the data are needed.

1.1. The consumer must determine DEP's expectations for data quality in terms of the precision, accuracy, and detection limit (reporting level or criteria) for each reported value.

1.2. Examples include: permit compliance at some specified concentration levels; compliance monitoring at specified reporting levels; and site cleanup to specified soil and water criteria levels.

2. The benefits of using contracted or in-house analytical services.

3. The specific laboratory services that are required:

- 3.1. Are sample collection and sample analysis required, or just sample analysis.
- 3.2. Types of samples (groundwater, drinking water, soils, sediments, hazardous wastes, etc.).
- 3.3. The sample delivery schedule including:
  - 3.3.1. The number of samples to be collected.
  - 3.3.2. The frequency with which samples will be submitted to the laboratory.
  - 3.3.3. The types of matrices to be analyzed.
- 3.4. The test methods that must be used (normally found in the permit requirements, consent orders, contracts, or relevant rules).
- 3.5. The expected quality based on DEP's requirements.
- 3.6. The expected turnaround time for laboratory analysis.
- 3.7. The deliverables including the report format.
- 3.8. Field related services such as:
  - 3.8.1. Sample collection
  - 3.8.2. Sample containers
  - 3.8.3. Sample preservation
  - 3.8.4. Equipment rental or cleaning services; or
  - 3.8.5. Instrument calibration services.
4. Any required laboratory credentials such as certification.
5. Identifying key personnel in the consumer's organization that will be interfacing with the laboratory:
  - 5.1. Administrative contact: Usually responsible for obtaining laboratory services.
  - 5.2. Technical contact: Usually a person who will be evaluating the laboratory's performance.
  - 5.3. Sample control contact: Usually a person who will be scheduling services with the laboratory.
6. Have an understanding of the current market price for the tests to be performed.
  - 6.1. Gather information on pricing from several laboratories.
  - 6.2. Request current and historical pricing schedules.

## **FM 2120. EVALUATING THE LABORATORY**

### **1. LABORATORY CREDENTIALS**

- 1.1. The laboratory must hold National Environmental Laboratory Accreditation Program (NELAP) certification from the Florida Department of Health's Environmental Laboratory Certification Program (DoH ELCP).
- 1.2. Out-of-state laboratories must be either certified by DoH, or be NELAP-certified by another state **with secondary accreditation** by DoH.

- 1.3. The laboratory must be certified for the test technology, analyte, and matrices that will be requested. This does not apply to analysis being done for drinking water.
- 1.4. Request a copy of the Current Certification and Analyte Sheets (must be for the current fiscal year which runs July 1 to June 30).
- 1.5. Verify the certification through the DEP Web Site, or the DoH offices.

## 2. ON-SITE VISIT

Conduct an on-site visit to verify the laboratory's capabilities and to determine if the laboratory has the equipment and personnel resources necessary for proposed services.

- 2.1. The laboratory must show a willingness to meet the client's needs.
- 2.2. The laboratory (both the analytical and administrative areas) should appear organized.
- 2.3. The analytical staff must be knowledgeable about the services to be provided.
  - 2.3.1. At least one person (supervisor or analyst) must be experienced in performing all activities on the proposed scope of work.
- 2.4. The administrative staff must appear organized.
- 2.5. The laboratory must have the capacity to accommodate the proposed scope of work in terms of personnel and equipment.

## 3. LABORATORY PERFORMANCE EVALUATION

- 3.1. Blind Check Samples: Prior to contract signing or any agreement, submit a set of blind check samples to the laboratory.
  - 3.1.1. A blind check sample is a sample in a real matrix (water, soil, sediment, etc.) that appears to be a real sample, except that the submitter has a list of the components and their known concentration values.
  - 3.1.2. Submit the sample(s) to the laboratory as a routine sample(s).
  - 3.1.3. Evaluate the results of the reported values against the certified values in the sample(s).
  - 3.1.4. The values must be within the laboratory's stated precision for the measurement.

## 4. CUSTOMER SATISFACTION

- 4.1. Obtain a list of current and previous clients.
- 4.2. Call several of the clients to determine:
  - Satisfaction with laboratory
  - Were problems resolved satisfactorily?
  - Reasons for not using the laboratory (if applicable)
  - Reasons for using the laboratory

## 5. FISCAL STABILITY

- 5.1. Request a copy of the current financial statement.

## **FM 2130. CONTRACTING**

1. PURPOSE
  - 1.1. Provide a detailed list of the scope of services to be contracted.
  - 1.2. Include the purpose for which the data are to be used (permit, compliance, etc.).
2. KEY CONTACTS: Identify key contacts for both laboratory and client:
  - 2.1. Administrative: Dealing with billing, contract writing, invoicing, etc.
  - 2.2. Technical: Dealing with data, and quality control issues and problems.
  - 2.3. Sample Control: Dealing with scheduling, shipping supplies, sample receipt.
3. ANTICIPATED NEEDS: Specify:
  - 3.1. The schedule of activities;
  - 3.2. The expected number of samples, analytes, matrices and tests; and
  - 3.3. Field support services, including containers, preservatives, cleaning and calibration services.
4. EXPECTATIONS
  - 4.1. Certification
    - 4.1.1. The laboratory must maintain certification for the analyte, technology, and matrices to be performed.
    - 4.1.2. The laboratory must immediately notify its clients if the certification status for any analyte changes.
    - 4.1.3. The laboratory must state that it will generate all results in strict compliance with the National Environmental Laboratory Accreditation Conference (NELAC) Standards.
    - 4.1.4. The laboratory must flag and justify any results that were not generated in accordance with NELAC.
  - 4.2. Analytical Expectations
    - 4.2.1. Provide a list of analytical methods to be performed and the matrices for each method.
    - 4.2.2. Provide a copy of the permit, QAPP, Sampling Plan or other document that outlines DEP's requirements.
    - 4.2.3. Specify the expected turn-around time for the analyses.
    - 4.2.4. Specify the shipping schedule if sample containers or supplies are to be provided.
  - 4.3. Container/Equipment Services: State the scope of container and equipment services:
    - 4.3.1. Precleaned Containers: Types and Numbers
      - 4.3.1.1. Must be cleaned according to DEP SOP procedures (see FC 1000) or purchased precleaned from a vendor.
      - 4.3.1.2. Provide copy of procedures, if the laboratory does not follow the DEP SOP procedures.

- 4.3.1.3. Determine if containers must be certified clean by either the laboratory or the vendor.
- 4.3.2. Preservatives
  - 4.3.2.1. Premeasured into containers, where appropriate.
  - 4.3.2.2. Provided in appropriate containers with dispensing implement.
- 4.3.3. Equipment
  - 4.3.3.1. Type and numbers.
  - 4.3.3.2. Condition of equipment (precleaned, etc.).
  - 4.3.3.3. Equipment must be cleaned according to DEP SOP procedures (see FC 1000). Obtain a copy of the laboratory procedures if the laboratory does not follow the DEP SOP procedures.
  - 4.3.3.4. Determine if equipment must be certified clean by the laboratory.
- 4.3.4. Equipment Calibration
  - 4.3.4.1. The calibration method;
  - 4.3.4.2. The frequency of calibration;
  - 4.3.4.3. Preventative maintenance on instrument;
  - 4.3.4.4. Certification statement verifying the calibration; and
  - 4.3.4.5. Documentation of all maintenance and calibrations in laboratory records.
- 4.4. Quality Control
  - 4.4.1. State adherence to NELAC quality control requirements.
  - 4.4.2. Specify any additional quality control measures that are required but are different from NELAC.
  - 4.4.3. Specify acceptable ranges for spikes, duplicates, surrogates, and other QC measures if appropriate.
- 4.5. Custody/Sample Tracking
  - 4.5.1. Specify adherence to NELAP documentation and record keeping requirements.
  - 4.5.2. State a time-period for retaining all records if greater than 5 years.
  - 4.5.3. Make arrangement for transfer of records should the laboratory go out of business or transfer ownership before the records retention time period has lapsed.
  - 4.5.4. Specify the level of custody (routine, legal, etc.).
- 4.6. Minimum Reporting Levels
  - 4.6.1. Provide the laboratory with the minimum acceptable values to be reported (method detection limit, etc.).
  - 4.6.2. Describe contingencies if these levels cannot be met.
- 4.7. Reporting Format
  - 4.7.1. All analytical reports issued by the laboratory must comply with DEP and NELAP reporting requirements.

4.7.2. Specify whether the information must be provided as hardcopy, electronic or both.

4.7.2.1. If electronic, specify the format for submission.

4.7.3. The use of appropriate DEP data qualifiers (see Table FM 1000-1) must be used.

4.8. Deliverables: In addition to the NELAP-compliant report, specify any other deliverables that must be provided with the laboratory report such as:

- Laboratory Quality Control results;
- Field Quality Control results;
- Performance Test results;
- Copies of all raw data and associated records;
- Written narrative of the analytical event; and/or
- Description of any modifications to methods.

4.9. Subcontracting

4.9.1. The laboratory must inform the client **before** any analytical services are subcontracted to another laboratory.

4.9.2. The laboratory must ensure that the subcontracted laboratory meets the same qualifications and requirements as the primary laboratory.

4.9.3. If the results from subcontracted laboratories are incorporated into the final laboratory report, the subcontracted results must be clearly identified.

4.10. Method Modifications

4.10.1. The laboratory must identify any modifications that have been made to the requested analytical methods.

4.10.2. The client must be notified of any method modifications prior to use in the laboratory, and must provide written consent.

4.11. Dilutions

4.11.1. Negotiate how multiple dilutions will be handled. They may be considered a separate analysis and therefore an additional cost.

4.11.2. Agree to pay for the analysis of dilutions only if:

4.11.2.1. The sample concentration exceeds the calibration range and the laboratory was not aware of the expected sample concentration; or

4.11.2.2. A dilution is required to quantitate all required components.

5. PENALTIES AND CONSEQUENCES

5.1. Negotiate penalties or other consequences (no payment) for these problems:

- Failure to provide data or associated (expected) information;
- Failure to meet deadlines;
- Failure to provide acceptable data; and
- Failure to meet contract requirements.

- 5.2. Consider these consequences:
  - Costs of resampling;
  - Fines incurred because of unacceptable data;
  - Costs associated with having evaluated and/or processed unacceptable data;  
and
  - Reanalysis costs (if reanalysis is due to laboratory error or failed QC).
- 5.3. Reserve the right to reject data. If any data are used, laboratory should be paid according to negotiated terms.

#### **FM 2140. ON-GOING EVALUATION**

1. Monitor laboratory's performance against the specific contract requirements.
2. Continue to use blind QC samples as a measure of routine performance.
  - 2.1. Vendor supplied samples;
  - 2.2. Samples prepared to a known concentration; or
  - 2.3. Split samples with another laboratory.

#### **FM 2150. DATA REVIEW**

1. Review the data for logical trends:
  - 1.1. Are the reported concentrations different from the routine (expected) levels?
  - 1.2. Is the same value reported for the same analyte (except non detects) in the same set of samples or over a historical period of time?
  - 1.3. Do the parts add up to the total?
    - 1.3.1. Ortho phosphate must be less than total phosphate.
    - 1.3.2. Total nitrate-nitrite must be equal to nitrate plus nitrite.
    - 1.3.3. Total values must be greater than or equal to dissolved values.
  - 1.4. Are different but related analyses consistent?
    - 1.4.1. High turbidity and high total suspended solids.
    - 1.4.2. High turbidity and increased method detection limits for other tests.
  - 1.5. Do results indicate a sample collection problem?
    - 1.5.1. High dissolved oxygen in groundwater.
    - 1.5.2. High turbidity and elevated metals results.
  - 1.6. Are the QC check samples within acceptable ranges?
    - 1.6.1. Are the ranges reasonable?
  - 1.7. Are non-detects reported correctly (should be a value with a "U")?
  - 1.8. Over the history of laboratory use, were any QC problems reported?
  - 1.9. Is there any laboratory or field blank contamination?

1.10. Do the reports contain all required information?

**FM 2160. ASK QUESTIONS**

Ask questions if:

- There are problems associated with the data review.
- The QC check sample data are not acceptable.
- The laboratory consistently reports the same QC failure.
- The laboratory uses different methods than requested.
- The laboratory subcontracts analyses without notifying the client.
- The laboratory does not meet contract requirements.
- The laboratory misses holding times.
- The laboratory fails to provide requested resource(s) (containers, calibration, etc.) in a timely manner.
- There any doubts about the acceptability of the data.
- Detection limits are above the expected values and the laboratory provides no reasonable explanation.

**FM 2200. Scheduling Services**

1. Notify the laboratory about the analytical and equipment needs at least a week in advance of the actual sampling trip.

2. Even if the trip is routine (monthly, weekly, quarterly compliance sampling), provide the laboratory with a written request. Include:

- Number and types of samples to be collected;
- Test methods to be performed;
- Expectations for quality control acceptance criteria (if not already listed in a contract);
- Estimated numbers of each type of container;
- Required preservatives, including whether the laboratory will dispense premeasured quantities into the sample containers;
- Preservation supplies such as graduated, disposable pipets;
- Additional preservatives (even if the containers are prepreserved);
- Sampling equipment including material construction;
- Shipping containers;
- Forms (both courier and transmittal/custody forms);
- Any calibration services;
- Estimated time of delivery;
- Expected turn-around time;

- Special needs such as "requires legal chain of custody" or "requires 24-hour turn-around time";
- Data processing services (such as completing regulatory forms); and
- Expected contamination levels. This is important if a highly contaminated site is sampled.

## ***FM 3000. TRIP PLANNING***

1. Ensure that everyone involved with the event understands the purpose of the trip:
  - 1.1. Review the associated sampling plan, quality assurance project plan or permit requirements.
  - 1.2. Review the applicable safety plans and site files.
2. Determine the number of people that will be required to complete the sampling activities within the allotted time frame. For safety and efficiency, a field team should consist of at least two people.
3. Identify sampling team member(s) and schedule a meeting of the sampling team.
  - 3.1. Develop a detailed itinerary and schedule.
    - 3.1.1. Plan to sample from the least contaminated to the most contaminated sampling point.
    - 3.1.2. Plan to work upstream in flowing water.
  - 3.2. Review personnel training and make assignments based on experience.
    - 3.2.1. Ensure that at least one trained, experienced individual is part of the team.
  - 3.3. Review the SOPs and any associated documents (sampling plan, quality assurance project plan, permit, etc.).
  - 3.4. Review project/site files for unusual procedures or site peculiarities.
  - 3.5. Review the safety plan and discuss contingencies (weather, broken equipment, site access, etc.).
    - 3.5.1. If the sampling event is more than 3 - 5 days, a written contingency plan is recommended.
    - 3.5.2. If a boat will be used, a float plan is highly recommended.
    - 3.5.3. At a minimum discuss and have available:
      - 3.5.3.1. Phone and directions to nearest emergency facility;
      - 3.5.3.2. Phone number(s) of supervisor and/or project manager;
      - 3.5.3.3. Locations of power lines and underground utilities; and
      - 3.5.3.4. Expected environmental hazards.
4. Schedule the date for deployment and the duration of the sampling event.
  - 4.1. Obtain the necessary entry permits, keys, etc.
  - 4.2. Identify name(s) and phone number(s) of landowner, tenant or other responsible party.

5. Assemble any needed maps, directions and site descriptions. Include information on:
  - 5.1. Traffic conditions and/or traffic patterns; and
  - 5.2. Parking areas.
6. Identify the number of sampling points, and for each sampling point:
  - 6.1. Determine the matrices that will be sampled;
  - 6.2. Identify the specific analyses to be performed per matrix;
  - 6.3. Identify the sampling equipment needs based on the matrix and analytes to be collected. Include tubing, mixing implements and other support equipment;
  - 6.4. Based on the analytical tests and the matrices, determine the number and types of sample containers;
  - 6.5. Based on the analytical tests and the matrices, determine the types of preservatives that will be needed;
  - 6.6. Determine what field measurements must be made; and
  - 6.7. Identify transportation mode to reach the location (boat, truck, etc.).
7. Calculate the total number of each container types (both preserved and unpreserved).
8. Determine the total number of sampling equipment sets (tubing, mixing trays, coring devices, etc.) that will be needed for the sampling event.
9. Notify the laboratory of the trip and arrange for necessary containers, preservatives and other supplies (see FM 2200).
10. Reserve appropriate vehicles.
11. Assemble all field records (notebooks, forms, transmittal forms, etc.).

## ***FM 4000. EQUIPMENT AND SUPPLY PREPARATION***

1. SAMPLING EQUIPMENT: Assemble all equipment identified in FM 3000, section 8.
  - 1.1. Inspect equipment for cracks, breaks, and other signs of wear.
  - 1.2. If necessary, repair any equipment and document the repairs in appropriate maintenance logs.
  - 1.3. Reclean any equipment that was cleaned but not protected from the environment (stored on dusty shelves).
    - 1.3.1. If not already clean, decontaminate equipment according to FC 1000.
    - 1.3.2. Clean all transport ice chests and water transport containers (see FC 1190 and FC 1180, respectively).
  - 1.4. Check to make sure fuel and battery powered pumps are working.
  - 1.5. See "Field Sample Collection Equipment Checklist".
2. FIELD MEASUREMENTS: Assemble field instruments to make the measurements identified in FM 3000, section 6.6.
  - 2.1. Inspect instruments for damage.

- 2.1.1. Repair and/or replace parts as necessary, and document in appropriate maintenance logs.
- 2.1.2. Assemble the appropriate calibration standards and supplies.
- 2.1.3. Determine the accuracy of the instruments by either performing an initial calibration or checking the calibration before leaving the base of operations. Document the calibration check.
- 2.2. See "General Field Support Equipment Checklist", item 7.
3. DOCUMENTATION: Assemble field record supplies:
  - Notebooks, and/or forms
  - Indelible/waterproof pens
  - Clipboards
  - Cameras
  - GPS unit, if needed
  - See "General Field Support Equipment Checklist".
4. SAMPLE CONTAINERS: Assemble the appropriate types of sample containers or obtain them from the contracted laboratory. See "General Field Support Equipment Checklist", item 8.
5. PRESERVATIVES: Assemble preservation supplies if not provided by the laboratory.
  - 5.1. Discard any old solutions; clean containers; and prepare fresh solutions.
  - 5.2. See "General Field Support Equipment Checklist", item 2.
6. FIELD DECONTAMINATION SUPPLIES: Assemble field decontamination supplies.
  - 6.1. Discard any old solutions; clean containers; and prepare fresh solutions.
  - 6.2. Discard analyte-free water and obtain fresh water.
  - 6.3. See "General Field Support Equipment Checklist", item 1.
7. SHIPPING SUPPLIES: Assemble shipping supplies:
  - 7.1. Determine nearest point to obtain ice;
  - 7.2. Marking pens, shipping labels, tape, custody seals (if required);
  - 7.3. See "General Field Support Equipment Checklist", item 3.
8. VEHICLES:
  - 8.1. Make sure vehicle maintenance is up-to-date.
  - 8.2. Check fluids.
  - 8.3. Check tire pressure.
  - 8.4. Check fuel and fuel supply.
  - 8.5. See "General Field Support Equipment Checklist", item 10.

9. SAFETY EQUIPMENT: Assemble any needed safety equipment:
- Protective gloves.
  - Protective clothing including boots.
  - SCUBA gear or other supplied air supply.
  - First aid kit.
  - Drinking water.
  - Float plan.
  - Address and phone numbers for nearest emergency room.
  - See "General Field Support Equipment Checklist", item 6.

**Appendix FM 1000**

**Tables, Figures and Checklists**

Table FM 1000-1 Data Qualifier Codes

General Field Support Equipment Checklist

Field Sample Collection Equipment Checklist

**Table FM 1000-1  
 DATA QUALIFIER CODES**

The following codes shall be used by laboratories and/or field organizations when reporting data values that either meet the specified description outlined below or do not meet the quality control criteria of the laboratory:

Symbol	Meaning
A	Value reported is the arithmetic mean (average) of two or more determinations. This code shall be used if the reported value is the average of results for two or more discrete and separate samples. These samples shall have been processed and analyzed independently. Do not use this code if the data are the result of replicate analysis on the same sample aliquot, extract or digestate.
B	Results based upon colony counts outside the acceptable range. This code applies to microbiological tests and specifically to membrane filter colony counts. The code is to be used if the colony count is generated from a plate in which the total number of coliform colonies is outside the method indicated ideal range. This code is not to be used if a 100 mL sample has been filtered and the colony count is less than the lower value of the ideal range.
F	When reporting species: F indicates the female sex.
H	Value based on field kit determination; results may not be accurate. This code shall be used if a field screening test (i.e., field gas chromatograph data, immunoassay, vendor-supplied field kit, etc.) was used to generate the value and the field kit or method has not been recognized by the Department as equivalent to laboratory methods.
I	The reported value is greater than or equal to the laboratory method detection limit but less than the laboratory practical quantitation limit.
J	Estimated value. A "J" value shall be accompanied by a detailed explanation to justify the reason(s) for designating the value as estimated. Where possible, the organization shall report whether the actual value is estimated to be less than or greater than the reported value. A "J" value shall not be used as a substitute for K, L, M, T, V, or Y, however, if additional reasons exist for identifying the value as an estimate (e.g., matrix spiked failed to meet acceptance criteria), the "J" code may be added to a K, L, M, T, V, or Y. Examples of situations in which a "J" code must be reported include: instances where a quality control item associated with the reported value failed to meet the established quality control criteria (the specific failure must be identified); instances when the sample matrix interfered with the ability to make any accurate determination; instances when data are questionable because of improper laboratory or field protocols (e.g., composite sample was collected instead of a grab sample); instances when the analyte was detected at or above the method detection limit in a blank other than the method blank (such as calibration blank or field-generated blanks and the value of 10 times the blank value was equal to or greater than the associated sample value); or instances when the field or laboratory calibrations or calibration verifications did not meet calibration acceptance criteria.

**Table FM 1000-1  
 DATA QUALIFIER CODES**

Symbol	Meaning
	Off-scale low. Actual value is known to be less than the value given. This code shall be used if:
K	1. The value is less than the lowest calibration standard and the calibration curve is known to be non-linear; or
	2. The value is known to be less than the reported value based on sample size, dilution.
	This code shall not be used to report values that are less than the laboratory practical quantitation limit or laboratory method detection limit.
L	Off-scale high. Actual value is known to be greater than value given. To be used when the concentration of the analyte is above the acceptable level for quantitation (exceeds the linear range or highest calibration standard) and the calibration curve is known to exhibit a negative deflection.
M	When reporting chemical analyses: presence of material is verified but not quantified; the actual value is less than the value given. The reported value shall be the laboratory practical quantitation limit. This code shall be used if the level is too low to permit accurate quantification, but the estimated concentration is greater than or equal to the method detection limit. If the value is less than the method detection limit use "T" below.
	Presumptive evidence of presence of material. This qualifier shall be used if:
N	1. The component has been tentatively identified based on mass spectral library search; or
	2. There is an indication that the analyte is present, but quality control requirements for confirmation were not met (i.e., presence of analyte was not confirmed by alternative procedures).
O	Sampled, but analysis lost or not performed.
Q	Sample held beyond the accepted holding time. This code shall be used if the value is derived from a sample that was prepared or analyzed after the approved holding time restrictions for sample preparation or analysis.
T	Value reported is less than the laboratory method detection limit. The value is reported for informational purposes only and shall not be used in statistical analysis.
U	Indicates that the compound was analyzed for but not detected. This symbol shall be used to indicate that the specified component <b>was not</b> detected. The value associated with the qualifier shall be the laboratory method detection limit. Unless requested by the client, less than the method detection limit values shall not be reported (see "T" above).
V	Indicates that the analyte was detected at or above the method detection limit in both the sample and the associated method blank and the value of 10 times the blank value was equal to or greater than the associated sample value. Note:

**Table FM 1000-1  
 DATA QUALIFIER CODES**

Symbol	Meaning
	unless specified by the method, the value in the blank shall not be subtracted from associated samples.
X	Indicates, when reporting results from a Stream Condition Index Analysis (LT 7200 and FS 7420), that insufficient individuals were present in the sample to achieve a minimum of 280 organisms for identification (the method calls for two aliquots of 140-160 organisms), suggesting either extreme environmental stress or a sampling error.
Y	The laboratory analysis was from an improperly preserved sample. The data may not be accurate.
Z	Too many colonies were present for accurate counting. Historically, this condition has been reported as "too numerous to count" (TNTC). The "Z" qualifier code shall be reported when the total number of colonies of all types is more than 200 in all dilutions of the sample. When applicable to the observed test results, a numeric value for the colony count for the microorganism tested shall be estimated from the highest dilution factor (smallest sample volume) used for the test and reported with the qualifier code.
?	Data are rejected and should not be used. Some or all of the quality control data for the analyte were outside criteria <sub>1</sub> and the presence or absence of the analyte cannot be determined from the data.
*	Not reported due to interference.

The following codes deal with certain aspects of field activities. The codes shall be used if the laboratory has knowledge of the specific sampling event. The codes shall be added by the organization collecting samples if they apply:

Symbol	Meaning
D	Measurement was made in the field (i.e., in situ). This code applies to any value (except field measurements of pH, specific conductance, dissolved oxygen, temperature, total residual chlorine, transparency, turbidity or salinity) that was obtained under field conditions using approved analytical methods. If the parameter code specifies a field measurement (e.g., "Field pH"), this code is not required.
E	Indicates that extra samples were taken at composite stations.
R	Significant rain in the past 48 hours. (Significant rain typically involves rain in excess of 1/2 inch within the past 48 hours.) This code shall be used when the rainfall might contribute to a lower than normal value.
I	Data deviate from historically established concentration ranges.

**General Field Support Equipment Checklist**

Date: \_\_\_\_\_

Project/Site: \_\_\_\_\_

**DECONTAMINATION SUPPLIES**

- Basins, buckets or bowls to hold wash water and various rinse waters
  - Brushes or other implements to clean equipment
  - Detergents
    - Liqui-Nox or equivalent
    - Alconox or equivalent
  - Acids
    - Nitric
    - Hydrochloric
  - Solvents
  - Pesticide grade isopropanol
    - Other: \_\_\_\_\_
  - Protective wrapping
    - Foil
    - Untreated Plastic bags
    - Bubble wrap
  - Analyte-free water
    - Distilled in HDPE
    - Deionized in HDPE
  - Organic-free in HDPE, Teflon or glass
  - Dispensing bottles
  - HDPE for acids and detergents
  - Teflon for solvents and organic-free water
  - Paper towels or other absorbent material
  - Containers for IDW
- PRESERVATION SUPPLIES**
- Acids
    - Nitric
    - Hydrochloric
    - Sulfuric
  - Dechlorination reagents
    - Sodium thiosulfate
    - Ascorbic acid
  - Sodium hydroxide
  - Dispensing devices

- Graduated disposable plastic pipets
- Glass Pasteur pipets
- Bulbs
- Premeasured reagents in vials
- Narrow range pH paper (range of no more than 3 pH units)
  - pH range of 1 – 3
  - pH range of 11 – 14
  - pH range of 6 – 8
- Cyanide processing
  - Sulfide test paper
  - Precipitating Chemical
  - Cadmium nitrate or Cadmium carbonate or
    - Lead nitrate or Lead carbonate
    - KI starch paper
    - Ascorbic acid
    - Filter paper

**SAMPLE TRANSPORTATION SUPPLIES**

- Ice chests
- Wet ice
- Sealing tape
- Shipping labels
- Shipping forms
- Bubble wrap
- Plastic bags
- Vermiculite
- Custody seals

**DOCUMENTATION SUPPLIES**

- Notebooks/logs/field forms
- Pens and markers (waterproof)
- Sample container labels/tags
- Custody tags
- Custody/transmittal forms
- Clipboard
- Camera
- Film

- GPS equipment
- Calculator

**REFERENCE MATERIALS**

- Site maps and directions
- QAPP
- Sampling plan
- SOPs
- Itinerary
- Float plan
- Contingency plan

**HEALTH & SAFETY SUPPLIES**

- Cell phone
- First aid kit
- Drinking water
- Protective gloves
- Insect repellent
- Sunscreen
- Numbers for nearest emergency facilities
- Safety goggles
- Applicable MSDS sheets
- Respirators
- Fire extinguisher
- Hard hats
- Flotation jackets
- Cable cutters
- Traffic cones
- SCUBA gear
- SCBA gear
- Other personal protection gear

**FIELD MEASUREMENT EQUIPMENT**

- Lint-free tissues
- Flow-through cells
- pH meter
  - 4, 7 & 10 buffers
- Conductivity meter
  - Solution at expected conductivity
- DO meter
- Turbidimeter
  - Gel or Formazin standards

**General Field Support Equipment Checklist**

Date: \_\_\_\_\_

Project/Site: \_\_\_\_\_

- Residual chlorine
  - Secondary or primary standards
- Secchi disk
- MultiProbe

**SAMPLE CONTAINERS**

- Extractable Organics
  - Volatile Organics
  - Nutrients
    - Glass
    - Plastic
  - Inorganic Non-metallics
    - Glass
    - Plastic
  - Physical Parameters
    - Glass
    - Plastic
  - Metals
    - Glass
    - Plastic
  - Microbiology
    - Glass
    - Plastic
  - Whole Effluent Toxicity
  - Tissues
  - Macrobenthic invertebrates
  - Periphyton
  - Sediment/Soil volatiles
  - Sediment/Soil
- Remember:
- Extra containers
  - Extra VOC septa

**FILTRATION EQUIPMENT**

- 1 µm filter units
- 0.45 µm filters
- Peristaltic pump
- Pressurized bailers
- Syringe with Luer-Lok fitting
- Tripod filter with pressure/vacuum source
- Forceps for handling filters

**VEHICLES**

- Truck
- Fuel
- Boat
- Fuel
- Motor
- Paddles/oars
- Safety vests

**MISCELLANEOUS SUPPLIES**

- Hip boots
- Chest waders
- Rain gear
- Tool kit
- Extra batteries
- Stopwatch

**Field Sample Collection Equipment Checklist**

Date: \_\_\_\_\_

Project/Site: \_\_\_\_\_

**GROUNDWATER**

**Pumps**

- Peristaltic
- Centrifugal
- Variable speed submersible
- Submersible
- Variable speed bladder
- Bladder

**Tubing**

- Teflon \_\_\_\_\_ Sets
- Polyethylene \_\_\_\_\_ Sets
- Polypropylene \_\_\_\_\_ Sets
- Vinyl \_\_\_\_\_ Sets
- Rubber \_\_\_\_\_ Sets
- Tygon \_\_\_\_\_ Sets

**Bailers**

- Teflon
- Stainless steel
- Polyethylene
- Acrylic
- PVC

**Support Equipment**

- Graduated containers for measuring purge water
- Containers for holding purge waters
- Water level measuring device
- Plastic sheeting
- Lanyard material
- Reels
- Energy source for pumps

**SURFACE WATER**

**Pumps:**

- Peristaltic
- Automatic composite sampler
- Other

**Tubing**

- Teflon™ \_\_\_\_\_ Sets
- Polyethylene \_\_\_\_\_ Sets
- Polypropylene \_\_\_\_\_ Sets
- Vinyl \_\_\_\_\_ Sets
- Rubber \_\_\_\_\_ Sets
- Tygon \_\_\_\_\_ Sets

**Bailers**

- Teflon
- Stainless Steel
- Polyethylene
- Acrylic
- PVC

**Grab Sampling Devices:**

- Dipper
- Kemmerer
- Alpha water sampler
- Niskin
- Beta sampler
- Retrieval lines

**Mixing Implements**

- Churn splitter

**WASTEWATER**

- Pond sampler
- Dippers
- Peristaltic pump

**Tubing**

- Teflon \_\_\_\_\_ Sets
- Polyethylene \_\_\_\_\_ Sets
- Polypropylene \_\_\_\_\_ Sets
- Vinyl \_\_\_\_\_ Sets
- Rubber \_\_\_\_\_ Sets
- Tygon \_\_\_\_\_ Sets
- Kemmerer
- Van Dorn
- Nansen
- Alpha bottle
- Beta bottle
- Niskin
- DO dunker
- Automatic composite sampler

**Tubing**

- Teflon \_\_\_\_\_ Sets
- Polyethylene \_\_\_\_\_ Sets
- Polypropylene \_\_\_\_\_ Sets
- Vinyl \_\_\_\_\_ Sets
- Rubber \_\_\_\_\_ Sets
- Tygon \_\_\_\_\_ Sets

**Bailers**

- Plastic
- Teflon
- Stainless steel

**Scoops**

- Plastic
- Teflon
- Stainless steel

**Beakers**

- Plastic
- Teflon
- Stainless steel

**Buckets**

- Plastic
- Stainless steel

**SEDIMENTS**

**Dredges**

- Petersen
- Ponar
- Ekman
- Young Grab
- Van Veen
- Shipek
- Orange-peel grab
- Smith-McIntyre grab

**Drag buckets**

- Winch
- Cable/line
- Messenger

**Coring Devices**

- Stainless steel
- Glass
- Plastic
- Teflon-lined

**SOIL**

- Bucket auger
- Split spoon sampler
- Stainless steel shovel
- Garden shovel
- Stainless steel trowel or scoop
- Plastic trowel or scoop
- Trenching device
- Coring Devices
- Stainless steel
- Glass
- Plastic
- Teflon-lined
- Shelby tube
- EnCore

**Field Sample Collection Equipment Checklist**

Date: \_\_\_\_\_ Project/Site: \_\_\_\_\_

**WASTE**

- Stainless steel scoop
- Stainless steel spoons or spatulas
- Stainless steel push tubes
- Stainless steel auger
- Stainless steel Ponar dredge
- Glass coliwasa
- Drum thief
- Mucksucker
- Dipstick
- Stainless steel bacon bomb
- Stainless steel bailer
- Teflon bailer
- Peristaltic pump
- Stainless steel split spoon
- Roto-hammer
- Glass tubing

**SHELLFISH**

- Seine
- Trawl
- Bucket type/double pole
- Tong/Double handed grab
- Line or cable operated grab bucket
- Petersen
- Ponar
- Ekman
- Orange-peel grab
- Biological or hydraulic dredge
- Scoops/shovels
- Scrapers
- Rakes
- D-traps
- Processing Equipment
- Holding trays
- Stainless steel shucking knife
- Calipers or ruler
- Aluminum foil
- Plastic bags

**FINFISH**

- Electrofishing devices
- Seines

- Trawls
- Angling
- Gill net
- Trammel net
- Hoop, fyke & pound nets
- D-traps
- Processing Equipment
- Holding trays
- Measuring board or ruler
- Stainless steel descaler
- Stainless steel scalpel
- Balance
- Aluminum foil
- Plastic bags

**BIOLOGICAL COMMUNITY**

**SAMPLING**

- Phytoplankton
- Van Dorn
- Alpha bottle
- Logol's solution
- Periphyton
- Periphytometer
- Microscope slides
- 100% buffered formalin
- Nylon twine
- Qualitative Periphyton Sampling
- Stainless steel spatula/spool
- Stainless steel forceps
- Suction bulb
- Preservative
  - Buffered formalin
  - Lugol's solution
- M3
- Resealable plastic bags
- White picking pan
- Benthic Macroinvertebrates
- Forceps
- Transfer pipettes
- White picking pans
- 10X hand lens
- Alcohol-filled jars
- Dip net (30 mesh)
- Hester-Dendy
- Coring device

- Dredge
- Ekman
- Petite ponar
- 30 mesh box sieve

## **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., <math><6^{\circ}\text{C}</math>), 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

DEP-SOP-001/01  
 FS 1000 General Sampling Procedures  
**Table FS 1000-1**  
**Equipment Construction Materials**

Construction Material <sup>1</sup>	Acceptable Analyte Groups	Precautions
<b>Metals</b>		
316 Stainless Steel	All analyte groups. Recommended for inorganic nonmetalloids, metals, volatile and extractable organics.	Do not use if weathered, corroded or pitted. <sup>2</sup>
300-Series Stainless Steel (304, 303, 302)	Suitable for all analyte groups (if used, check for corrosion before use). Recommended for inorganic nonmetalloids, metals, volatile and extractable organics.	Do not use if weathered, corroded or pitted. <sup>2</sup> 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 nonmetalloids only.	Coring devices are acceptable for all analyte groups <b>if</b> appropriate liners are used. Use Teflon liners for organics. Use plastic or Teflon liners for metals. Do not use if weathered, corroded or pitted. <sup>2</sup> 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 nonmetalloids only.	Do not use if weathered, corroded or pitted. <sup>2</sup>
<b>Plastics<sup>3</sup></b>		
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.

DEP-SOP-001/01  
 FS 1000 General Sampling Procedures  
**Table FS 1000-1**

**Equipment Construction Materials**

Construction Material <sup>1</sup>	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.
Viton	All analyte groups except extractable and volatile organics. <sup>4</sup>	Do not use silicone if sampling for silica. Minimize contact with sample. Use only if no alternative material exists.
<b>Glass</b>		
Glass, borosilicate	All analyte groups except silica and boron.	

Adapted from USGS Field Manual, Chapter 2, January 2000.

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- <sup>1</sup> 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.)
- <sup>2</sup> Corroded/weathered surfaces are active sorption sites for organic compounds.
- <sup>3</sup> Plastics used in connection with inorganic trace element samples (including metals) must be uncolored or white.
- <sup>4</sup> 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**

<b>Analyte Group</b>	<b>Acceptable Materials</b>
Microbiological samples	Teflon Stainless steel Polyethylene (All types) Polypropylene (All types) Tygon, Viton, Silicone, Neoprene PVC Glass Sterilize all <b>sample</b> containers. Thoroughly clean <b>sampling equipment</b> and rinse several times with sample water before collection. Sampling equipment <b>does not</b> <b>require</b> sterilization <b>Do not rinse sample containers</b>

**Table FS 1000-3**  
**Equipment Use and Construction**

<u>EQUIPMENT</u>	<u>CONSTRUCTION</u> HOUSING <sup>1</sup>	<u>USE</u> TUBING	<u>PERMISSIBLE ANALYTE GROUPS</u>	<u>RESTRICTIONS AND PRECAUTIONS</u>
<b>WATER SAMPLING</b>				
<b>GROUNDWATER</b>				
1 Positive displacement pumps <sup>2</sup>				
a. Submersible (turbine, helical rotor, gear driven)	SS, Teflon	Purging	All analyte groups	<sup>3,4,5</sup> must be variable speed
	SS, Teflon	Sampling	All analyte groups	<sup>3,4,5</sup> must be variable speed
		Purging	All analyte groups	<sup>3,4,5</sup> must be variable speed; polishing required <sup>7</sup>
	Non-inert <sup>6</sup>	Sampling	All analyte groups <u>except</u> 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	Purging	All analyte groups	<sup>3,4,5</sup> must be variable speed
		Sampling	All analyte groups	<sup>3,4</sup> 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	Purging	All analyte groups	<sup>3,4</sup> must be variable speed; polishing required <sup>7</sup> <b>This configuration is <u>not</u> recommended</b>
	Non-inert <sup>6</sup>	Sampling	All analyte groups <u>except</u> volatile and extractable organics	<sup>3,4</sup> must be variable speed If sampling for metals, the tubing must be non-metallic if not SS
	Non-inert <sup>6</sup>	Purging	All analyte groups	<sup>3,4</sup> must be variable speed; polishing required <sup>7</sup>
		Sampling	All analyte groups <u>except</u> volatile and extractable organics	<sup>3,4</sup> must be variable speed; polishing required <sup>7</sup> If sampling for metals, the tubing must be non-metallic if not SS

**Table FS 1000-3  
Equipment Use and Construction**

<u>EQUIPMENT</u>	<u>CONSTRUCTION</u> <u>HOUSING</u> <sup>1</sup>	<u>USE</u>	<u>PERMISSIBLE ANALYTE GROUPS</u>	<u>RESTRICTIONS AND PRECAUTIONS</u>
<u>TUBING</u>				
2. Suction lift pumps				
a. Centrifugal	N/A	SS, Teflon, PE, PP	All analyte groups	<sup>4</sup> foot-valve required Must be variable speed
	N/A	Non-inert <sup>6</sup>	All analyte groups	<sup>4</sup> foot-valve required; polishing required Must be variable speed
b. Peristaltic				
	N/A	SS, Teflon, PE, PP	All analyte groups	<sup>4</sup> foot-valve required; polishing required or continuous pumping required Must be variable speed
		Sampling	All analyte groups <u>except</u> volatile organics	<sup>4</sup> Silicone tubing in pump head Must be variable speed
	N/A	Purging	All analyte groups	<sup>4</sup> foot-valve required
		Sampling	All analyte groups <u>except</u> volatile and extractable organics	<sup>4</sup> Silicone tubing in pump head Must be variable speed
3. Bailers				
	SS, Teflon, PE, PP	N/A	All analyte groups	None; <b>not recommended</b>
		Sampling	All analyte groups	None; <b>not recommended</b>
	Non-inert <sup>6</sup>	N/A	All analyte groups <u>except</u> volatile and extractable organics	None; <b>not recommended</b> If sampling for metals, the tubing must be non-metallic if not SS
		Purging	All analyte groups <u>except</u> volatile and extractable organics	None; <b>not recommended</b> 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; <b>not recommended</b> 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	All analyte groups	None
	Glass	N/A	All analyte groups <u>except</u> boron and fluoride	None
	Non-inert <sup>6</sup>	N/A	All analyte groups <u>except</u> volatile and extractable organics	None

**Table FS 1000-3  
Equipment Use and Construction**

<u>EQUIPMENT</u>	<u>CONSTRUCTION</u> HOUSING <sup>1</sup>	<u>TUBING</u>	<u>USE</u>	<u>PERMISSIBLE ANALYTE GROUPS</u>	<u>RESTRICTIONS AND PRECAUTIONS</u>
2. Nansen, Kemmerer, Van Dorn, Alpha and Beta Samplers, Niskin (or equivalent)	SS, Teflon, Teflon-coated, PE, PP Non-inert <sup>o</sup>	N/A N/A	Specific depth grab sampling	All analyte groups All analyte groups <u>except</u> volatile and extractable organics	None 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 Non-inert <sup>o</sup>	N/A N/A	Grab sampling Grab sampling	All analyte groups All analyte groups <u>except</u> volatile and extractable organics	None None If sampling for metals, the tubing must be non-metallic if not SS
5. Peristaltic pump	N/A N/A	SS, Teflon, PE, PP Non-inert <sup>o</sup>	Specific depth sampling	All analyte groups <u>except</u> volatile organics All analyte groups <u>except</u> volatile and extractable organics	Silicone tubing in pump head Must be variable speed 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 Inorganic nonmetallics in groundwater Metals in groundwater and static wastewater and surface water Metals in moving surface water (i.e., river/stream)	Must use a 0.45 µm filter Must use a 0.45 µm filter 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 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**

<u>EQUIPMENT</u>	<u>CONSTRUCTION</u> HOUSING <sup>1</sup>	<u>USE</u> TUBING	<u>PERMISSIBLE ANALYTE GROUPS</u>	<u>RESTRICTIONS AND PRECAUTIONS</u>
<b>SOLID SAMPLING</b>				
<b>Soils</b>				
1. Core barrel (or liner)	SS, Teflon, glass, Teflon-coated, aluminum, PE, PP	N/A	All analyte groups <sup>8</sup>	9, 10, 11
	Non-inert <sup>6</sup> nonmetals	N/A	All analyte groups	12
	Non-inert <sup>6</sup> metals	N/A	All analyte groups	12
2. Trowel, scoop, spoon or spatula	SS, Teflon, Teflon-coated, PE, PP	N/A	All analyte groups <sup>8</sup>	
	Plastic	N/A	All analyte groups except volatile organics All analyte groups <u>except</u> volatile and extractable organics	Samples for volatile organics must grab samples None Must be nonmetallic if not SS
3. Mixing tray (pan)	SS, Teflon, glass, Teflon-coated, aluminum, PE, PP	N/A	All analyte groups <sup>8</sup>	11
	Non-inert <sup>6</sup>	N/A	All analyte groups except volatile organics All analyte groups	11 10, 11, 12 must be nonmetallic if not SS
		N/A	All analyte groups	
4. Shovel, bucket auger	SS	N/A	All analyte groups <sup>8</sup>	None
	Non-SS	N/A	All analyte groups <sup>8</sup>	10, 11, 12
5. Split spoon	SS or carbon steel w/ Teflon insert	N/A	All analyte groups <sup>8</sup>	10, 11, 12
		N/A	All analyte groups <sup>8</sup>	
6. Shelby tube	SS	N/A	All analyte groups <sup>8</sup>	9
	Carbon steel	N/A	All analyte groups	9, 10, 12
<b>SEDIMENT</b>				
1. Coring devices	SS, Teflon, glass, Teflon-coated, aluminum, PE, PP	N/A	All analyte groups <sup>8</sup>	9, 10, 11

**Table FS 1000-3  
Equipment Use and Construction**

<u>EQUIPMENT</u>	<u>CONSTRUCTION</u>	<u>USE</u>	<u>PERMISSIBLE ANALYTE GROUPS</u>	<u>RESTRICTIONS AND PRECAUTIONS</u>
	<u>HOUSING<sup>1</sup></u>	<u>TUBING</u>		
	Non-inert <sup>6</sup> nonmetallics	N/A	All analyte groups	<sup>12</sup>
	Non-inert <sup>6</sup> metals	N/A	All analyte groups	<sup>9,10,11</sup>
2. Grab – Young, Petersen, Shipek	Teflon, Teflon-lined, SS	N/A	All analyte groups <sup>3</sup>	None
	Carbon steel	N/A	All analyte groups	<sup>10,11</sup>
3. Dredges – Eckman, Ponar, Petit Ponar Van Veen	SS	N/A	All analyte groups <sup>6</sup>	None
	Carbon steel, brass	N/A	All analyte groups	<sup>10,11</sup>
4. Trowel, scoop, spoon or spatula	SS, Teflon, Teflon-coated, PE, PP	N/A	All analyte groups <sup>8</sup>	Samples for volatile organics be grab samples
	Plastic	N/A	All analyte groups except 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	All analyte groups <sup>8</sup>	<sup>11</sup>
	Non-inert <sup>6</sup>	N/A	All analyte groups except volatile and extractable organics	none <sup>11</sup> must be nonmetallic if not SS
<b>WASTE<sup>13</sup></b>				
Scoop	SS	N/A	Liquids, solids & sludges	Cannot collect deeper phases
Spoon	SS	N/A	Solids, sludges	Cannot collect deeper phases
Push tube	SS	N/A	Solids, sludges	Cannot collect deeper phases
Auger	SS	N/A	Solids	None

**Table FS 1000-3  
Equipment Use and Construction**

<u>EQUIPMENT</u>	<u>CONSTRUCTION</u>		<u>USE</u>	<u>PERMISSIBLE ANALYTE GROUPS</u>	<u>RESTRICTIONS AND PRECAUTIONS</u>
	<u>HOUSING</u> <sup>1</sup>	<u>TUBING</u>			
Sediment sampler	SS	N/A	Impoundments, piles	All analyte groups <sup>8</sup>	None
Ponar dredge	SS	N/A	Solids, sludges & sediments	All analyte groups <sup>8</sup>	None
Coilwasa, 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 <sup>8</sup>	Not recommended for viscous wastes
Bailer	SS, Teflon	N/A	Liquids	All analyte groups <sup>8</sup>	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 <sup>8</sup>	
Roto-Hammer	Steel	N/A	Solids	All analyte groups <sup>8</sup>	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**

- 
- <sup>1</sup> 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.).
- <sup>2</sup> If used to collect volatile or extractable organics, all power cords and other tubing must be encased in Teflon, PE or PP.
- <sup>3</sup> If used as a non-dedicated system, pump must be completely disassembled, if practical, and cleaned between wells.
- <sup>4</sup> 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.
- <sup>5</sup> In-line check valve required.
- <sup>6</sup> "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.
- <sup>7</sup> "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.
- <sup>8</sup> Do not use if collecting for hexavalent chromium (Chromium<sup>+6</sup>)
- <sup>9</sup> 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.
- <sup>10</sup> 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.
- <sup>11</sup> Aluminum foil, trays or liners may be used only if aluminum is not an analyte of interest.
- <sup>12</sup> If non-inert-liner, core barrel or implement is used, take samples from the interior part of the collected sample.
- <sup>13</sup> 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 <sup>1</sup>	Preservation <sup>2, 3</sup>	Maximum holding time <sup>4</sup>
<b>Table IA—Bacterial Tests:</b>			
1–5. Coliform, total, fecal, and <i>E. coli</i>	PA, G	Cool, <10 °C, 0.0008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>5</sup>	6 hours <sup>6,7</sup>
6. Fecal streptococci	PA, G	Cool, <10 °C, 0.0008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>5</sup>	6 hours <sup>6</sup>
7. Enterococci	PA, G	Cool, <10 °C, 0.0008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>5</sup>	6 hours <sup>6</sup>
8. Salmonella	PA, G	Cool, <10 °C, 0.0008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>5</sup>	6 hours <sup>6</sup>
<b>Table IA—Aquatic Toxicity Tests:</b>			
9–11. Toxicity, acute and chronic	P, FP, G	Cool, ≤6 °C <sup>8</sup>	36 hours
<b>Table IB—Inorganic Tests:</b>			
1. Acidity	P, FP, G	Cool, ≤6 °C <sup>9</sup>	14 days
2. Alkalinity	P, FP, G	Cool, ≤6 °C <sup>9</sup>	14 days
4. Ammonia	P, FP, G	Cool, ≤6 °C <sup>9</sup> , H <sub>2</sub> SO <sub>4</sub> to pH<2	28 days
9. Biochemical oxygen demand	P, FP, G	Cool, ≤6 °C <sup>9</sup>	48 hours
10. Boron	P, FP, or Quartz	HNO <sub>3</sub> 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 <sup>9</sup>	48 hours
15. Chemical oxygen demand	P, FP, G	Cool, ≤6 °C <sup>9</sup> , H <sub>2</sub> SO <sub>4</sub> 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 <sup>9</sup>	48 hours
23–24. Cyanide, total or available (or CATC)	P, FP, G	Cool, ≤6 °C <sup>9</sup> , NaOH to pH>12 <sup>10</sup> , reducing agent <sup>5</sup>	14 days
25. Fluoride	P	None required	28 days
27. Hardness	P, FP, G	HNO <sub>3</sub> or H <sub>2</sub> SO <sub>4</sub> 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 <sup>9</sup> , H <sub>2</sub> SO <sub>4</sub> to pH<2	28 days
<b>Table IB—Metals:</b>			
7. 18. Chromium VI	P, FP, G	Cool, ≤6 °C <sup>9</sup> , pH = 9.3–9.7 <sup>12</sup>	28 days
35. Mercury (CVAA)	P, FP, G	HNO <sub>3</sub> to pH<2	28 days

**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 <sup>1</sup>	Preservation <sup>2, 3</sup>	Maximum holding time <sup>4</sup>
35. Mercury (CVAFS)	FP, G; and FP-lined cap <sup>13</sup>	5 mL/L 12N HCl or 5 mL/L BrCl <sup>13</sup>	90 days <sup>13</sup>
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 <sub>3</sub> to pH<2, or at least 24 hours prior to analysis <sup>14</sup>	6 months
38. Nitrate	P, FP, G	Cool, ≤6 °C <sup>9</sup>	48 hours
39. Nitrate-nitrite	P, FP, G	Cool, ≤6 °C <sup>9</sup> , H <sub>2</sub> SO <sub>4</sub> to pH<2	28 days
40. Nitrite	P, FP, G	Cool, ≤6 °C <sup>9</sup>	48 hours
41. Oil and grease	G	Cool, ≤6 °C <sup>9</sup> , HCl or H <sub>2</sub> SO <sub>4</sub> to pH<2	28 days
42. Organic Carbon	P, FP, G	Cool, ≤6 °C <sup>9</sup> , HCl, H <sub>2</sub> SO <sub>4</sub> , or H <sub>3</sub> PO <sub>4</sub> to pH<2.	28 days
44. Orthophosphate	P, FP, G	Cool, ≤6 °C <sup>9</sup>	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 <sup>9</sup> , H <sub>2</sub> SO <sub>4</sub> to pH<2	28 days
49. Phosphorous (elemental)	G	Cool, ≤6 °C <sup>9</sup>	48 hours
50. Phosphorous, total	P, FP, G	Cool, ≤6 °C <sup>9</sup> , H <sub>2</sub> SO <sub>4</sub> to pH<2	28 days
53. Residue, total	P, FP, G	Cool, ≤6 °C <sup>9</sup>	7 days
54. Residue, Filterable	P, FP, G	Cool, ≤6 °C <sup>9</sup>	7 days
55. Residue, Nonfilterable (TSS)	P, FP, G	Cool, ≤6 °C <sup>9</sup>	7 days
56. Residue, Settleable	P, FP, G	Cool, ≤6 °C <sup>9</sup>	48 hours
57. Residue, Volatile	P, FP, G	Cool, ≤6 °C <sup>9</sup>	7 days
61. Silica	P or Quartz	Cool, ≤6 °C <sup>9</sup>	28 days
64. Specific conductance	P, FP, G	Cool, ≤6 °C <sup>9</sup>	28 days
65. Sulfate	P, FP, G	Cool, ≤6 °C <sup>9</sup>	28 days
66. Sulfide	P, FP, G	Cool, ≤6 °C <sup>9</sup> , 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 <sup>9</sup>	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 <sup>1</sup>	Preservation <sup>2, 3</sup>	Maximum holding time <sup>4</sup>
69. Temperature	P, FP, G	None required	Analyze
73. Turbidity	P, FP, G	Cool, ≤6 °C <sup>9</sup>	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 <sup>9</sup> , 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>5</sup>	14 days
6, 57, 106. Purgeable aromatic hydrocarbons	G, FP-lined septum	Cool, ≤6 °C <sup>9</sup> , 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>5</sup> , HCl to pH 2 <sup>16</sup>	14 days <sup>16</sup>
3, 4. Acrolein and acrylonitrile	G, FP-lined septum	Cool, ≤6 °C <sup>9</sup> , 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>5</sup> , pH to 4–5 <sup>17</sup>	14 days <sup>17</sup>
23, 30, 44, 49, 53, 77, 80, 81, 98, 100, 112. Phenols <sup>18</sup>	G, FP-lined cap	Cool, ≤6 °C <sup>9</sup> , 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>5</sup>	7 days until extraction, 40 days after extraction
7, 38. Benzidines <sup>18, 19</sup>	G, FP-lined cap	Cool, ≤6 °C <sup>9</sup> , 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>5</sup>	7 days until extraction <sup>20</sup>
14, 17, 48, 50–52. Phthalate esters <sup>18</sup>	G, FP-lined cap	Cool, ≤6 °C <sup>9</sup>	7 days until extraction, 40 days after extraction
82–84. Nitrosamines <sup>18, 21</sup>	G, FP-lined cap	Cool, ≤6 °C <sup>9</sup> , store in dark, 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>5</sup>	7 days until extraction, 40 days after extraction
88–94. PCBs <sup>18</sup>	G, FP-lined cap	Cool, ≤6 °C <sup>9</sup>	1 year until extraction, 1 year after extraction
54, 55, 75, 79. Nitroaromatics and isophorone <sup>18</sup>	G, FP-lined cap	Cool, ≤6 °C <sup>9</sup> , store in dark, 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>5</sup>	7 days until extraction, 40 days after extraction
1, 2, 5, 8–12, 32, 33, 58, 59, 74, 78, 99, 101. Polynuclear aromatic hydrocarbons <sup>18</sup>	G, FP-lined cap	Cool, ≤6 °C <sup>9</sup> , store in dark, 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>5</sup>	7 days until extraction, 40 days after extraction
15, 16, 21, 31, 87. Haloethers <sup>18</sup>	G, FP-lined cap	Cool, ≤6 °C <sup>9</sup> , 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>5</sup>	7 days until extraction, 40 days after extraction
29, 35–37, 63–65, 107. Chlorinated hydrocarbons <sup>18</sup>	G, FP-lined cap	Cool, ≤6 °C <sup>9</sup>	7 days until extraction, 40 days after extraction
60–62, 66–72, 85, 86, 95–97, 102, 103. CDDs/CDFs <sup>18</sup>			
Aqueous Samples: Field and Lab Preservation	G	Cool, ≤6 °C <sup>9</sup> , 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>5</sup> , 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 <sup>1</sup>	Preservation <sup>2, 3</sup>	Maximum holding time <sup>4</sup>
Solids and Mixed-Phase Samples: Field Preservation	G	Cool, ≤6 °C <sup>9</sup>	7 days
Tissue Samples: Field Preservation	G	Cool, ≤6 °C <sup>9</sup>	24 hours
Solids, Mixed-Phase, and Tissue Samples: Lab Preservation	G	Freeze, ≤-10 °C	1 year
<b>Table ID—Pesticides</b>			
Tests: 1–70. Pesticides <sup>18</sup>	G, FP-lined cap	Cool, ≤6 °C <sup>9</sup> , pH 5–9 <sup>22</sup>	7 days until extraction, 40 days after extraction
<b>Table IE—Radiological Tests:</b>			
1–5. Alpha, beta, and radium	P, FP, G	HNO <sub>3</sub> to pH<2	6 months
<b>Table IH—Bacterial Tests:</b>			
1. <i>E. coli</i>			
2. Enterococci	PA, G	Cool, <10 °C, 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>5</sup>	6 hours <sup>6</sup>
<b>Table IJ—Protozoan Tests:</b>			
8. Cryptosporidium	LDPE; field filtration	0–8 °C	96 hours <sup>23</sup>
9. Giardia	LDPE; field filtration	0–8 °C	96 hours <sup>23</sup>

Reference: This table is adapted from Table II, 40 CFR Part 136, 2007

<sup>1</sup> “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 sterilizable material (polypropylene or other autoclavable plastic); “LDPE” is low density polyethylene.

<sup>2</sup> 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,

**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)

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).

<sup>3</sup> 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 (HNO<sub>3</sub>) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H<sub>2</sub>SO<sub>4</sub>) 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).

<sup>4</sup> 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

**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)

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.

<sup>5</sup> Add a reducing agent only if an oxidant (e.g., chlorine) is present. Reducing agents shown to be effective are sodium thiosulfate ( $\text{Na}_2\text{S}_2\text{O}_3$ ), ascorbic acid, sodium arsenite ( $\text{NaAsO}_2$ ), or sodium borohydride ( $\text{NaBH}_4$ ). 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  $\text{NaBH}_4$  or  $\text{NaAsO}_2$  is used, 25 mg/L  $\text{NaBH}_4$  or 100 mg/L  $\text{NaAsO}_2$  will reduce more than 50 mg/L of chlorine (see method “Kelada-01” and/or Standard Method 4500–CN<sup>7</sup> for more information). After adding reducing agent, test the sample using KI paper, a test strip (e.g. for chlorine, SenSafe™ 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.

<sup>6</sup> 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.

<sup>7</sup> 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.

<sup>8</sup> 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.

<sup>9</sup> Aqueous samples must be preserved at  $\leq 6$  °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 “ $\leq 4$  °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 (1/100<sup>th</sup> 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)

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).

<sup>10</sup> 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., Cubitainer™). 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 >

**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)

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)

(6) CHLORINE, HYPOCHLORITE, OR OTHER OXIDANT: Treat a sample known or suspected to contain chlorine, hypochlorite, or other oxidant as directed in footnote 5.

<sup>11</sup> 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.

<sup>12</sup> 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.

<sup>13</sup> 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.

<sup>14</sup> 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.

<sup>15</sup> Guidance applies to samples to be analyzed by GC, LC, or GC/MS for specific compounds.

<sup>16</sup> If the sample is not adjusted to pH 2, then the sample must be analyzed within seven days of sampling.

<sup>17</sup> 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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<sup>18</sup> 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).

<sup>19</sup> If 1,2-diphenylhydrazine is likely to be present, adjust the pH of the sample to  $4.0 \pm 0.2$  to prevent rearrangement to benzidine.

<sup>20</sup> Extracts may be stored up to 30 days at  $< 0$  °C.

<sup>21</sup> For the analysis of diphenylnitrosamine, add 0.008%  $\text{Na}_2\text{S}_2\text{O}_3$  and adjust pH to 7–10 with NaOH within 24 hours of sampling

<sup>22</sup> 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%  $\text{Na}_2\text{S}_2\text{O}_3$ .

<sup>23</sup> 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 <sup>1</sup>	Container <sup>2</sup>	Preservation <sup>3</sup>	Maximum Holding Time <sup>4</sup>
Bromine	DPD Colorimetric <sup>5</sup>	SM 4500-CI-G	P, G	None required	Analyze immediately
Bromates	Ion Chromatography	EPA 300.0 <sup>6</sup>	P, G	Cool 4°C	30 days
Chlorophylls	Spectrophotometric	SM 10200 H	P, G <sup>7</sup>	Dark 4°C Filtered, dark, 20°C	48 hours chilled until filtration <sup>8</sup> , and analyze immediately or 48 hours chilled until filtration <sup>8</sup> , and 28 days (frozen) after filtration
Corrosivity	Calculated (CaCO <sub>3</sub> Stability, Langelier Index)	SM 2330 ASTM D513-92	P, G	Cool 4°C <sup>9</sup>	7 days <sup>9</sup>
FL-PRO	Gas Chromatography	DEP (11/1/95)	G only	Cool 4°C, H <sub>2</sub> SO <sub>4</sub> 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 <sup>10</sup> Hydrometric <sup>10</sup>	SM 2520 B SM 2520 C	G, wax seal	Analyze immediately or use wax seal	30 days <sup>10</sup>
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 <sub>2</sub> SO <sub>4</sub> or HCl to pH<2	28 days
Transparency	Irradiometric <sup>11</sup>	62-302.200(6), FAC	_____	_____	Analyze in-situ
Un-ionized Ammonia	Calculated <sup>12</sup>	DEP-SOP <sup>13</sup>	P, G	Cool 4°C <sup>12</sup> Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>12</sup>	8 hours unpreserved <sup>12</sup> 28 days preserved <sup>12</sup>
Organic Pesticides <sup>14</sup>	GC and HPLC	EPA (600-series) <sup>14</sup>	<sup>15</sup>	<sup>15</sup>	<sup>15</sup>

<sup>1</sup> SM XXXX = procedures from "Standard Methods for the Examination of Water and Wastewater", APHA-AWWA-WPCF, 20<sup>th</sup> 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.

<sup>2</sup> P = plastic, G = glass.

<sup>3</sup> When specified, sample preservation should be performed immediately upon sample collection.

<sup>4</sup> 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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- <sup>5</sup> 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).
- <sup>6</sup> 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.
- <sup>7</sup> Collect samples in opaque bottles and process under reduced light.
- <sup>8</sup> 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..
- <sup>9</sup> 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.
- <sup>10</sup> 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.
- <sup>11</sup> 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 Kahisico Underwater Irradiometer, Model No. 268 WA 310, or an equivalent device having a comparable spectral response.
- <sup>12</sup> 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<sub>2</sub>SO<sub>4</sub> 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.
- <sup>13</sup> DEP Central Analytical Laboratory, Tallahassee, FL, Revision No. 2, 2-12-2001. The document is available from the DEP Standards & Assessment Section..
- <sup>14</sup> 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).
- <sup>15</sup> 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 <sup>1</sup>	14 days until extraction, 40 days after extraction
Dioxins		8290	Amber Glass, 8 oz widemouth with Teflon® -Lined lid	Cool 4°C <sup>1</sup> 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 <sup>1</sup>	1 month until extraction, 4 days after extraction <sup>2</sup>
Mercury	Manual Cold Vapor AA	7471	Glass or plastic 8 oz widemouth (200 grams sample)	Cool 4 ± 2°C <sup>1</sup>	28 days
Microbiology (MPN)		MPN	Sterile glass or plastic	Cool 4°C <sup>1</sup>	24 hours
Aggregate Properties			Glass or plastic	Cool 4°C <sup>1</sup>	14 days
Inorganic nonmetallics all except: Sulfite, Nitrate, Nitrite & o-phosphate Elemental Phosphorus			Glass or plastic Glass or plastic Glass	Cool 4°C <sup>1</sup>	28 days 48 hours 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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<sup>1</sup> Keep soils, sediments and sludges cool at 4°C from collection time until analysis. No preservation is required for concentrated waste samples.

<sup>2</sup> Storage Temperature is 4°C, ±2°C

Table FS 1000-7

Sample Handling, Preservation and Holding Time Table for SW 846 Method 5035

Conc. Level	Sampling Device	Collection Procedure	Sample Container		Preservation	Sample Preparation	Max HT <sup>①</sup>	Determinative Procedure
			Type	Vial Preparation				
≤200 ug/kg	Coring Device	5035 - Section 6.2.1	Glass Vial w/ PTFE-silicone Septum	5035 - 6.1.1	NaHSO <sub>4</sub> / 4°C	5035 - Section 7.2	14 D	Any recognized VOC Method
				5035 - 6.1.1 <sup>②</sup>	4°C	5035 - Section 7.2	48 H	Any recognized VOC Method
				5035 - 6.1.1 <sup>②</sup>	4°C / -10°C <sup>③,④</sup>	5035 - Section 7.2	48 H / 14 D <sup>⑤</sup>	Any recognized VOC Method
	EnCore or equivalent	5035 - Section 6.2.1	EnCore or equivalent	5035 - 6.1.1 <sup>②,⑥,⑦</sup>	4°C	5035 - Section 7.2	48 H	Any recognized VOC Method
		5035 - Section 6.2.1	EnCore or equivalent	5035 - 6.1.1 <sup>⑥,⑦</sup>	NaHSO <sub>4</sub> / 4°C	5035 - Section 7.2 <sup>⑥</sup>	48 H / 14 D <sup>⑤</sup>	Any recognized VOC Method
		5035 - Section 6.2.1	EnCore or equivalent	5035-6.1.1 <sup>②,⑥,⑦</sup>	4°C / -10°C <sup>③,④</sup>	5035 - Section 7.2 <sup>⑥</sup>	48 H / 14 D <sup>⑤</sup>	Any recognized VOC Method
>200 ug/kg	EnCore or equivalent	5035 - Section 6.2.2.3 <sup>⑥</sup>	EnCore or equivalent	5035 - 6.1.3 <sup>⑥,⑦</sup>	4°C	5035 - Sections 7.3.2 & 7.3.3 <sup>⑥</sup>	48 H / 14 D <sup>⑤</sup>	Any recognized VOC Method
>200 ug/kg <sup>⑧</sup>	Coring Device	5035 - Section 6.2.2.3 <sup>⑧</sup>	Glass Vial w/ PTFE-silicone Septum	6.1.3 <sup>⑧</sup>	Methanol/PEG + 4°C	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	4°C	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	4°C	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 + 4°C	5035 - Sections 7.4.3	14 D	Any recognized VOC Method
Dry Wt.	Conventional Devices		Glass with Teflon liner		4°C	5035 - Section 7.5		
Soil Screen	Conventional Devices	DEP SOP - Section 4.3	Glass w/ PTFE-silicone Septum		4°C	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 4°C and stored at -10°C.
- 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 4°C 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 <sup>1</sup>	Holding Time <sup>2</sup>	Holding Time for Extract <sup>3</sup>	Container <sup>4</sup>
MICROBIOLOGICAL-BACTERIA	Cool < 10°C, Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>5</sup>			P or G
Total Coliforms, fecal coliforms & <i>E. coli</i> in drinking water	Cool < 10°C <sup>6</sup> , Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>5</sup>	30 Hours <sup>7</sup>		P or G
Total coliforms and fecal coliforms in source water	Cool < 10°C, Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>5</sup>	8 hours		P or G
Heterotrophic bacteria in drinking water	Conc. HCl or HNO <sub>3</sub> to pH <2 <sup>8,9</sup>	6 mo		P or G
Gross Alpha	Conc. HCl or HNO <sub>3</sub> to pH <2 <sup>8,9</sup>	6 mo		P or G
Gross beta	Conc. HCl or HNO <sub>3</sub> to pH <2 <sup>8,9</sup>	6 mo		P or G
Strontium-89	Conc. HCl or HNO <sub>3</sub> to pH <2 <sup>8,9</sup>	6 mo		P or G
Strontium-90	Conc. HCl or HNO <sub>3</sub> to pH <2 <sup>8,9</sup>	6 mo		P or G
Radium-226	Conc. HCl or HNO <sub>3</sub> to pH <2 <sup>8,9</sup>	6 mo		P or G
Radium-228	Conc. HCl or HNO <sub>3</sub> to pH <2 <sup>8,9</sup>	6 mo		P or G
Cesium-134	Concentrated HCl to pH <<2 <sup>8,9</sup>	6 mo		P or G
Iodine-131	None	8 da		P or G
Tritium	None	6 months		G
Uranium	Conc. HCl or HNO <sub>3</sub> to pH <2 <sup>8,9</sup>	6 mo		P or G
Photon emitters	Conc. HCl or HNO <sub>3</sub> to pH <2 <sup>8,9</sup>	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, 4°C, 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 PTFE 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 <sup>1</sup>	Holding Time <sup>2</sup>	Holding Time for Extract <sup>3</sup>	Container <sup>4</sup>
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	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 <sup>1</sup>	Holding Time <sup>2</sup>	Holding Time for Extract <sup>3</sup>	Container <sup>4</sup>
	dark, ≤10°C for first 48 hr, ≤6°C thereafter			
547	Sodium Thiosulfate Cool, 4°C	14 days (18 mo. frozen)		Glass with PTFE-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 PTFE-lined Septum
549.2	Sodium Thiosulfate (H <sub>2</sub> SO <sub>4</sub> 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 PTFE-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 PTFE-lined Septum
552.1	Ammonium chloride, Cool, 4°C, Dark	14 days	≤4°C, dark 48 hours	Amber Glass with PTFE-lined cap
552.2	Ammonium chloride, Cool, 4°C, Dark	14 days	≤4°C, dark 7 days ≤-10°C 14 days	Amber Glass with PTFE-lined cap
555	Sodium Sulfite, HCl, pH ≤ 2, Dark, Cool 4°C	14 days		Glass with PTFE-lined cap
1613B	Sodium Thiosulfate, Cool, 0-4°C, Dark		Recommend 40 days	Amber Glass with PTFE-lined Cap

<sup>1</sup> Preservation, when required, must be done immediately upon sample collection.

<sup>2</sup> Stated values are the maximum regulatory holding times. Sample processing must begin by the stated time.

<sup>3</sup> Stated time is the maximum time a prepared sample extract may be held before analysis.

<sup>4</sup> (P) polyethylene or (G) or glass. For microbiology, plastic sample containers must be made of sterilizable materials (poly-propylene or other autoclavable plastic).

<sup>5</sup> 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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- <sup>6</sup> 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.
- <sup>7</sup> 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.
- <sup>8</sup> 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.
- <sup>9</sup> 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**

<b>ANALYTE NAME</b>	<b>CONTAINER</b>	<b>PRESERVATION</b>	<b>MAX HOLDING TIME</b>
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				
Mercury	Tissue (filets and edible portions, homogenates)	Plastic, borosilicate glass, quartz, PTFE			Freeze at <-20° C	28 days
Other metals	Tissue (filets and edible portions, homogenates)	Plastic, borosilicate glass, quartz, PTFE	Cool in wet ice or: -----	24 hours	Freeze at <-20° C	6 months
Organics	Tissue (filets and edible portions, homogenates)	Borosilicate glass, PTFE, quartz, aluminum foil	Freeze on dry ice	48 hours	Freeze at <-20° C	1 year
Dioxin	Tissue (filets 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 (filets 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**

<b>Holding Time (Days)</b>				
	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

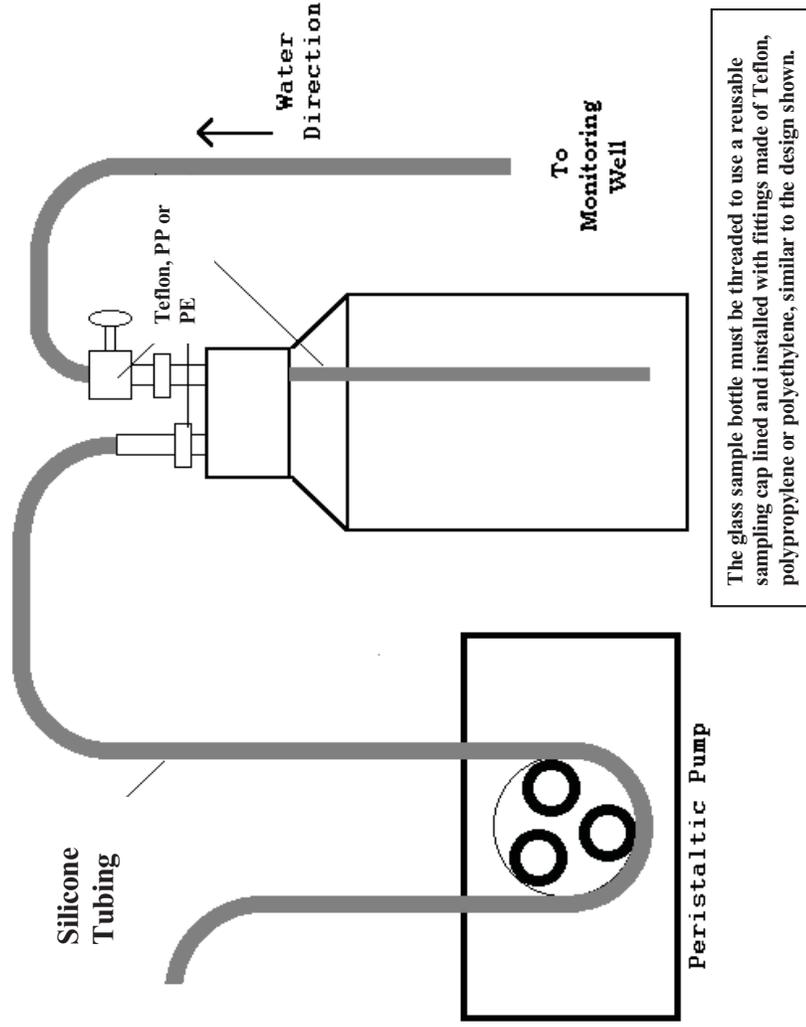
**NA – Not Applicable**

**Table FS 1000-12  
 Preventive Maintenance Tasks**

<b>INSTRUMENT/ACTIVITY</b>	<b>FREQUENCY</b>
<b>REFRIGERATORS, INCUBATORS, OVENS</b> Clean interior Check thermometer temperature against certified thermometer or equivalent	Monthly Annually
<b>ANYTICAL BALANCES</b> Clean pan and compartment Check with Class S weights Manufacturer cleaning and calibration	Daily <sup>1</sup> Monthly Annually
<b>pH AND ION SELECTIVE ELECTRODES PROBE</b> Check probe for cracks and proper levels of filling solution; check reference junction; clean electrode Check response time <b>METER</b> Check batteries and electronics for loose connections and cracked leads	Daily, Replace as necessary Daily <sup>1</sup> Daily <sup>1</sup> , Replace as necessary
<b>TURBIDIMETER</b> Clean instrument housing Clean cells	Monthly Daily <sup>1</sup>
<b>CONDUCTIVITY METER</b> Check batteries and probe cables Replatinize Probe	Daily <sup>1</sup> Per manufacturer's recommendations
<b>DISSOLVED OXYGEN METERS PROBE</b> Check membrane for deterioration; check filling solution <b>METER</b> Battery level and electronics checked	Daily <sup>1</sup> , Replace as necessary Daily <sup>1</sup> , Replace as necessary
<b>THERMOMETERS</b> Check for cracks and gaps in the mercury	Daily <sup>1</sup> , Replace as necessary
<b>TEMPERATURE PROBE</b> Check connections, cables Check against calibrated thermometer	Daily <sup>1</sup> Daily <sup>1</sup>
<b>AUTOMATIC SAMPLE COLLECTION SYSTEMS</b> (e.g., ISCO, Sigma) Check sampler operation (forward, reverse, automatic through three cycles of the purge-pump-purge cycle) Check purge-pump-purge cycle when sampler is installed Check the flow pacer that activates the sampler to assure proper operation Check desiccant Check batteries Check pumping rate against manufacturer's specifications	Daily <sup>1</sup> Prior to Sampling Event Daily <sup>1</sup> Prior to Sampling Event Daily <sup>1</sup> Prior to Sampling Event Daily <sup>1</sup> , Replace as Necessary Daily <sup>1</sup> , Replace as Necessary Daily <sup>1</sup> , Replace as Necessary

<sup>1</sup>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**



## ***FS 2000. GENERAL AQUEOUS SAMPLING***

See also the following Standard Operating Procedures:

- FA 1000 Administrative Procedures
- FC 1000 Cleaning/Decontamination Procedures
- FD 1000-9000 Documentation Procedures
- FM 1000 Field Planning and Mobilization
- FQ 1000 Field Quality Control Requirements

### 1. COMMON PROCEDURES

The following procedures are applicable to the collection of all water samples.

1.1. Refer to FS 1000 for procedures that are common to all types of sample collection including general preservation and thermal preservation procedures.

#### 1.2. Grab Samples

1.2.1.1. This is an individual sample collected over a period of time, usually all in one motion, generally not exceeding 15 minutes. The 15-minute time limit applies to aqueous samples only. No time limit applies to the collection of solid samples (e.g., residuals).

1.2.1.2. Grab samples represent the conditions that exist at the moment the sample is collected and do not necessarily represent conditions at any other time. Grab sampling is the preferred method of sampling under the following conditions:

- A snapshot of the water quality at a particular instant in time is desired.
- The water or wastewater stream is not continuous (e.g., batch discharges or intermittent flow).
- The characteristics of the water or waste stream are known to be constant or nearly so.
- When conditions are relatively constant over the period of discharge. In lieu of complex sampling activities, a grab sample provides a simple and accurate method of establishing waste characteristics.
- The sample is to be analyzed for analytes whose characteristics are likely to change significantly with time (e.g., dissolved gases, microbiological tests, pH).
- The sample is to be collected for analytes such as Oil and Grease, bacteriological tests or other parameters listed in number 3 of this section where the compositing process could significantly affect the actual concentration.
- Data on maximum/minimum concentrations are desired for a continuous water or wastewater stream.
- When identifying and tracking slug loads and spills.

1.2.1.3. If required, measure the following parameters on grab samples or in-situ.

NOTE: If the permit specifies a composite sample for any of the parameters mentioned below, **FOLLOW THE PERMIT CONDITIONS**

Cyanide	Oil and Grease
Residual Chlorine	pH
Dissolved constituents in field-filtered samples (ortho-phosphorus, metals, etc.)	Specific Conductance
Dissolved Oxygen and other dissolved gases	Un-ionized Ammonia
Microbiological Parameters	Volatile Organic Compounds
TRPHs	Temperature
Total Phenols	

### 1.3. Composite Samples

1.3.1. A composite sample is a sample collected over time, formed either by continuous sampling or by mixing discrete samples. Composite samples reflect the average characteristics during the compositing period.

1.3.2. Composite samples are used when stipulated in a permit or when:

- The water or wastewater stream is continuous;
- Analytical capabilities are limited;
- Determining average pollutant concentration during the compositing period;
- Calculating mass/unit time loadings; or
- Associating average flow data to parameter concentrations

1.3.3. Composite samples may be collected individually at equal time intervals if the flow rate of the sample stream does not vary more than plus or minus ten percent of the average flow rate or they may be collected proportional to the flow rate. The permit or work plan will specify which composite sample type to use, either time composites or flow proportional composites. The compositing methods, all of which depend on either continuous or periodic sampling, are described in the following discussions.

1.3.3.1. Time Composite Sample: Time composite samples are based on a constant time interval between samples. A time composite sample can be collected manually or with an automatic sampler. This type of composite is composed of discrete sample aliquots collected in one container at constant time intervals. This method provides representative samples when the flow of the sampled wastewater stream is constant. This type of sample is similar to a sequential composite sample described in number 3.3 of this section.

1.3.3.2. Flow Proportional Composite Sample: Flow proportional samples can be collected automatically with an automatic sampler and a compatible pacing flow measuring device, semi-automatically with a flow chart and an automatic sampler capable of collecting discrete samples, or manually. There are two methods used to collect this type of sample:

- Method 1: Collect a constant sample volume per stream flow (e.g., a 200 mL sample collected for every 5,000 gallons of stream flow) at time intervals proportional to stream flow. This method provides representative samples of all waste streams when the flow is measured accurately.
- Method 2: Collect a sample by increasing the volume of each aliquot as the flow increases, while maintaining a constant time interval between the aliquots (e.g., hourly samples are taken with the sample volume being proportional to the flow at the time the sample is taken).

1.3.3.3. Sequential Composite Sample: Sequential composite samples are composed of discrete samples taken into individual containers at constant time intervals or constant discharge increments. For example, samples collected every 15 minutes are composited for each hour.

- The 24-hour composite is made up from the individual one-hour composites. Each of the 24 individual samples is manually flow-proportioned according to the flow recorded for the hour that the sample represents. Each flow-proportioned sample is then added to the composite samples. The actual compositing of the samples is done by hand and may be done in the field or the laboratory. In most cases, compositing in the field is preferable since only one sample container must be cooled, and then transported to, and handled, in the laboratory. A 24-hour composite is frequently used since an automatic sampler can easily collect the individual samples.
- A variation of the 24-hour composite is to collect a constant volume of sample taken at constant discharge increments, which are measured with a totalizer. For example, one aliquot is collected for every 10,000 gallons of flow
- Sequential sampling is useful to characterize the waste stream because you can determine the variability of the wastewater constituents over a daily period. For example, for pretreatment studies you can visually determine when high strength wastes are being discharged from a facility or when heavy solid loads are being discharged during a 24-hour cycle. You can measure the pH throughout the day. The value of this type of sampling must be weighed against the manpower constraints and sampling goals

1.3.3.4. Continuous Composite Sample: Collected continuously from the stream. The sample may be a constant volume that is similar to the time composite, or the volume may vary in proportion to the flow rate of the waste stream, in which case the sample is similar to the flow proportional composite.

1.3.3.5. Areal Composite: A sample composited from individual grab samples collected on an areal or cross-sectional basis. Areal composites must be made up of equal volumes of grab samples; each grab sample must be collected in an identical manner. Examples include residual samples from grid system points on a land application site, water samples collected at various depths at the same point or from quarter points in a stream, etc sample is similar to the flow proportional composite.

#### 1.4. Collection Techniques

1.4.1. When filling a sample container that already contains premeasured preservative, slowly pour the sample down the side of the container so that the preservative does not

splatter. If the preservative is concentrated acid, and the sample water is added too quickly, the reaction between the water and the acid can generate enough heat to burn unprotected skin or could splatter and cause acid burning.

1.4.2. Collect grab samples (single, discrete samples) unless directed by permit, program, or approved sampling plan or work plan to collect composite samples.

1.4.3. Except for volatile organic compounds and sulfide, leave ample headspace in the sample bottle to allow for expansion, effervescence and proper mixing at the laboratory.

#### 1.5. Collecting Filtered/Dissolved Samples

1.5.1. Certain studies or projects require collection of dissolved (i.e., filtered) samples. Identify all analytes in samples that are filtered as “dissolved” or “filtered” in field notes or laboratory transmittal forms and on final reports.

1.5.2. Collect both filtered and unfiltered samples from the same water in a collection device (e.g., bailer, intermediate container) or consecutively if sampling from a pump.

1.5.3. Collect dissolved metals in groundwater according to the procedures discussed in FS 2225. **Do not** collect filtered samples for metals from groundwater sources unless:

1.5.3.1. The DEP has required or approved the protocol and the DEP program allows the use of the procedure; or

1.5.3.2. The organization is documenting that a filtered groundwater sample is as or more representative of the groundwater quality. In this case, collect **both** unfiltered and filtered samples for analysis. Submit the results of both samples the DEP for review.

1.5.4. Filtration, when performed, must begin within 15 minutes of sample collection.

1.5.5. Collect dissolved groundwater samples for metals with a one-piece molded construction 1 µm filter unless otherwise specified by a DEP program. Use a 0.45 µm filter when filtering all other constituents **including** metals in surface water.

1.5.6. The filter must be compatible with the analyte to be filtered (e.g., zero carbon content for carbon analysis; non-protein binding filters for nitrogen).

1.5.7. Equipment blanks, when collected, must be processed through the filtration apparatus and analyzed for the analytes of interest.

1.5.8. Filters and filtration equipment are intermediate devices and therefore must be adequately rinsed per FS 2110 section 1.1.2.1.

#### THE FOLLOWING ARE SPECIAL CONSIDERATIONS FOR VARIOUS ANALYTE GROUPS:

#### FS 2001. *pH-Preserved Samples*

##### 1. SAMPLE CONTAINERS

1.1. Use properly cleaned sample containers (see FC 1300).

1.2. Inspect all containers for visual defects or contamination. Discard if defects are present or containers do not appear clean.

##### 2. SAMPLE COLLECTION PROCEDURES

2.1. Perform any filtration **before** the sample is poured into the container and **before** the sample is preserved.

2.2. Remove the cap from the sample container, and carefully pour the sample into the container without allowing sampling equipment or hands to touch the rim of the sample container.

2.3. If the preservative is added after the sample is collected, (the container is not prepreserved), do not fill the container to the rim.

### 3. PRESERVATION

3.1. Preserve the sample within 15 minutes of sample collection or filtration (if applicable) unless collected as a composite sample (see FS 1006, section 1.3) or for analysis of lead and copper for drinking water compliance (see FS 2310, section 2).

3.2. Preserve the sample with the chemical specified by the method or preservation tables (Tables FS 1000-4 to FS 1000-10).

3.2.1. The chemical reagents must be pure enough so that the reagent does not contribute contamination or interferences to the analytes of interest.

3.3. Preserve the sample by adding an accurately measured amount of preservative to the container. Premeasured vials of the preservative, or a graduated container or pipet, may be used.

3.3.1. Tightly cap the sample container and gently tip the container two to three times to distribute the chemical.

3.4. The pH of the preserved sample must meet the pH criterion of the applicable preservation tables (see Tables FS 1000-4 to FS 1000-10). **Do not over preserve the sample.**

3.4.1. Pour an aliquot of the preserved sample into a disposable container (e.g., sampling cup) or onto a piece of **narrow** range pH paper to determine if the pH meets the required level. **Do not put the pH paper directly into the sample container.**

3.4.2. If the pH does not meet the required level, add additional measured amounts of preservative and test with narrow range pH paper (see section 3.4.1 above) until the pH meets the pH requirement.

3.4.3. Record the total amount of preservative that was added to the sample. This documentation is necessary for the next site visit, since additional acid may be needed to adequately preserve the sample on subsequent visits.

3.5. Cooling to less than 6°C with wet ice (see FS 1006, section 5) may be required.

3.6. Protect from direct sunlight.

3.7. Preserve at least one of the equipment blanks with the **greatest** amount of preservative that was required in the sample set and note the amount in field documentation.

3.8. After the sample has been preserved, screw the cap on tightly.

4. Verifying pH-Preserved Samples: Verify the pH of all pH-preserved samples (except volatile organics) in the field (see FS 2001, section 3.4). If samples are routinely collected from the same sample location, a pH check is not required each time samples are collected.

4.1. If the frequency of sample collection at a specified location is once per month or greater (e.g., weekly or daily), check the pH of **at least one** sample per parameter group according to the following schedule:

- 4.1.1. Weekly sampling: 1 pH check per month
  - 4.1.2. Daily sampling: 1 pH check per week
  - 4.2. 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.
    - 4.2.1. If site conditions vary from sampling event to sampling event, perform pH checks at increased intervals.
    - 4.2.2. For all other sample collection frequencies, pH checks may be reduced as follows:
      - 4.2.2.1. During the first sampling event at a particular site, check **all** samples (except volatile organics) that are pH-adjusted, and
      - 4.2.2.2. During subsequent visits to a particular site, check **at least one** sample per parameter group that must be pH-adjusted.
5. DOCUMENTATION
    - 5.1. Complete the sample container label and stick firmly on the container.
    - 5.2. Complete the field notes.
    - 5.3. Make notes on the transmittal form and in field records about any relevant observations or problems such as entrained sediment or preservation problems.

## **FS 2002.   *Metals***

1. SAMPLE CONTAINERS
  - 1.1. Use properly cleaned containers (see FC 1300).
  - 1.2. Inspect the containers and caps for visual defects or contamination. Do not use containers if defects are present or if they do not appear clean.
2. SAMPLE COLLECTION PROCEDURES
  - 2.1. Perform any filtration **before** the sample is poured into the container and **before** the sample is preserved.
  - 2.2. Remove the cap from the sample container and carefully pour the sample into the container without allowing sampling equipment or hands to touch the rim of the sample container.
3. PRESERVATION - Follow preservation procedures outlined in FS 2001 above.
  - 3.1. Requirements for specific metals:
    - 3.1.1. For boron or cold-vapor atomic absorption Mercury with a grade of nitric acid (HNO<sub>3</sub>) that is suitable for use for metals analysis. Use concentrated HNO<sub>3</sub> or 1:1 HNO<sub>3</sub> to lower the pH of less than 2 S.U., but greater than 1.62 S.U.
    - 3.1.2. For Chromium VI add sufficient ammonium sulfate buffer solution specified per Table FS 1000-4 to the sample to raise the pH of the sample to a pH of 9.3 – 9.7 and place in ice (see FS 2002).
    - 3.1.3. Trace Level Mercury
      - 3.1.3.1. Collect samples for trace level mercury (<100 ug/L) in tightly-capped fluoropolymer or glass bottles.

3.1.3.2. If the samples cannot be received by the laboratory within 48 hours of sample collection, preserve the sample with BrCl or HCl solution.

3.1.3.3. For dissolved trace level mercury, samples must be filtered through a 0.45 µm filter within 24 hours of sample collection. If the samples cannot be transported to the laboratory within 24 hours, follow the procedures in FS 8200 for field filtration.

3.1.4. Samples collected for lead and copper for drinking water compliance and metals other than those listed above do not require immediate acid preservation.

3.1.4.1. When samples are not acidified with acid, the transmittal form to the laboratory must:

- Clearly state that the samples are unpreserved; and
- Request that the laboratory preserve the samples.

3.1.4.2. If samples are acidified, use concentrated HNO<sub>3</sub> or 1:1 HNO<sub>3</sub> to lower the pH of less than 2 S.U., but greater than 1.62 S.U.

3.2. After the sample has been preserved, screw the cap on tightly.

#### 4. DOCUMENTATION

4.1. Complete the sample container label and stick firmly on the container.

4.2. Complete the field notes.

4.3. Make notes on the transmittal form and in field records about any relevant observations or problems such as entrained sediment.

4.4. On the transmittal form, clearly identify samples that must be acidified by the laboratory (FS 2002, 3.1.3 or 3.1.4 above).

### **FS 2003. *Extractable Organics***

#### 1. SAMPLE CONTAINERS

1.1. Most samples are collected in glass containers with Teflon-lined caps. Note: Teflon containers are also acceptable. There are some exceptions such as collecting samples in amber glass (e.g., nitroamines, nitroaromatics, etc.). If in doubt, verify the proper container type in Tables FS 1000-4 through FS 1000-10.

1.2. Inspect glass bottles to assure that there are no visual glass or liner defects. If defects are present and/or the sample containers do not appear clean, the bottles must be discarded.

1.3. Collect composite samples from automatic sample collection devices in refrigerated glass or Teflon containers through Teflon, polyethylene or polypropylene tubing.

#### 2. SAMPLE COLLECTION PROCEDURES

2.1. Remove the cap from the sample container without touching the interior Teflon liner.

2.2. Carefully pour the sample into the container without allowing sampling equipment or hands to touch the rim of the sample container.

2.3. Fill bottle with sample to almost full capacity.

#### 3. PRESERVATION

- 3.1. In general, these types of samples must be preserved by cooling to 4°C.
  - 3.1.1. Some analyte groups require a chemical preservation. See Tables FS 1000-4 through FS 1000-10 for any additional preservation.
  - 3.1.2. If the samples for pesticides cannot be extracted within 72 hours of collection, the sample pH must be in the range of 5 to 9. If needed, adjust sample to the specified pH range with sodium hydroxide or sulfuric acid.
  - 3.1.3. Add sodium thiosulfate if residual chlorine is present.
- 3.2. Place samples in **wet** ice within 15 minutes of sample collection (see FS 1006, section 5).
4. DOCUMENTATION
  - 4.1. Complete the sample container label and stick firmly on the container.
  - 4.2. Document when samples were placed in wet ice immediately (see FS 1006, section 5).
  - 4.3. Complete the field notes.
  - 4.4. Make notes on the lab transmittal form and the field records about any sample that appears highly contaminated or exhibits other abnormal characteristics (i.e., foaming, odor, etc.).

## **FS 2004.**     *Volatile Organics*

1. SAMPLE CONTAINERS
  - 1.1. Use a screw cap glass sample vial that is sealed with a Teflon-coated septum.
  - 1.2. Collect **at least two** vials of each sample. Some laboratories may require three or more vials, therefore verify the laboratory's policy on the number of vials they require unless the laboratory provides the sampling kit.
  - 1.3. Inspect the vials for glass or septum defects (e.g., rim must not have nicks or visible depressions and the septum must not be deformed). Do not use containers if defects are present or if they do not appear clean.
2. SAMPLE COLLECTION PROCEDURES
  - 2.1. Special precautions for petroleum sources:
    - 2.1.1. If possible, transport and store fuels in a separate vehicle from sampling equipment, empty vials and collected samples. If these items must be transported in the same vehicle as fuel, store the fuels as far away from the vials as possible.
    - 2.1.2. Place all fuel or exhaust sources downwind of the sampling location.
    - 2.1.3. Position all petroleum-fueled engines (including the vehicle) downwind of the sampling operations.
  - 2.2. Do not allow the sampling equipment or hands to touch the rim of the sample container.
  - 2.3. Do not remove septum caps from VOC vials until just prior to filling. Cap vials immediately after filling with sample.
  - 2.4. **DO NOT PRERINSE VOC VIALS.**

- 2.5. Do not aerate the sample during sample collection. If collecting from a spigot or pump, reduce the flow rate to less than 100 mL/min.
- 2.6. If preservation is required, proceed to section 3 below unless the laboratory supplied vials with premeasured quantities of acid, and the sample does not need to be dechlorinated (see 3.2 below).
- 2.6.1. If no preservation is required or if the vials are prepreserved (see 2.5 above), slowly and carefully allow the sample to flow down the **side** of the vial to minimize turbulence. Fill the vial until the surface tension holds the water in a “convex meniscus”.
- 2.6.2. If a vial overflows during the filling process, document the problem and notify the laboratory that the vial may not contain sufficient acid.
- 2.6.3. If using a bailer, the bailer must be equipped with a controlled flow bottom assembly.

### 3. PRESERVATION

- 3.1. Preserve the sample **during** the sample collection process.
- 3.2. Dechlorination: Some treated water samples (drinking water and treated wastewater) may contain residual chlorine that must be removed with a dechlorination agent such as sodium thiosulfate or ascorbic acid. This process must occur **before** any additional preservatives (i.e., acid) are added. The dechlorination agent must be **in the vial** before the sample is added.
- 3.2.1. Laboratories may supply vials with premeasured quantities of dechlorination agent. If acid preservation **is not required**, fill the vials (see section 2.5.1 above) and proceed to section 4 below.
- 3.2.2. For chlorinated drinking water samples, add 3 mg sodium thiosulfate per 40 mL vial.
- 3.2.3. If the chlorine level is unknown, the concentration must be measured (see FT 2000). For sources other than drinking water (e.g., chlorinated effluent), 10 mg sodium thiosulfate per 40 mL vial will remove up to 5 ppm Cl<sub>2</sub>.
- 3.3. Acid Preservation
- 3.3.1. Chlorinated Samples
- 3.3.1.1. If acid preservation is required, carefully fill the vial with sample, but not to a convex meniscus as described in section 2.5.1 above.
- 3.3.1.2. Add four drops of concentrated HCl (more acid may be needed if the sample is known to contain high levels of bicarbonate or is otherwise buffered).
- 3.3.1.3. Add additional sample to create a convex meniscus.

**NOTE:** If the sample reacts with the acid by generating gas, do not submit preserved samples for analysis. Instead, collect unpreserved samples (seven-day holding time must be met).

#### 3.3.2. Unchlorinated Samples

- 3.3.2.1. The laboratory may supply vials with premeasured quantities of acid. In this case, proceed to section 2.5.1 above. If a vial overflows during the filling process, document the problem and notify the laboratory that the vial may not contain sufficient acid.

3.3.2.2. If the samples are preserved in the field, follow the procedure in section 3.3 above.

#### 4. CAPPING THE VIAL

4.1. Fill the vial so that the sample surface is above the container rim (convex meniscus).

4.1.1. **Do not pour** sample into cap.

4.1.2. Fill vial from the original source (tubing, spigot, etc.) **Do not fill vial from sample collected in the cap.**

4.2. **Immediately** cap the vial with the Teflon seal contacting the sample. Some sample may overflow while tightening the cap.

4.3. If acid has been added to the sample, tip the vial gently two or three times to distribute the preservative.

4.4. Turn the vial over and tap it to check for the presence of bubbles.

4.4.1. If bubbles are present, and the total volume of the bubbles is less than 5 mm in diameter, the sample may be submitted.

4.4.2. If the total volume of the bubbles is greater than 5 mm in diameter, discard the vial and fill a new one.

4.4.3. **Do not open a vial to add additional sample.**

#### 5. SAMPLE PACKING

5.1. Label each vial with an appropriate field ID number and preservation (e.g., preserved with acid, sodium thiosulfate/acid, etc.).

5.2. Wrap each vial in a protective material (e.g., bubble wrap).

5.3. Place the set of vials in a small, sealable, untreated plastic bag unless the laboratory supplies an alternate method of packing.

5.4. Place samples in **wet** ice within 15 minutes of sample collection (see FS 1006, section 5).

5.5. Protect samples from environmental contamination during storage and transport to the laboratory.

5.6. As an added measure, DEP recommends wrapping the set of replicate samples in bubble wrap and sealing them in a container. This procedure will add further protection from potential contamination.

#### 6. DOCUMENTATION

6.1. Label all the vials.

6.2. Complete field records.

6.3. Make note in the field records of any samples that appear highly contaminated or appear to effervesce when acid is added.

### **FS 2005.** *Bacteriological Sampling*

#### 1. SAMPLE CONTAINERS

1.1. Collect the samples in properly sterilized containers.

- 1.1.1. Presterilized Whirl-pak bags (or equivalent) are generally used.
- 1.1.2. If Whirl-pak bags are not used, the sample container must have a volume of at least 125 mL.
- 1.1.3. If using bottles, the caps must be sterilized. If the caps are lined, there must be documentation to show that the liner does not produce toxic compounds when sterilized.
- 1.1.4. Bottles and caps must be sterilized according to procedures in FC 1320 or purchased presterilized from a commercial vendor.

## 2. SAMPLE COLLECTION PROCEDURES

- 2.1. Unless a composite is specified by permit, all samples must be grab samples.
- 2.2. Do not open the container once it has been sealed.
- 2.3. Do not rinse sample container before collecting the sample.
- 2.4. Use aseptic techniques to collect the sample:
  - 2.4.1. If an intermediate device is used, thoroughly rinse with sample water. To ensure proper rinsing, DEP recommends that microbiological samples be the last sample collected with the sampling device.
  - 2.4.2. Do not put fingers into the mouth of the container or on the interior of the cap.
  - 2.4.3. Do not disinfect the sample equipment or sampling port.
- 2.5. Rinse the sampling equipment with sample water before collecting the sample. Therefore, collect microbiological samples at the end of a sampling sequence.
- 2.6. Wells with In-Place Plumbing, Spigots and/or Faucets
  - 2.6.1. Do not disinfect the spigot with bleach, alcohol or heat. Turn on spigot and flush at maximum velocity (see FS 2310).
  - 2.6.2. After flushing, reduce the water flow to approximately 500 mL/min and allow the water to flow for a few minutes before collecting samples. If other samples (metals, nutrients, etc.) are to be collected, collect these samples first.
  - 2.6.3. **Do not stop the flow before or during the filling process.**
- 2.7. Direct Grab Sample Collection
  - 2.7.1. Hold a rigid container near the base and plunge neck downward, below the surface. Turn container until the neck points slightly upward with the mouth directed toward the current. Fill to within about 1/2 inch of the top and cap immediately.
  - 2.7.2. Whirl-pak bags (or equivalent)
    - Open the bag by zipping off the top and pulling the white tabs to open the bag. Hold the bag behind the wire ties, and plunge neck downward and up in one sweeping arc; or
    - Zip off the top of the bag. Hold bag so that the mouth and wire ties are in front of the hands and fingers. Immerse the bag, and open the bag into the current.
    - The above procedures may also be accomplished by attaching the bag to a pole.
    - 2.7.2.1. Bring the bag to the surface, and press out excess water.

2.7.2.2. Seal the bag by folding the open ends at least three times and securely twisting the wire ties.

## 2.8. Intermediate Device Collection

2.8.1. When using an intermediate sampling device (bailer, DO dunker, niskin bottle, etc.), obtain sufficient sample in the sample collection device to completely fill the sample container. Begin pouring sample out of the device BEFORE collecting into the container. Continue to pour sample out of the device, place container under flowing stream, and fill. **Do not stop the flow before or during the filling process.**

## 3. PRESERVATION

3.1. Preserve samples according to Tables FS 1000-4 through FS 1000-10.

3.2. Place all samples in wet ice immediately after sample collection (see FS 1006, section 5).

3.3. When the sample contains residual chlorine, add a dechlorinating agent such as sodium thiosulfate to the sample container.

3.3.1. The final concentration of sodium thiosulfate must be approximately 100 milligrams per liter (mg/L) in the sample (add 0.1 mL of a 10% solution of thiosulfate to a 125 mL sample).

3.3.2. Some vendors or laboratories provide sterile containers with premeasured amounts of dechlorinating agent. Determine if the source of the field containers already contain a dechlorinating agent.

3.3.3. **Do not use containers with dechlorinating chemicals** when collecting samples from sources that are known to be free from residual chlorine.

## 4. HOLDING TIME

4.1. The holding time for microbiological samples is very short. Let the laboratory know the approximate time that samples will be collected and when they are expected to be delivered to the laboratory.

4.2. The holding time begins at the time (hours and minutes) the sample is collected and ends at the time that the sample is placed on the applicable growth media.

4.3. Consult Tables FS 1000-4, -6, -8, and -9 for holding times.

## 5. DOCUMENTATION

5.1. Label each sample container with an appropriate field ID number.

5.2. Place samples in **wet** ice within 15 minutes of sample collection (see FS 1006, section 5).

5.3. Complete field records.

5.4. Make note in the field records of any unusual sample appearances or sampling conditions.

## **FS 2006.** *Oil and Grease (O&G) and Total Recoverable Petroleum Hydrocarbons (TRPHs)*

### 1. SAMPLE CONTAINERS

1.1. Collect samples for O&G and TRPHs in 1-liter wide mouth amber glass bottles.

1.2. The cap must have a Teflon liner.

1.3. Visually inspect glass bottles and caps for defects. Do not use container if defects are present or if they do not appear clean.

## 2. SELECTION OF SAMPLING POINTS

2.1. Oil and grease may be present in wastewater as a surface film, an emulsion, a solution, or as a combination of these forms. Since it is very difficult to collect a representative ambient sample for oil and grease analysis, the sampler must carefully evaluate the location of the sampling point.

2.1.1. Select a point of greatest mixing.

2.1.2. For compliance samples at a facility, collect samples from a point that best represents oil and grease concentrations.

## 3. SAMPLE COLLECTION PROCEDURES

3.1. All samples must be grab samples.

3.1.1. If composite data are required, collect individual grab samples over the specified time period.

3.1.2. Submit all samples for analysis.

3.1.3. Average the concentrations of the results to determine the average concentration over time.

3.2. Do not collect the sample by skimming the surface.

3.3. Collect a discrete sample that will be used for analysis. Do not use this sample for any other test.

3.4. Remove the cap from the glass bottle without touching the interior of the container or lid.

3.5. Do not rinse the sampling device or the sample container with sample water.

3.6. Collect the sample directly into the container.

3.6.1. If intermediate sampling equipment is needed, do not allow the sampling equipment to touch the rim of the sample container.

3.6.2. Do not use automatic samplers to collect these types of samples.

3.6.3. Fill the bottle with the sample water to almost full capacity.

3.6.4. Add preservatives (see section 4 below).

3.6.5. Quickly cap the container and tighten securely.

## 4. PRESERVATION

4.1. Preserve the sample within 15 minutes of sample collection.

4.2. The pH of the acidified sample must be less than 2. **Do not over acidify the sample.**

4.3. Preserve the sample by adding an accurately measured amount of sulfuric or hydrochloric acid to the container. Premeasured vials of acid, or a graduated container or pipet, may be used.

4.3.1. Tightly cap the sample container and shake to distribute the acid.

4.3.2. Pour an aliquot of the acidified sample into a disposable container (e.g., sampling cup) or onto a piece of **narrow** range pH paper to determine if the pH is less than 2. **Do not put the pH paper directly into the sample container.**

4.3.3. If the pH is greater than 2, add additional measured amounts of acid and test with narrow range pH paper (see section 4.3.2 above) until the pH has been reduced to below 2 pH units.

4.3.4. Record the total amount of acid that was added to the sample.

4.4. Acidify at least one of the equipment blanks with the **greatest** amount of acid that was required in the sample set and note the amount in field documentation.

4.5. After the sample has been preserved, screw the cap on tightly.

4.6. Immediately place the sample in **wet** ice after preserving with acid (see FS 1006, section 5).

## 5. DOCUMENTATION

5.1. Label each vial with an appropriate field ID number.

5.2. Protect glass container from breakage ("bubble wrap" is recommended).

5.3. Complete field records.

5.4. Make notes on the transmittal form and in field records about any relevant observations or problems such as entrained sediment.

## **FS 2007.** *Radiological Sampling (Excludes Radon)*

### 1. SAMPLE CONTAINERS

1.1. Use polyethylene, polyvinyl chloride (PVC), or Teflon containers.

1.2. Visually inspect the containers and caps for defects. If defects are present and/or sample containers do not appear to be clean, do not use the containers.

### 2. SAMPLE COLLECTION PROCEDURES

2.1. On unknown sites, survey the area with a beta-gamma survey instrument, such as a Geiger-Müller meter.

2.1.1. If radiation levels are above instrument background, consult a radiation safety specialist to determine appropriate safety procedures.

2.2. Remove the cap from the sample container and carefully pour the sample into the container without allowing sampling equipment or hands to touch the rim of the sample container.

### 3. PRESERVATION

3.1. Preserve the sample with a suitable grade of nitric acid (HNO<sub>3</sub>).

3.2. Preserve the sample within 15 minutes of sample collection.

3.3. The pH of the acidified sample must be less than 2. **Do not over acidify the sample.**

3.4. If the preservative is added after the sample is collected (the container is not prepreserved), do not fill the container to the rim.

3.5. Preserve the sample by adding an accurately measured volume of concentrated HNO<sub>3</sub> or 1:1 HNO<sub>3</sub> to the container. Premeasured vials of acid, or a graduated container or pipet, may be used.

3.5.1. Tightly cap the sample container and shake to distribute the acid.

3.5.2. Pour an aliquot of the acidified sample into a disposable container (e.g., sampling cup) or onto a piece of **narrow** range pH paper to determine if the pH is less than 2. **Do not put the pH paper directly into the sample container.**

3.5.3. If the pH is greater than 2, add additional measured amounts of acid and test with narrow range pH paper (see section 3.5.2 above) until the pH has been reduced to just below 2 pH units.

3.5.4. Record the total amount of acid that was added to the sample.

3.5.5. Cooling to 4°C is not required.

3.6. Acidify at least one of the equipment blanks with the **greatest** amount of acid that was required in the sample set and note the amount in field documentation.

3.7. After the sample has been preserved, screw the cap on tightly.

#### 4. DOCUMENTATION

4.1. Complete the sample container label and stick firmly on the container.

4.2. Complete the field notes.

4.3. Make notes on the transmittal form and in field records about any relevant observations or problems such as entrained sediment.

### **FS 2008.** *Radon Sampling*

Radon is a gas and is easily removed from water sources. Therefore, follow the same precautions and care used to collect volatile organic samples. Minimize contact with air during sample collection. Other sample collection techniques may be appropriate, depending on the analytical method or as specified in the project data quality objectives.

#### 1. SAMPLE CONTAINERS

1.1. Use glass sample vials containing a premeasured portion of the scintillation "cocktail."

1.2. Visually inspect the containers and caps for defects. If defects are present and/or sample containers do not appear to be clean, do not use the containers.

1.3. Collect at least two samples.

2. PRESERVATION: The scintillation cocktail is the only required preservative.

3. SAMPLE COLLECTION PROCEDURES Obtain specific sample collection instructions from the laboratory that will analyze the samples. These instructions must include proper handling as well as sample size and packing instructions. The following are general instructions for collecting the samples:

3.1. Carefully fill a syringe (usually 10 mL) with sample water so that air bubbles are not pulled in with the sample before, during or after filling.

3.2. Place the tip of the syringe **BELOW** the scintillation cocktail and slowly dispense the sample **BENEATH** the cocktail surface.

- 3.3. Replace the lid and cap tightly.
  - 3.4. Generally, the vial is used in the laboratory analytical instrument and labels or ID numbers on the sides of the containers may interfere with the analysis. Check with the laboratory for proper placement of labels or field ID numbers.
  - 3.5. Ship in an upright position in the shipping containers that have been provided by the laboratory. If none are provided, protect vials from breakage ("bubble wrap" is recommended), segregate replicate samples in separate plastic bags, and ship to the laboratory in an upright position.
4. DOCUMENTATION
    - 4.1. Complete the field notes.
    - 4.2. Make notes on the transmittal form and in field records about any relevant observations or problems such as entrained sediment.

### **FS 2009.**     *Cyanide Sampling*

Cyanide is a very reactive and unstable species and is highly toxic. Samples suspected of containing cyanide must be handled very carefully.

1. SAMPLE CONTAINERS
  - 1.1. Use polyethylene or glass sample containers.
  - 1.2. Use properly cleaned containers (see FC 1300).
  - 1.3. Visually inspect the containers and caps for defects. If defects are present and/or sample containers do not appear to be clean, do not use the containers.
2. SAMPLE COLLECTION PROCEDURES
  - 2.1. Remove the cap from the sample container, and carefully pour the sample into the container without allowing sampling equipment or hands to touch the rim of the sample container.
3. PRESERVATION
  - 3.1. Many different analytes interfere with the cyanide analysis (e.g., sulfides). If any interferences are known to be present, pretreat the sample for interferences by following the applicable footnotes in Table FS 1000-4.
  - 3.2. Preserve the sample within 15 minutes of sample collection.
  - 3.3. Preserve samples with sodium hydroxide to a pH greater than 12.
  - 3.4. Preserve the sample by adding an accurately measured amount of a sodium hydroxide solution or sodium hydroxide pellets to the container. Use a graduated container or pipet to add the solution.
    - 3.4.1. Tightly cap the sample container and shake to distribute the preservative.
    - 3.4.2. Pour an aliquot of the preserved sample into a disposable container (e.g., sampling cup) or onto a piece of **narrow** range pH paper to determine if the pH is greater than 12. **Do not put the pH paper directly into the sample container.**
    - 3.4.3. If the pH is less than 12, add additional measured amounts of the preservative and test with narrow range pH paper (see section 3.4.2 above) until the pH has been raised to above 12 pH units.

- 3.4.4. Record the total amount of preservative that was added to the sample.
  - 3.5. After the sample has been preserved, screw the cap on tightly.
  - 3.6. Immediately put the sample in **wet** ice (see FS 1006, section 5).
  - 3.7. Preserve at least one of the equipment blanks with all the reagents and the **greatest** amount of sodium hydroxide that was required in the sample set and note the amount in field documentation.
4. DOCUMENTATION
- 4.1. Complete the sample container label and stick firmly on the container.
  - 4.2. Complete the field notes.
  - 4.3. Make notes on the transmittal form and in field records about any relevant observations or problems such as entrained sediment.
  - 4.4. Ensure that all preservation measures are part of the field notes.

### **FS 2010** *Sulfide Sampling*

1. Analyze samples within 15 minutes of collection, or the preserve the sample within 15 minutes for later analysis. If preservation is required add the zinc acetate and sodium hydroxide to the container **before** filling with sample.
2. Avoid aerating the sample during collection. Slowly pour the sample slowly and carefully allow the sample to flow down the **side** of the container to minimize turbulence.
3. Check the pH (if necessary) before completing the filling process.
4. Complete the filling process. **Do not leave a head space.**

## **FS 2100. SURFACE WATER SAMPLING**

See also the following Standard Operating Procedures:

- FA 1000 Administrative Procedures
- FC 1000 Cleaning/Decontamination Procedures
- FD 1000 Documentation Procedures
- FM 1000 Field Planning and Mobilization
- FQ 1000 Field Quality Control Requirements
- FS 1000 General Sampling Procedures
- FS 2000 General Aqueous Sampling
- FS 2400 Wastewater Sampling
- FT 1000 – FT 2000 Field Testing and Calibration Procedures

### 1. INTRODUCTION AND SCOPE

1.1. This section presents standard operating procedures to be used to consistently collect representative surface water samples. Each collection event must be performed so that samples are neither contaminated nor altered from improper handling.

1.2. The following topics include acceptable equipment selection and equipment construction materials; and standard grab, depth-specific and depth-composited surface water sampling techniques. Information regarding sample types and flow- or time-weighted aqueous sampling is found in FS 2420.

### 2. GENERAL CAUTIONS

2.1. When using watercraft, take samples near the bow, away and upwind from any gasoline outboard engine. Orient watercraft so that bow is positioned in the upstream direction.

2.2. When wading, collect samples upstream from the body.

2.3. Avoid disturbing sediments in immediate area of sample collection.

2.4. Collect water samples prior to taking sediment samples when obtaining both from the same area (site).

2.5. Consider the representativeness of selected sampling locations, for example, when attempting to characterize a water body that may be stratified or heterogeneous.

2.6. Unless dictated by permit, program or order, sampling at or near structures (e.g., dams, weirs or bridges) may not provide representative data because of unnatural flow patterns.

2.7. Collect surface water samples from downstream towards upstream.

### 3. EQUIPMENT AND SUPPLIES

3.1. Use sampling equipment constructed of materials consistent with the analytes of interest. Refer to FS 1000, Tables 1000-1 and 1000-2 for material selection. Select equipment based on the analytes of interest, the specific equipment use and the available equipment. Refer to FS 1000, Table 1000-3 for selection of appropriate equipment.

- 3.2. For information on sample container size and construction, preservation and holding time requirements, see FS 1000, Tables 1000-4, 1000-5, 1000-8, 1000-9 and 1000-11.
- 3.3. For information on sampling equipment cleaning requirements, see FC 1000.
- 3.4. For information on documentation requirements, see FD 1000.

## **FS 2110. SURFACE WATER SAMPLING TECHNIQUES**

Use the following protocols when collecting surface water samples. Adhere to all general protocols applicable to aqueous sampling detailed in FS 2000 when following the surface water sampling procedures addressed below.

1. **MANUAL SAMPLING:** Use manual sampling for collecting grab samples for immediate in-situ field analyses. Also use manual sampling in lieu of automatic equipment over extended periods of time for composite sampling, especially when it is necessary to observe and/or note unusual conditions.

### 1.1. Surface Grab Samples

See FS 2000, section 1.2. for discussions concerning the appropriate uses of grab samples.

Collect surface grab samples within the top 12 inches of the water column. Avoid skimming the surface of the water during collection unless specifically required by the sampling plan. Very shallow water bodies require careful techniques of sample collection to avoid disturbing sediments

Where practical, use the actual sample container as the collection device (direct grab). Sample containers attached to poles are also considered direct grabs.

The use of unpreserved sample containers is encouraged since the same container can be submitted for laboratory analysis after appropriate preservation. This procedure reduces sample handling and potential loss of analytes or contamination of the sample from other sources (e.g., additional sampling equipment, environment, etc.).

#### 1.1.1. Direct Grab Technique

##### 1.1.1.1. Using an unpreserved sample container to collect the sample:

- Remove the container cap and slowly submerge the container, opening first, into the water.
- Invert the bottle so the opening is upright and pointing towards the direction of water flow (if applicable). Allow water to run slowly into the container until filled.
- Return the filled container quickly to the surface.
- Pour out a small volume of sample away from and downstream of the sampling location. This procedure allows for addition of preservatives and sample expansion. Do not use this step for volatile organics or other analytes where headspace is not allowed in the sample container.
- Add preservatives, if required, securely cap container, label and complete field notes.

##### 1.1.1.2. Using a sample container with premeasured preservative to collect the sample. (An unpreserved sample container may also be used with this technique.)

- Submerge the unopened sample container to the appropriate level.
- Turn the container so that the opening is upright and towards the direction of water flow (if applicable).
- Open the container and allow the water to run into the container almost full (leave an air space).
- Cap the container and return to the surface.

1.1.1.3. If preservatives have been added, invert the container several times to ensure sufficient mixing of sample and preservatives.

1.1.1.4. Check preservation of the sample and adjust pH with additional preservative, if necessary. When a pH adjustment is made and a prepreserved container was used to collect the sample, always check all containers for proper preservation.

1.1.2. Sampling with an Intermediate Vessel or Container: If the sample cannot be collected directly into the sample container to be submitted to the laboratory use an unpreserved sample container or an intermediate vessel (e.g., beakers, buckets or dippers) to obtain the sample. These vessels must be appropriately cleaned and constructed including any poles or extension arms used to access the sample location.

1.1.2.1. Rinse the intermediate vessel with ample amounts of site water prior to collecting the first sample. Discard rinsate away from or downstream of the sampling location.

1.1.2.2. After adequate rinsing, fill the intermediate vessel with sample water. Minimize agitation of the sample.

1.1.2.3. Fill sample containers from the intermediate vessel. Minimize agitation during filling. Do not touch the sample container with the intermediate vessel.

1.1.2.4. Leave adequate headspace in the sample container. This procedure allows for addition of preservatives (if required) and sample expansion. Do not use this step for volatile organics or other analytes where headspace is not allowed in the sample container.

1.1.2.5. Add preservatives if required, securely cap container, label and complete field notes.

1.1.2.6. Invert the container several times to ensure sufficient mixing of sample and preservatives.

1.1.2.7. Check preservation of the sample and adjust pH with additional preservative, if necessary.

1.1.3. Pump and Tubing: Use appropriate pumps, equipment, and tubing. (See restrictions listed in FS 1000 Tables FS 1000-1 through 1000-3).

**Do not collect oil & grease, TRPH or FL-PRO samples with a pump. See FS 2000 for proper collection procedures for extractable organics and volatile organic compounds.**

1.1.3.1. Lower tubing to a depth 6-12 inches below water surface, where possible.

1.1.3.2. Pump several tubing volumes through the system to flush the tubing prior to collecting the first sample.

1.1.3.3. Fill individual sample bottles via the discharge tubing, being careful not to remove the inlet tubing from the water.

1.1.3.4. Do not touch the discharge tubing to the sample container.

1.1.3.5. Leave adequate headspace in the sample container. This procedure allows for addition of preservatives (if required) and sample expansion. Do not use this step for volatile organics or other analytes where headspace is not allowed in the sample container.

1.1.3.6. Add preservatives if required, securely cap container, label and complete field notes.

1.1.3.7. Invert the container several times to ensure sufficient mixing of sample and preservatives.

1.1.3.8. Check preservation of the sample and adjust pH with additional preservative, if necessary.

1.2. Depth Grab Samples: Examples of equipment that may be used for depth grab sampling include Kemmerer, Niskin, Van Dorn and similar samplers; pumps with tubing and double check-valve bailers. See restrictions listed in FS 1000 Tables 1000-1, 1000-2 and 1000-3. Do not collect oil & grease, TRPH or FL-PRO samples with a pump. See FS 2000 for proper collection procedures for extractable organics and volatile organic compounds.

1.2.1. Kemmerer, Niskin and Van Dorn Type Devices

1.2.1.1. Many of these samplers are constructed of plastic and rubber that preclude their use for all volatile and extractable organic sampling. Some newer devices are constructed of stainless steel or are all Teflon or Teflon-coated. These are acceptable for all analyte groups without restriction.

1.2.1.2. Measure the water column to determine maximum depth and sampling depth prior to lowering the sampling device.

1.2.1.3. Mark the line attached to the sampler with depth increments so that the sampling depth can be accurately recorded.

1.2.1.4. Lower the sampler slowly to the appropriate sampling depth, taking care not to disturb the sediments.

1.2.1.5. At the desired depth, send the messenger weight down to trip the closure mechanism.

1.2.1.6. Retrieve the sampler slowly.

1.2.1.7. Rinse the sampling device with ample amounts of site water prior to collecting the first sample. Discard rinsate away from and downstream of the sampling location.

1.2.1.8. Fill the individual sample bottles via the discharge tube. Sample bottles must be handled as described in sections 1.1.3.3 – 1.1.3.8 above.

1.2.2. Double Check-Valve Bailers: Collect samples using double check-valve bailers if the data requirements do not necessitate a sample from a strictly discrete interval of the water column. Bailers with an upper and lower check-valve can be lowered through the water column and water will continually be displaced through the bailer until the desired depth is reached, at which point the bailer is retrieved.

DEP-SOP-001/01  
FS 2100 Surface Water Sampling

1.2.2.1. Sampling with this type of bailer must follow the same protocols outlined in section 1.2.1 above except that a messenger weight is not applicable.

1.2.2.2. Although not designed specifically for this kind of sampling, a bailer is acceptable when a mid-depth sample is required.

1.2.2.3. Note: This sampler does not perform as well as the devices described above or the pump and tubing described in section 1.2.3 below.

1.2.2.4. As the bailer is dropped through the water column, water is displaced through the body of the bailer. The degree of displacement depends upon the check-valve ball movement to allow water to flow freely through the bailer body.

1.2.2.5. Slowly lower the bailer to the appropriate depth. Upon retrieval, the two check-valves seat, preventing water from escaping or entering the bailer.

1.2.2.6. Rinse the sampling device with ample amounts of site water prior to collecting the first sample.

1.2.2.7. Fill the individual sample bottles via the discharge tube. Sample bottles must be handled as described in sections 1.1.3.3 – 1.1.3.8 above.

1.2.3. Pump and Tubing: Use appropriate pumps, equipment and tubing. (See restrictions listed in FS 1000 Tables 1000-1, 1000-2 and 1000-3). Do not collect oil & grease, TRPH or FL-PRO samples with a pump. See FS 2000 for proper collection procedures for extractable organics and volatile organic compounds.

1.2.3.1. Measure the water column to determine the maximum depth and the sampling depth.

1.2.3.2. Tubing will need to be tied to a stiff pole or be weighted down so the tubing placement will be secure. Do not use a lead or metallic weight if collecting metals samples. Any dense, non-contaminating, non-interfering material will work (brick, stainless steel weight, etc.). Tie the weight with a lanyard (braided or monofilament nylon, etc.) so that it is located below the inlet of the tubing.

1.2.3.3. Pump several tubing volumes through the system to flush the tubing prior to collecting the first sample.

1.2.3.4. Fill the individual sample bottles via the discharge tube, being careful not to remove the inlet tubing from the water. Do not touch the discharge tubing to the sample container.

1.2.3.5. Leave adequate headspace in the sample container. This procedure allows for addition of preservatives (if required) and sample expansion. Do not use this step for volatile organics or other analytes where headspace is not allowed in the sample container.

1.2.3.6. Add preservatives if required, securely cap container, label and complete field notes.

1.2.3.7. Invert the container several times to ensure sufficient mixing of sample and preservatives.

1.2.3.8. Check preservation of the sample and adjust pH with additional preservative, if necessary.

2. AUTOMATIC SAMPLERS: Use automatic samplers when several sites are to be sampled at frequent intervals or when a continuous sample is required. Composite samplers can be used

to collect time composite or flow proportional samples (see FS 2000, section 1.3 for discussions on types of composite and appropriate use of composite sampling). Use appropriate equipment and tubing. (See restrictions listed in FS 1000 Tables 1000-1, 1000-2 and 1000-3). Do not collect oil & grease, TRPH or FL-PRO samples with automatic samplers unless required by the sampling plan. See FS 2000 for proper collection procedures for extractable organics and volatile organic compounds.

The use of automatic samplers for collecting surface water samples will more frequently run into situations where sampling equipment is deployed on-site for a long term or dedicated to the site.

## 2.1. Installing and Programming the Composite Sampler

2.1.1. Use all new or precleaned pump tubing each time the sampler is brought to the field and set up. If the automatic sampler is deployed in the field for extended periods, it is recommended to replace the tubing at a minimum of every six months. Other replacement schedules may be required, depending on the specific installation and project requirements. Inspect the tubing each time the composite-sample container is picked up. If there is evidence of loss of elasticity or discoloration or other conditions that would impact the quality of the sample (such as algal growth), or the pumping flow rate, then replace the tubing. Select the tubing for the pump head and sampling train according to the analytes of interest and the allowable construction materials specified in FS 1000 Table FS 1000-1, 1000-2 and 1000-3.

2.1.1.1. Cut the proper length of precleaned Teflon or Tygon tubing.

2.1.1.2. Equipment Blanks: Collect equipment blanks each time the tubing is changed or at a frequency of 5% of the tubing changes, whichever is less. Collect a minimum of one blank each year. Collect the blank by passing analyte-free water through the equipment that is exposed to the sample.

- Composite sample containers may be cleaned either in the field or in a fixed base operation. Demonstrate cleaning effectiveness by collecting equipment blanks on the composite sample containers according to the frequency specified in FQ 1000. Collect sample container equipment blanks by adding analyte-free water to the cleaned sample container, mix the water thoroughly within the container and then pour off an aliquot for analysis.

2.1.1.3. Put the collection sieve and tubing in the appropriate sample location, using conduit if necessary to hold it in place. Ensure the supporting conduit does not contaminate the incoming sample water.

2.1.1.4. Program the sampler per manufacturer's directions and as required in the permit or work plan conditions.

2.1.1.5. Automatic Sampler Security: Place a lock or seal on the sampler to prevent or detect tampering. This procedure, however, does not prevent tampering with the sampler tubing. See additional discussions on sample security in FS 2410, section 2.3.2.

## 2.2. Sample Acquisition

2.3.1. At the end of each sampling period, stir the contents of the composite jug and transfer the contents into the respective containers. If the sampler was configured to collect discrete samples ensure that the contents of each container are adequately mixed while pouring the sample into the sample container.

2.3.2. Immediately preserve the sample, if required, securely cap container, label and complete field notes.

2.3. Long Term Deployment of Automatic Composite Samplers: In certain sampling situations, automatic composite samplers are permanently installed at surface water stations and remain in the field for months or even years. Under these conditions, there are specific sampling issues that need to be addressed.

2.3.1. Sample Preservation

2.3.1.1. If the only analyte of interest is Total Phosphorus and the project is unrelated to an NPDES permit, the sample must be chemically preserved with sulfuric acid ( $H_2SO_4$ ) but it need not be cooled to 4°C with wet ice.

- The acid must be in the container prior to drawing the first composite sample into the container.

When using large (i.e., 3 gallon) composite sample containers, and there is potential for the sample size to vary greatly due to variable flow rates at the site, the volume of acid for preservation should be small (e.g., 1 to 2 mL of 50%  $H_2SO_4$ ). **Do not over acidify the sample.** Upon sample pick-up, if needed, add additional acid to achieve the proper pH adjustment for preservation.

- If parameters other than total phosphorus are to be analyzed, appropriate additional preservation (e.g., cooling with ice or refrigeration) is required.

2.3.1.2. Deviations from these SOPs concerning preservation and holding times relating to remote and long term deployments due to site specific considerations must be agreed upon by project management.

2.3.2. Cleaning Requirements

2.3.2.1. Clean composite sampler containers after collection of each composite sample using cleaning solutions and procedures specified in FC 1140, sections 5 through 9.

2.3.2.2. Composite sample containers may be cleaned either in the field or in a fixed based operation. Demonstrate cleaning effectiveness by collecting equipment blanks on the composite sample containers according to the frequency specified in FQ 1000. Collect sampler container equipment blanks by adding analyte-free water to the cleaned sample container, mix the water thoroughly within the container and then pour off an aliquot for analysis.

2.3.2.3. Inspect and replace tubing at a minimum of every six months or when applicable, as discussed in section 2.1.1 above. Collect equipment blanks as specified in section 2.1.1.2 above. If the tubing is being replaced for multiple autosamplers at the same time, one equipment blank may be collected on the entire length of replacement tubing. Collect this equipment blank by passing analyte-free water through the entire length of new tubing.

## 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:

$$V = (0.041)d \times d \times h$$

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:

$$V = [\text{Gallons per Foot of Water}] \times h$$

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:

$$V = p + ((0.041)d \times d \times l) + fc$$

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 Wells with Fully Submerged Screen and Pump or Intake Tubing Placed at the Top of the Water Column (conventional purge): 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 Wells with Fully Submerged Screen and Pump or Intake Tubing Placed Within the Screened Interval (minimizing purge volume): 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:  $\pm 0.2^{\circ} \text{C}$
- pH:  $\pm 0.2$  Standard Units
- Specific Conductance:  $\pm 5.0\%$  of reading
- Dissolved Oxygen:  $\leq 20\%$  Saturation
- Turbidity:  $\leq 20$  NTU

3.2 Naturally occurring conditions may prevent attaining the  $\leq 20\%$  saturation criterion for dissolved oxygen, typically in surficial aquifers. See section 3.5, below.

3.3 Naturally occurring conditions may prevent attaining the  $\leq 20$  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  $\leq 20$  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:  $\pm 0.2^{\circ} \text{C}$
- pH:  $\pm 0.2$  Standard Units
- Specific Conductance:  $\pm 5.0\%$  of reading
- Dissolved Oxygen:  $\pm 0.2 \text{ mg/L}$  or 10%, whichever is greater
- Turbidity:  $\pm 5 \text{ NTUs}$  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  $\leq 500$  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  $\leq 100$  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  $\leq 500$  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  $\leq 100$  mL/minute before collecting the samples.

**FS 2216.** *Purging Airstrippers and Remedial Treatment Systems*

If collecting samples for groundwater contamination monitoring, follow FS 2215 above.

## 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  $\leq 1$  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     Submerge 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  $\leq 100$  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     Submerge 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  $\leq 100$  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  $\leq 100$  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- $\mu$ m 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

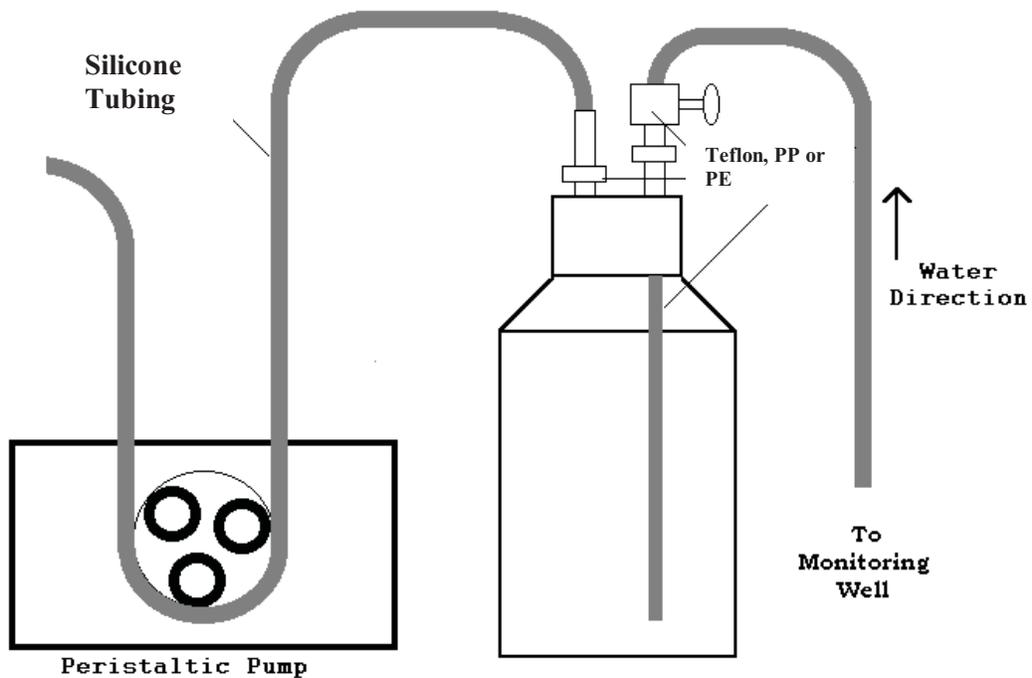
**Table FS 2200-3  
 Allowable Uses for Bailers**

• 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.

DEP-SOP-001/01  
FS 2200 Groundwater Sampling

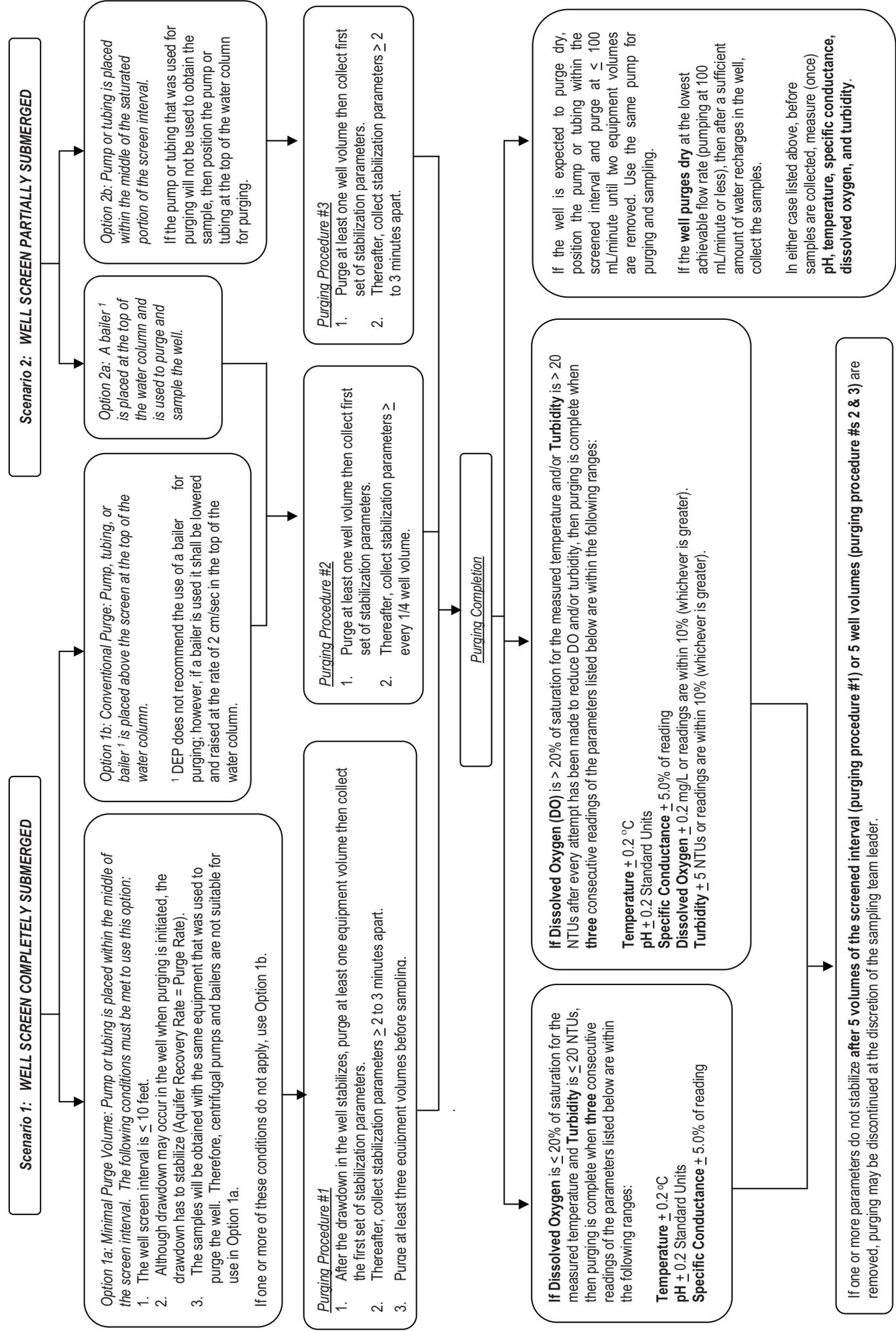
• ANALYTE GROUP(S)	• PURGING (Not Recommended)	• SAMPLING	
	Use:	Use:	Not Recommended:
Biologicals Inorganic Non-Metallics Aggregate Organics Microbiological Physical and Aggregate Properties	If allowed by permit, program, contract or order  or If operated by a skilled individual with documented training 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.

DEP-SOP-001/01  
FS 2200 Groundwater Sampling



## **FS 2300. Drinking Water Sampling**

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 1000 General Sampling Procedures
- FS 2000 General Aqueous Sampling
- FT 1000 – FT 2000 Field Testing and Calibration Procedures

### 1. INTRODUCTION AND SCOPE

1.1. The following procedures describe generalized drinking water sampling from private potable wells and drinking water supply systems.

### 2. EQUIPMENT AND SUPPLIES

2.1. For information on the selection of appropriate sample containers, refer to Table FS 1000-2.

2.2. For information on preservation and holding time requirements, refer to Tables FS 1000-4 through FS 1000-9.

2.3. For information on documentation requirements, refer to FD 1000-9000.

### 3. SPECIAL SAMPLING PROTOCOLS

3.1. Follow special sampling for the types of analytes discussed in FS 2001 – FS 2010.

3.2. 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.

## **FS 2310. POTABLE WELL SAMPLING**

### 1. SAMPLING DRINKING WATER WELLS

1.1. As a rule, purge and sample from a spigot closest to the well head.

1.1.1. Remove all hoses, aerators or filters (if possible).

1.1.2. Open the spigot and purge sufficient volume to flush the spigot and lines.

1.1.3. Do not use any kind of disinfectant (alcohol, bleach, etc.) or heat to sterilize the spigot.

1.2. Reduce the flow rate to approximately 500 mL/minute (a 1/8" stream) or approximately 0.1 gal/minute before collecting samples other than for VOCs. Minimize aeration when filling VOC sample containers. Reduce the flow rate to approximately  $\leq 100$  mL/minute when collecting VOC samples.

1.3. Sample Containers with no Preservatives

DEP-SOP-001/01  
FS 2300 Drinking Water Sampling

1.3.1. Remove the screw cap from the bottle. Do not touch the interior of the cap or the container with your hand or the rim of the spigot.

1.3.2. Tilt the container so that flow falls onto the interior surface. DO NOT AGITATE OR SHAKE THE CONTAINER WHILE FILLING.

1.3.3. Fill the bottle almost to capacity. For collection of volatile organics or trihalomethane samples, refer to FS 2004.

1.3.4. Replace the screw cap securely on the bottle.

1.3.5. Dry the exterior surface of the bottle using a clean paper towel.

1.3.6. Affix a sample label and seal (if required), and complete the chain of custody form.

1.3.7. Place the sample bottle in a plastic sample bag and cool (where required) to 4°C on wet ice or place sample rack in cooler and nestle in ice, making sure that any melted ice water does not raise above the sample containers.

1.4. Sample Containers with Preservatives

1.4.1. Follow the same protocol outlined above.

1.4.2. Since some of the preservatives may react with the sample water, hold the open end of the container away from you while filling.

1.4.3. Replace the screw cap securely on the bottle and gently tip the container several times to mix the preservative with the sample.

1.4.4. Dry the exterior surface of the bottle using a clean paper towel.

1.4.5. Affix a sample label and seal (if required), and complete the chain of custody form.

1.4.6. Place the sample bottle in a plastic sample bag and cool (where required) to 4°C on wet ice or place sample rack in cooler and nestle in ice, making sure that any melted ice water does not raise above the sample containers.

2. SAMPLING DRINKING WATER SOURCES FOR LEAD AND COPPER

2.1. Selection of the sampling point depends on whether the sample is being taken to verify compliance with the Drinking Water Regulations. If so, sample from a COLD WATER tap in either the kitchen or bathroom.

2.2. Collect samples after the water HAS NOT been used for at least SIX HOURS.

2.3. DO NOT FLUSH OR PURGE THE SYSTEM.

2.4. Collect the first flush into the sample container for trace metals. DO NOT RINSE SAMPLE CONTAINER.

2.5. Tilt the container so that the initial flow falls onto the interior surface. DO NOT AGITATE.

2.6. For prepreserved containers, hold the open end of the container away from you while filling.

2.7. Add preservatives (if needed). To avoid problems of residents handling nitric acid, acidification of first-draw samples may be done up to 14 days after the sample is collected. After acidification to resolubilize the metals, the sample must stand in the original container

for the time specified in the approved EPA method before the sample can be analyzed. (refer to EPA 40 CFR Part 141.86).

- 2.8. Replace the screw cap securely on the bottle and gently tip the container several times to mix the preservative with the sample.
- 2.9. Dry the exterior surface of the bottle using a clean paper towel.
- 2.10. Affix a sample label and seal (if required), and complete the chain of custody form.

### **FS 2320. DRINKING WATER SUPPLY SYSTEM SAMPLING**

Use the following protocols when sampling drinking water supply systems.

1. When sampling for drinking water compliance, the sampling point is normally designated by permit or municipal authorities. If not specified by permit or municipal authority, select an accessible location near the supply line or, if at a private residence, at an outside spigot.
2. Follow the protocols outlined in FS 2310, section 2 when sampling for lead and copper.
3. Procedures to sample drinking water directly from the supply system are the same as above, except for treatment of residual chlorine.
  - 3.1. Flush the lines for two to five minutes before collecting any samples.
  - 3.2. Reduce the flow rate to less than 500 mL/minute (1/8" stream) or approximately 0.1 gal/minute before collecting samples other than for VOCs. Minimize aeration when filling VOC sample containers. Reduce the flow rate to approximately  $\leq 100$  mL/minute when collecting VOC samples.
4. In many instances, the water supply to residences may be treated with chlorine, which causes interference with certain types of analyses (e.g., VOCs, Extractable Organics and some bacteriological samples).
5. Use a chemical test kit to check a separate sample for residual chlorine. If residual chlorine is present, collect the sample in the appropriate sample container(s) using the required preservatives.
  - 5.1. Replace the screw cap securely on the bottle and tip the container several times to mix the preservative with the sample.
  - 5.2. Dry the exterior surface of the bottle using a clean paper towel.
  - 5.3. Affix a sample label and seal (if required), and complete the chain of custody form.
  - 5.4. Place the sample bottle in a plastic sample bag and cool (where required) to 4°C on wet ice or place sample rack in cooler and nestle in ice, making sure that any melted ice water does not raise above the sample containers.

### **FS 2330. SAMPLING CRYPTOSPORIDIUM AND GIARDIA**

Samples collected for the analysis of *Cryptosporidium* and *Giardia* must follow the procedures in the U.S. EPA [ICR Microbial Laboratory Manual](#), Section VII, Part 9 - Sampling.

1. Transport the sample to the laboratory on wet ice or with but not on cold packs and refrigerate at 2-5°C. DO NOT freeze the filter during transport or storage.
2. The initiation of sample collection and elution from the collection filter must be performed within 96 hours.

## **FS 2400. Wastewater Sampling**

See also the following Standard Operating Procedures:

- FA 1000 Regulatory Scope and Administrative Procedures for Use of DEP SOPs
- FC 1000 Cleaning/Decontamination Procedures
- FD 1000 Documentation Procedures
- FM 1000 Field Planning and Mobilization
- FQ 1000 Field Quality Control Requirements
- FS 1000 General Sampling Procedures
- FS 2000 General Aqueous Sampling
- FT 1000 – FT 2000 Field Testing and Calibration Procedures

### **1. INTRODUCTION AND SCOPE**

1.1. Use this Standard Operating Procedure (SOP) during field investigations to ensure that representative wastewater samples are collected.

1.2. All persons conducting wastewater sampling must be knowledgeable of the protocols in this SOP. The sampling organization must maintain documentation demonstrating that all sampling personnel have been adequately trained, have copies of this SOP and are familiar with the sampling protocols.

1.3. Prior to mobilizing, the sampler must decide what kind of samples to collect, what analytes are to be analyzed, and where to collect the samples. The sampler must take care to ensure that the sampling location is correct and that the samples are representative of the discharge. The sample site locations and sample types must be consistent with the permit(s), if applicable, or as described in a work plan.

1.4. General guidance for the operation, calibration, and maintenance of autosamplers is included in this SOP. The individual user should consult the equipment's operating and maintenance manuals for operating instructions, maintenance, and troubleshooting of the equipment.

### **2. General Cautions**

2.1. In order to obtain a representative sample, collect samples where wastewater flow is adequately mixed. Flow mixing is particularly important for ensuring uniformity. In general, use these criteria to evaluate the location:

2.2. Sample in the center of the flow where velocity is highest and there is little possibility of solids settling.

2.2.1. Collect the sample at a depth between 40% and 60% of the total depth where the turbulence is maximized. Avoid the water surface or the channel bottom.

2.3. Take precautions when collecting samples near a weir to avoid solids that tend to collect upstream and floating oil and grease that accumulate downstream.

2.4. If the sample is to be tested for volatile organics or will be affected by stripping of dissolved gases, do not stir or otherwise agitate the sample, and take precautions to minimize aeration of the sample.

2.4.1. Do not collect VOC samples as composites or attempt to manually composite VOC samples in the field. If composite VOC results are required, consult with the analyzing laboratory about obtaining composite results from individually submitted grab samples.

2.5. In sampling from wide conduits, consider cross-sectional sampling. Use a dye as an aid in determining the most representative sampling point(s). Note: Experienced personnel should be consulted for the type of dye and appropriate protocols.

2.6. If manual compositing is employed, mix the contents of the individual sample bottles thoroughly before pouring the individual aliquots into the final composite container. See section 2.4.1 above.

2.7. If the sample is taken from an effluent tap, allow the tap to run for one to two minutes to allow the settled solids to flush from the line. Reduce the flow to 500 mL/minute before collecting samples other than for VOCs. Minimize aeration when filling VOC sample containers. Reduce the flow rate to approximately  $\leq 100$  mL/minute when collecting VOC samples.

2.8. Sampling and flow measuring are integrally related. The sampler must know the wastewater flow variability before a sampling program can be initiated. Whether to use a flow proportional or time composite sampling scheme depends on the variability of the wastewater flow. If a sampler knows or suspects significant variability in the wastewater flow or knows nothing about the facility, a flow proportional sample should be collected; otherwise, a time composite sample would be acceptable.

2.9. Prior to sampling, examine the flow measuring system (primary flow device, totalizer, recorder). See section 18 on Flow Measurement in the "EPA Environmental Investigations Standard Operating Procedures and Quality Assurance Manual". If the flow measuring system is unacceptable, the sampler may have to install a flow-measuring device. If the flow measuring system is acceptable, samples can be collected by the appropriate method.

2.10. Using dedicated equipment at each sampling station will avoid cross-contamination between sampling stations. If using sampling equipment for multiple sampling locations, and volatile organics, extractable organics or metals are not analytes of concern, decontaminate the sampling device between sites by rinsing with ample amounts of site water. See FC 1130 for decontamination protocols for the sampling equipment once it is returned to the base of operations or if metals or organics are analytes of concern.

## **FS 2410. EQUIPMENT AND SUPPLIES**

Select sampling equipment based on the parameters of interest, the specific equipment use and the available equipment. Select sampling equipment from table FS 2400-1. Sample containers and sampling equipment must be of the appropriate construction material as described in FS 1000, Tables FS 1000-1, FS 1000-2, and FS 1000-3.

Clean all sampling equipment and obtain clean sample containers using the appropriate protocols specified in FC 1000.

1. **MANUAL SAMPLING:** Manual sampling is used for collecting grab samples and/or for immediate in-situ field analyses. However, it can be used in lieu of automatic equipment over extended periods of time for composite sampling, especially when it is necessary to evaluate unusual waste stream conditions.

## 2. AUTOMATIC SAMPLERS

2.1. A wide variety of automatic samplers are commercially available. Most have the following five interrelated subsystem components:

2.1.1. Sample Intake Subsystem: The sample intake gathers representative samples from the sampling stream.

2.1.1.1. The intake is usually the end of a plastic suction tube that should also be resistant to physical damage from large objects in the flow stream. Non-leaching Tygon tubing is most often used.

2.1.1.2. If collection of organics (including all extractable organics and pesticides) is required by permit, use Teflon, polyethylene or polypropylene tubing. Fix the tubing end to a piece of conduit or a pole bent to hold the sample port in the waste stream at the correct location to get a representative sample. Support the tubing so either the supporting pole or the method of attachment does not contaminate the incoming sample. If a base is employed to hold the end of the tubing in the waste stream it must be constructed of non-contaminating materials and any screening material must still allow the collection of representative samples.

2.1.2. Sample Gathering Subsystem: Automatic samplers provide one of three basic gathering methods:

2.1.2.1. Mechanical: Mechanical gathering subsystems are usually built into place and include devices such as cups on cables, calibrated scoops, and paddle wheels with cups. Although these systems obstruct the stream flow, they take into account site-specific considerations, such as high sampling lift and wide/deep channel flow. Because of the mechanical system employed, these units require periodic maintenance.

2.1.2.2. Forced Flow: Forced flow gathering subsystems are often built into place as permanent sampling facilities. Like the mechanical gathering subsystems, they obstruct the stream flow. They also require periodic inspection and maintenance. However, forced flow subsystems have the advantage of being able to sample at great depths. In addition, because this gathering system uses air pressure to transport the sample, it may be ideal for sample collection in potentially explosive environments.

2.1.2.3. Suction Lift: The suction lift is the most widely used type of sample gathering subsystem due to its versatility and minimal effect on flow patterns. Suction lifts are limited to 25 vertical feet or less because of internal friction losses and atmospheric pressure. Collect at least 100 mL of sample each time the pump is actuated.

2.1.3. Sample Transport Subsystem: The sample is usually transported from the sample intake to the collection bottle by a plastic tube called the "sample transport subsystem". Make sure the sampler is placed well above the effluent stream to ensure the tubing runs in a taut, straight line to prevent pooling of liquid. Take care to avoid sharp bends and twists in the transport line.

2.1.4. Sample Storage Subsystem: The sample storage subsystem can accommodate either a single large collection bottle or a number of smaller collection bottles. Samplers with individual bottles for discrete collection are usually equipped with a cassette that rotates to fill the bottle during sampling. The total sample

volume storage capability should be at least 2 gallons (7.6 liters). Some samplers have a capacity of up to 5 gallons.

2.1.4.1. If using an unrefrigerated sampler unit and the project calls for cooling during collection, storage subsystems must be large enough to provide space for sufficient ice to chill the sample during the entire collection event.

2.1.5. Controls and Power Subsystem: The control units allow for the selection of time or flow compositing, or a continuous sampling method. The automatic samplers most widely used have encapsulated solid-state controls. This configuration minimizes the effects of unfavorable environments that are encountered in the field, such as high humidity and corrosiveness. These units are also sealed so they may be used with minimal risk in potentially explosive environments. In addition, sealed units protect the controls if the sampler is accidentally submerged.

2.2. Automatic sampling equipment must meet the following requirements:

2.2.1. Properly clean sampling equipment to avoid cross-contamination that could result from prior use (see FC 1140 for specific cleaning procedures).

2.2.2. If samples for extractable organics are to be collected, all parts of the sampler that come in contact with the wastewater stream must conform to the construction material requirements in FS 1000, Tables FS 1000-1, FS 1000-2 and FS 1000-3.

2.2.3. If the preservation requirements for a particular component specify that a sample be thermally preserved, cool the sampler so samples are kept at 4°C during the sampling period. Use ice or refrigeration units in the sampler.

2.2.4. The sampler must be able to collect a large enough sample for all analyses needed. Additionally, split samples may be necessary when specified in the permit or project data quality objectives.

2.2.5. If using a peristaltic pump, collect a minimum of 100 mL each time the sampler is activated.

2.2.6. The sampler should provide a lift up to at least 20 feet and the sampler should be adjustable so that volume is not a function of the pumping head.

2.2.7. The pumping velocity must be adequate to transport solids and not allow solids to settle.

2.2.8. The automatic sampler must provide for line purging after each sample is drawn to prevent contamination of subsequent samples. The minimum intake line inside diameter must be at least 1/4 inch, which is large enough to lessen chances of clogging but small enough to maintain velocity and to avoid solids settling.

2.2.9. Ensure that an adequate power supply is available to operate the sampler during the entire sampling event.

2.2.10. Sample collection vessels, either large composite or discrete sample containers, must be constructed of materials appropriate for the tests to be performed.

2.3. In addition to the above requirements, consider the following when selecting automatic sampling equipment:

2.3.1. Convenience of Installation and Maintenance: Always carefully handle sampling equipment and maintain equipment in accordance with the manufacturer's

instructions. Careless handling and poor maintenance cause most equipment failures.

2.3.2. Equipment Security: Security is important when sampling is done as part of an enforcement proceeding. Covered manhole locations will aid in maintaining security. If sampling equipment must be left unattended, the sampler should be provided with a lock or seal that, if broken or disturbed, would indicate that tampering had occurred and sample integrity possibly compromised.

### 2.3.3. Operation in Cold or Hot Weather

2.3.3.1. Cold Weather: Intake lines may freeze when collecting samples during extremely cold days. If necessary, use heat tape or place the sampler inside a thermostatically controlled, electrically heated enclosure. In the absence of any special heating equipment, wrap the sampler with eight to nine inches of insulation and place in a manhole or wet well to prevent freezing.

2.3.3.2. Hot Weather: During hot weather, choose a shaded or cooled place for the sampler, if possible. Wrapping the sampler with insulation may also help. Painting the sampler white will reflect some heat. If using refrigerated or iced units, refill the automatic sampler with ice or check to see that the refrigeration unit is operating before leaving the site.

## **FS 2420. SAMPLE TYPES**

1. There are two primary types of samples: 1) grab samples; and 2) composite samples. Each type has distinct advantages and disadvantages. While grab sampling allows observation of unusual conditions that may exist during discharge, this method is labor intensive and impractical when sampling is performed at many locations over extended periods of time. When sampling a large number of locations, the use of automatic samplers is more practical.
2. Automatic samplers also help reduce human error, specifically in complex sampling activities such as flow proportional sampling, and reduce exposure to potentially hazardous environments. The primary disadvantage to automatic sampling is the cost of the equipment and maintenance requirements (samplers tend to fail, battery quits, no refrigeration, etc.).
3. In order to obtain a more complete characterization of a specific facility's effluent, the two sample types can be used independently or in combination. The sampler must weigh advantages and disadvantages when choosing between the use of grab or composite sampling methods if the sample type has not already been specified in a permit or project work plan.

## **FS 2422. *Grab Samples***

1. This is an individual sample collected over a period of time, usually all in one motion, generally not exceeding 15 minutes. The 15-minute time limit applies to aqueous samples only. No time limit applies to the collection of solid samples (e.g., residuals).
2. Grab samples represent the conditions that exist at the moment the sample is collected and do not necessarily represent conditions at any other time. Grab sampling is the preferred method of sampling under the following conditions:

- 2.1. A snapshot of the wastewater quality at a particular instant in time is desired.
  - 2.2. The water or wastewater stream is not continuous (e.g., batch discharges or intermittent flow).
  - 2.3. The characteristics of the water or waste stream are known to be constant or nearly so.
  - 2.4. When the waste conditions are relatively constant over the period of discharge. In lieu of complex sampling activities, a grab sample provides a simple and accurate method of establishing waste characteristics.
  - 2.5. The sample is to be analyzed for analytes whose characteristics are likely to change significantly with time (e.g., dissolved gases, microbiological tests, pH, etc.).
  - 2.6. The sample is to be collected for analytes such as Oil and Grease, bacteriological tests or other parameters listed in number 3 of this section where the compositing process could significantly affect the actual concentration.
  - 2.7. Data on maximum/minimum concentrations are desired for a continuous water or wastewater stream.
  - 2.8. When identifying and tracking slug loads and spills.
3. If required, measure the following parameters on grab samples or in-situ. NOTE: If the permit specifies a composite sample for any of the parameters mentioned below, **FOLLOW THE PERMIT CONDITIONS.**

Cyanide	Oil and Grease
Residual Chlorine	pH
Dissolved constituents in field-filtered samples (ortho-phosphorus, metals, etc.)	Specific Conductance
Dissolved Oxygen and other dissolved gases	Un-ionized Ammonia
Microbiological Parameters	Volatile Organic Compounds
TRPHs	Temperature
Total Phenols	

**FS 2423.**     *Composite Samples*

1. A composite sample is a sample collected over time, formed either by continuous sampling or by mixing discrete samples. Composite samples reflect the average characteristics during the compositing period.
2. Composite samples are used when stipulated in a permit or when:
  - 2.1. The water or wastewater stream is continuous;
  - 2.2. Analytical capabilities are limited;
  - 2.3. Determining average pollutant concentration during the compositing period;
  - 2.4. Calculating mass/unit time loadings; or
  - 2.5. Associating average flow data to parameter concentrations.

3. Composite samples may be collected individually at equal time intervals if the flow rate of the sample stream does not vary more than plus or minus ten percent of the average flow rate, or they may be collected proportional to the flow rate. The permit or work plan will specify which composite sample type to use, either time composites or flow proportional composites. The compositing methods, all of which depend on either continuous or periodic sampling, are described in the following discussions.

3.1. Time Composite Sample: Time composite samples are based on a constant time interval between samples. A time composite sample can be collected manually or with an automatic sampler. This type of composite is composed of discrete sample aliquots collected in one container at constant time intervals. This method provides representative samples when the flow of the sampled wastewater stream is constant. This type of sample is similar to a sequential composite sample described in number 3.3 of this section.

3.2. Flow Proportional Composite Sample: Flow proportional samples can be collected automatically with an automatic sampler and a compatible pacing flow measuring device, semi-automatically with a flow chart and an automatic sampler capable of collecting discrete samples, or manually. There are two methods used to collect this type of sample:

3.2.1. Method 1: Collect a constant sample volume per stream flow (e.g., a 200 mL sample collected for every 5,000 gallons of stream flow) at time intervals proportional to stream flow. This method provides representative samples of all waste streams when the flow is measured accurately.

3.2.2. Method 2: Collect a sample by increasing the volume of each aliquot as the flow increases, while maintaining a constant time interval between the aliquots (e.g., hourly samples are taken with the sample volume being proportional to the flow at the time the sample is taken).

3.3. Sequential Composite Sample: Sequential composite samples are composed of discrete samples taken into individual containers at constant time intervals or constant discharge increments. For example, samples collected every 15 minutes are composited for each hour.

3.3.1. The 24-hour composite is made up from the individual one-hour composites. Each of the 24 individual samples is manually flow-proportioned according to the flow recorded for the hour that the sample represents. Each flow-proportioned sample is then added to the composite samples. The actual compositing of the samples is done by hand and may be done in the field or the laboratory. In most cases, compositing in the field is preferable since only one sample container must be cooled, and then transported to, and handled, in the laboratory. A 24-hour composite is frequently used since an automatic sampler can easily collect the individual samples.

3.3.2. A variation of the 24-hour composite is to collect a constant volume of sample taken at constant discharge increments, which are measured with a totalizer. For example, one aliquot is collected for every 10,000 gallons of flow.

3.3.3. Sequential sampling is useful to characterize the waste stream because you can determine the variability of the wastewater constituents over a daily period. For example, for pretreatment studies you can visually determine when high strength wastes are being discharged from a facility or when heavy solid loads are being discharged during a 24-hour cycle. You can measure the pH throughout the day.

The value of this type of sampling must be weighed against the manpower constraints and sampling goals.

3.4. Continuous Composite Sample: Collected continuously from the waste stream. The sample may be a constant volume that is similar to the time composite, or the volume may vary in proportion to the flow rate of the waste stream, in which case the sample is similar to the flow proportional composite.

3.5. Areal Composite: A sample composited from individual grab samples collected on an areal or cross-sectional basis. Areal composites must be made up of equal volumes of grab samples; each grab sample must be collected in an identical manner. Examples include residual samples from grid system points on a land application site, water samples collected at various depths at the same point or from quarter points in a stream, etc.

## **FS 2430. WASTEWATER SAMPLING TECHNIQUES**

The following protocols must be used when collecting wastewater samples. All general protocols applicable to aqueous sampling detailed in FS 2000 must be adhered to when following the wastewater sampling procedures addressed below.

1. **MANUAL SAMPLING**: Use manual sampling for collecting grab samples for immediate in-situ field analyses. Also use manual sampling in lieu of automatic equipment over extended periods of time for composite sampling, especially when it is necessary to observe and/or note unusual waste stream conditions.

1.1. Surface Grab Samples: DO NOT use sample containers containing premeasured amounts of preservatives to collect surface grab samples. If the sample matrix is homogeneous, grab samples are an effective and simple technique. If homogeneity is not apparent based on flow or vertical variations (and should never be assumed) then consider other sample types to characterize the waste stream.

1.2. Where practical, use the actual sample container submitted to the laboratory for collecting samples to be analyzed for oil and grease, volatile organic compounds (VOCs) and bacteriological samples. This procedure eliminates the possibility of contaminating the sample with an intermediate collection container.

1.3. The use of unpreserved sample containers as direct grab samplers is encouraged because the same container can be submitted for laboratory analysis after appropriate preservation. This procedure reduces sample handling and eliminates potential contamination from other sources (e.g., additional sampling equipment, environment).

### 1.3.1. Grab Directly Into Sample Container

1.3.1.1. Submerge the container, neck first, into the water.

1.3.1.2. Invert the bottle so the neck is upright and pointing into the water flow (if applicable).

1.3.1.3. Return the filled container quickly to the surface.

1.3.1.4. Pour out a few mL of sample downstream of the sample collection point. This procedure allows for addition of preservatives and sample expansion. This step must not be followed for volatile organics or other analytes where headspace is not allowed in the sample container.

1.3.1.5. Add preservatives, securely cap container, and label.

1.3.2. If sample containers are attached to a pole via a clamp, submerge the sample container and follow steps 1.3.1.3 – 1.3.1.5 as outlined in this section omitting steps 1.3.1.1 and 1.3.1.2.

1.3.3. Sampling with an Intermediate Vessel or Container: If the sample cannot be collected directly into the sample container to be submitted to the laboratory or if the laboratory provides prepreserved sample containers, use an unpreserved sample container or an intermediate vessel to obtain the sample. Examples of intermediate vessels include precleaned beakers, buckets or dippers. If intermediate vessels are used at various sites they should be decontaminated appropriately. These vessels must be constructed appropriately including any poles or extension arms used to access the sample location.

1.3.3.1. Collect sample as outlined in steps 1.3.1.1 – 1.3.1.5 or 1.3.2 of this section, as applicable.

1.3.3.2. Pole mounted containers of appropriate construction are used to sample at distances away from shore, boat, etc. or at different depths. Follow the protocols in 1.1.2 of this section for collecting samples.

1.3.3.3. Make sure the intermediate vessel gets rinsed where appropriate.

1.3.3.4. Minimize aeration when filling VOC sample containers. Control the flow rate from any discharge tubing to  $\leq 100$  mL/minute when collecting VOC samples.

1.3.4. Peristaltic Pump and Tubing: This technique is not preferred for Oil & Grease, or TRPHs. If collecting Volatile Organic Compounds with a peristaltic pump please refer to FS 2221. Extractable Organics can be collected through the pump if the silicone tubing used in the pump head is twelve inches or less or if used with the organic trap setup as shown in FS 2200, Figure FS 2200-1.

1.3.4.1. Lower appropriately precleaned tubing to a depth 6 – 12 inches below water surface, where possible.

1.3.4.2. Pump several tubing volumes through the system to acclimate the tubing.

1.3.4.3. Fill the individual sample bottles via the discharge tubing being careful not to remove the inlet tubing from the water.

1.4. "Depth" Grab Samples: Mid-depth samples or samples taken at a specific depth can approximate the conditions throughout the entire water column. The equipment that may be used for this type of sampling consists of depth specific sampling devices (Kemmerer, Niskin, Van Dorn, etc.); pumps with tubing; or double-check valve bailers. When purchasing and choosing a device for a particular sampling event, ensure that construction materials are compatible for the analytes to be collected (see Tables FS 1000-1 and FS 1000-2). Note that all related components (stoppers, etc.) must be constructed of inert materials if volatile or extractable organics are to be sampled.

1.4.1. Kemmerer, Niskin, and Van Dorn Type Devices

1.4.1.1. Many Kemmerer samplers are constructed of plastic and rubber that preclude their use for all volatile and extractable organic sampling. Some of the newer devices are constructed of stainless steel or are all Teflon or Teflon-coated. These would be acceptable for all analyte groups without restriction.

1.4.1.2. Before lowering the sampler, measure the water column to determine maximum depth and sampling depth.

1.4.1.3. Mark the line attached to the sampler with depth increments so that the sampling depth can be accurately recorded.

1.4.1.4. When dropping the sampler to the appropriate depth, do it slowly so that sediments are not stirred up.

1.4.1.5. Once the desired depth is reached send the messenger weight down to trip the mechanism.

1.4.1.6. Retrieve the sampler slowly.

1.4.1.7. Fill the individual sample bottles via the discharge tube. Minimize aeration when filling VOC sample containers. Control the flow rate from the discharge tube to  $\leq 100$  mL/minute when collecting VOC samples. Sample bottles must be handled as described in steps 1.3.1.4 - 1.3.1.5 of this section.

1.4.2. Double Check-Valve Bailer: Collect samples using double check-valve bailers if the data requirements do not necessitate a sample from a strictly discrete interval of the water column. Bailers with an upper and lower check-valve can be lowered through the water column and water will be continually displaced through the bailer until the desired depth is reached, at which point the bailer is retrieved. This technique may not be successful in strong currents.

1.4.2.1. Follow the same protocols outlined in section 1.4.1 of this section except that a messenger weight is not applicable.

1.4.2.2. Although not designed specifically for this kind of sampling, it will be acceptable when a mid-depth sample is required.

1.4.2.3. Note: this sampler does not perform as well as the devices described above or the pump and tubing described in the next section.

1.4.2.4. As the bailer is dropped through the water column, water will be displaced through the body of the bailer. The degree of displacement is dependent upon the check-valve ball getting out of the way and allowing water to flow freely through the bailer body.

1.4.2.5. Drop the bailer slowly to the appropriate depth. Upon retrieval, the (two) check valves seat, preventing water from escaping out of, or entering, the bailer.

1.4.2.6. Fill the individual sample bottles via the discharge tube. Minimize aeration when filling VOC sample containers. Control the flow rate from the discharge tube to  $\leq 100$  mL/minute when collecting VOC samples. Handle sample bottles as described in 1.3.1.4 - 1.3.1.5 of this section.

1.4.3. Peristaltic Pump and Tubing: If necessary, collect samples using a pump, either power or hand operated, to withdraw a sample from the water or wastewater stream. The most portable pump for this technique is a (12 volt) peristaltic pump. Appropriately precleaned silastic tubing is required in the pump head and polyethylene, Tygon, etc. tubing is attached to the pump.

This technique is not preferred for Oil & Grease, or TRPHs. If collecting Volatile Organic Compounds with a peristaltic pump please refer to FS 2221. Extractable Organics can be collected through the pump if the silicone tubing used in the pump

head is twelve inches or less or if used with the organic trap setup as shown in FS 2200, Figure FS 2200-1

1.4.3.1. Measure the water column to determine the maximum depth and the sampling depth.

1.4.3.2. Tie the tubing to a stiff pole or weight it down so the tubing placement will be secure. Do not use a lead weight. Any dense, non-contaminating, non-interfering material will work (brick, stainless steel weight, etc.). Tie the weight with a lanyard (braided or monofilament nylon, etc.) so that it is located below the inlet of the tubing.

1.4.3.3. Turn the pump on and allow several tubing volumes of water to be discharged before taking the first sample. Minimize aeration when filling VOC sample containers. Control the flow rate from the discharge tube to  $\leq 100$  mL/minute when collecting VOC samples.

1.4.3.4. Sample bottles must be handled as described in 1.3.1.4 - 1.3.1.5 of this section.

## 1.5. Grab Samples from a Spigot

1.5.1. Open the spigot and purge sufficient volume to flush the spigot and lines.

1.5.2. Reduce the flow rate to approximately 500 mL/minute (a 1/8" stream) or approximately 0.1 gal/minute before collecting samples.

1.5.3. Remove the screw cap from the bottle. Do not touch the interior of the cap or the container with your hand or the rim of the spigot.

1.5.4. Tilt the container so that the flow falls onto the interior surface. Hold the open end of the container away from you if it contains preservatives.

1.5.5. Fill the bottle almost to capacity. For collection of volatile organics refer to FS 2004.

1.5.6. Add preservatives, if appropriate, securely cap container and label.

2. AUTOMATIC SAMPLERS: Use automatic samplers when several sites are to be sampled at frequent intervals or when a continuous sample is required. Composite samplers can be used to collect time composite or flow proportional samples. In the flow proportional mode, some samplers are activated by a compatible flow meter. Refer to your specific flow meter operating manual for details on meter operation. For older models, flow proportional samples can be collected using a discrete sampler and a flow recorder and manually compositing the individual aliquots in flow proportional amounts.

### 2.1. Installing and Programming the Composite Sampler

2.1.1. Use all new or precleaned pump tubing each time the sampler is brought to the field and set up. If the automatic sampler is deployed in the field for extended periods, it is recommended to replace the tubing at a minimum of every six months. Other replacement schedules may be required, depending on the specific installation and project requirements. Inspect the tubing each time the composite-sample container is picked up. If there is evidence of loss of elasticity or discoloration or other conditions that would impact the quality of the sample (such as algal growth), or the pumping flow rate, then replace the tubing. Select tubing construction for the pump head and sampling train according to the analytes of interest and the allowable

construction materials specified in FS 1000, Tables FS 1000-1, FS 1000-2, and FS 1000-3.

2.1.1.1. Cut the proper length of precleaned tubing.

2.1.1.2. Equipment Blanks: Collect equipment blanks each time the tubing is changed or at a frequency of 5% of the tubing changes, whichever is less. Collect a minimum of one blank each year. Collect the blank by passing analyte-free water through the equipment that is exposed to the sample.

- Composite sample containers may be cleaned either in the field or in a fixed based operation. Demonstrate cleaning effectiveness by collecting equipment blanks on the composite sample containers according to the frequency specified in FQ 1000. Collect sampler container equipment blanks by adding analyte-free water to the cleaned sample container, mix the water thoroughly within the container, and then pour off an aliquot for analysis.

2.1.1.3. Put the collection sieve and tubing in the appropriate sample location in the wastewater stream, using conduit if necessary to hold it in place. Ensure the supporting conduit does not contaminate the incoming sample water.

2.1.1.4. Program the sampler per manufacturer's directions and as required in the permit or work plan conditions.

2.1.1.5. For a time composite sample, program the sampler to collect a minimum of 100 mL for each sample interval. Adjust the volume collected according to the duration of the sampling event, the sampling interval, and the size of the container.

2.1.1.6. For a flow proportional sample, program the sampler to collect a minimum of 100 mL for each sample interval, with the interval predetermined based on the flow of the waste stream.

2.1.1.7. Automatic Sampler Security: A lock or seal may be placed on the sampler to prevent or detect tampering. However, this procedure does not prevent tampering with the sampler tubing. See additional discussions on sample security in FS 2410, section 2.3.

## 2.2. Sample Acquisition

2.2.1. At the end of each sampling period, stir the contents of the compositing jug (sample) and siphon contents (poured if no visible solids) into the respective containers. If the sampler was set up to collect discrete samples ensure that the contents of each container are adequately mixed while pouring the sample into the sample container.

2.2.2. Immediately preserve the sample, if required, cap, and label the sample container.

2.3. Long-Term Deployment of Automatic Composite Samplers: In certain sampling situations, automatic composite samplers are permanently installed at the sample stations and remain in the field for months or even years. Under these conditions, there are specific sampling issues that need to be addressed.

### 2.3.1. Sample Preservation

2.3.1.1. If the only analyte of interest is Total Phosphorus, and the project is unrelated to an NPDES permit, the sample must be chemically preserved with H<sub>2</sub>SO<sub>4</sub> but it need not be cooled to 4°C with wet ice.

- The acid must be in the container prior to drawing the first composite sample into the container. When using large (i.e., 3 gallon) composite sample containers, and there is potential for the sample size to vary greatly due to variable flow rates at the site, the volume of acid for preservation should be small (e.g., 1 to 2 mL of 50% H<sub>2</sub>SO<sub>4</sub>). **Do not over acidify the sample.** Upon sample pick-up, if needed, add additional acid to achieve the proper pH adjustment for preservation.
- If parameters other than total phosphorus are to be analyzed, appropriate additional preservation (e.g., cooling with ice or refrigeration) is required.

2.3.1.2. Deviations from these SOPs concerning preservation and holding times relating to remote and long term deployments due to site specific considerations must be agreed upon by project management.

### 2.3.2. Cleaning Requirements

2.3.2.1. Clean composite sampler containers after collection of each composite sample using cleaning solutions and procedures specified in FC 1140, sections 5 through 8.

2.3.2.2. Composite sample containers may be cleaned either in the field or in a fixed based operation. Demonstrate cleaning effectiveness by collecting equipment blanks on the composite sample containers according to the frequency specified in FQ 1000. Collect sampler container equipment blanks by adding analyte-free water to the cleaned sample container, mix the water thoroughly within the container, and then pour off an aliquot for analysis.

2.3.2.3. Inspect and replace tubing at a minimum of every six months or when applicable, as discussed in 2.1.1. Collect equipment blanks as specified in 2.1.1.2. If the tubing is being replaced for multiple autosamplers at the same time, one equipment blank may be collected on the entire length of replacement tubing. Collect this equipment blank by passing analyte-free water through the entire length of new tubing.

## **FS 2440. BIOSOLIDS**

These procedures are to be followed when sampling sludges generated by domestic wastewater treatment processes. These procedures are also applicable to other industrial treatment processes where the characteristics or the nature of the solids generated may vary considerably. Typically sludges will be flowing through pipes, moving on conveyor belts or stored in piles or bins.

The number of samples to be collected, the frequency of monitoring, and the type of sample (grab or composite) will be established by the appropriate DEP rule, the permit or project work plan. Biosolid samples collected for metals must be composite samples and samples for pathogens and percent volatile solids must be grabs to comply with Chapter 62-640, F.A.C. Collect composite samples in such a manner that the sample represents, as close as possible, the quality of the biosolids that will be disposed of or used. Seven grab samples must be collected for fecal coliform analyses to meet Class B Alternative 1 requirements.

### 1. GENERAL CONSIDERATIONS

- 1.1. Be aware of the characteristics of the sludge stream to allow the collection of representative samples. The solids content and viscosity of the waste stream will dictate the method by which the most representative samples will be obtained. Some biosolids behave like aqueous samples and should be collected using aqueous sampling procedures.
  - 1.2. Obtain well mixed samples that are representative of the entire flow.
2. SAFETY PRECAUTIONS: Follow safety precautions as outlined in "Standard Methods for the Examination of Water and Wastewater," 18<sup>th</sup>, 19<sup>th</sup> or 20<sup>th</sup> Edition, Section 1060A. Individuals performing sampling must be trained in the microbiological hazards of domestic wastewater and sludge and in safety precautions to take when sampling.
- 2.1. Wear gloves when handling or sampling sewage sludges.
  - 2.2. Clean the sample containers, gloves and your hands before delivering the samples to others.
  - 2.3. Take precautions not to touch other areas of your body while sampling.
  - 2.4. It is recommended that all personnel handling domestic sludges have their inoculations up to date.
  - 2.5. Take extreme care when sampling enclosed areas for biosolids due to the potential for the buildup of dangerous gases.

#### **FS 2441.**     *Equipment and Supplies*

See the introduction to FS 2410 and Table FS 2400-1 for the selection of equipment and supplies.

1. Sample containers used to collect samples must be widemouth bottles that can be capped or flexible plastic containers.
2. Sewage sludges can generate gases so do not completely fill the container.
  - 2.1. Do not fill the sample bottles for the oxygen uptake test more than half full to provide oxygen for respiration of the organisms in the sludge.
  - 2.2. Samples to be analyzed for anaerobic vector attraction reduction must not be exposed to oxygen more than momentarily. The containers must be completely full and have closures that can pop off or containers that are made of flexible plastic.
  - 2.3. Fill sample bottles for oxygen uptake rate only half full to provide oxygen for the respiration of the sludge.

#### **FS 2442.**     *Sampling Procedures*

1. FREE-FLOWING SLUDGE: Sewage sludges below 7% solids behave as moderately viscous liquids. They are heterogeneous and settle upon standing but the settling is slow and is overcome by adequate mixing. These types of sludges may be flowing in pipes, in a processing tank such as a clarifier or digester, stored in tanks or in lagoons. It is preferable to sample liquid sewage sludges as they are being transferred from one vessel to another, preferably sampled downstream of a pump that serves to mix the sludge thoroughly.

##### 1.1. Sampling from Taps

- 1.1.1. The selection of a tap for a sampling point is adequate if:

- 1.1.1.1. The tap is located on the side of the main discharge pipe.
- 1.1.1.2. The sampling point is over 10 pipe diameters downstream from the pipe inlet or the tap is downstream from a pump.
- 1.1.1.3. The flow is turbulent.
- 1.1.1.4. The tap is large enough to ensure that an adequate quantity of sample is pulled from the cross-section of the flow.
- 1.1.2. Thoroughly flush the sample port before collecting the sample.
- 1.1.3. Draw the sample fast enough to minimize the amount of thinned out fluid from the pipe wall.
- 1.1.4. Transfer the liquid sludge samples to a wide-mouth bottle or flexible plastic sample container.
- 1.1.5. Pails, buckets, pitchers, or cylinders may be used as intermediate sample collection devices. Transfer the sample to a sample container at the sample site. Make the transfer with a ladle rather than pouring to eliminate settling during the pouring process.
- 1.2. Sludge Discharges into an Open Channel
  - 1.2.1. Sample by passing a sample container through the discharge stream. The sample container opening should be large enough to catch the whole stream rather than just catching the edge or center of the stream.
  - 1.2.2. If access with a sample container is not possible, use a pail or beaker with an extension arm as an intermediate vessel. Transfer the sample immediately to the sample container.
  - 1.2.3. Securely cap sample container and label.
- 1.3. Sampling Biosolids in Tanks
  - 1.3.1. The purpose of the sampling is to determine the characteristics of the entire mass of sewage sludge.
  - 1.3.2. The entire tank must be well mixed or subsamples must be collected and composited. Take care since tanks might appear to be well mixed but gradients can form. If possible, collect the sample while the tank is being mixed.
  - 1.3.3. Sampling Enclosed Tanks
    - 1.3.3.1. Sample through pipelines entering the digester.
    - 1.3.3.2. Take samples through a minimum of three taps dispersed on the sidewall of the tank. The sample pipes must extend away from the inside walls of the tank.
    - 1.3.3.3. Thoroughly flush the sample line before collecting the sample.
    - 1.3.3.4. Back flush the sample line with tap water after collecting the sample to avoid the accumulation of sludge and microbial growth as a precaution for the next sampling event at that station.
  - 1.3.4. Sampling Open Tanks
    - 1.3.4.1. Vacuum Flask: Sample by drawing a vacuum on a vacuum-filtering flask by connecting a rigid tube to the filter flask and lowering to the desired depth of the

tank.

1.3.4.2. **Weighted Bottle:** Sample by lowering a weighted sample bottle that can be opened at desired depths.

2. **THICK SLUDGE IN LAGOONS:** Sludges that are above 7% solids start to demonstrate resistance to flow. Sludges in lagoons may thicken to up to 15% solids.

2.1. **Thief Sampler:** Collect a core sample to the bottom of the sludge layer. The sample obtained with this type of sampler will exclude the overlying water layer that would be included when core samplers are used.

2.2. **Weighted Bottle Sampler:** Another alternative for collecting thick sludges is to use a weighted bottle sampler that can be opened at desired depths. Where gradients exist, obtain equal amounts of sample from each gradient for compositing.

3. **DEWATERING EQUIPMENT SLUDGE**

3.1. **Conveyor Belts:** Collect the samples directly from the conveyor belts using a spoon, scoop, or shovel.

3.2. **Bulk Containers and Piles**

3.2.1. **Auger with Deeply Threaded Screws:** Obtain a cross-sectional sample by turning the auger into the pile and pulling it straight out. Remove the sample from the auger with a spatula, scoop, or spoon.

3.2.2. **Shovel:** Collect subsamples from the pile interior. Sample the pile in proportion to its mass; collecting more samples where the pile is deeper.

4. **DRY SLUDGE**

4.1. **Conveyor Belts:** Sample when the sludge is being transferred on the sampling belt. Using a spoon, scoop or shovel collect material across the entire width of the conveyor. If it is not possible to collect across the entire width of the conveyor at once, collect samples from various points across the conveyor to represent the entire width.

4.2. **Sludge Piles**

4.2.1. If the sludge is homogeneous and the sample can be collected within 24 hours of the pile creation follow the sampling procedures in 3.2 of this section.

4.2.2. If the sludge is heterogeneous in nature or sample collection occurs after 24 hours of the pile creation use the following sample procedures:

4.2.2.1. As early as 24 hours after the creation of the pile significant changes may occur that will cause the surface and the interior of the pile to vary significantly.

4.2.2.2. When the piles are more than one day, old collect samples from a pile cross-section. Use augers or sample thieves only where there are no large pieces of material or fine composted particles.

4.2.2.3. If augers or sample thieves cannot be used, collect a cross-section sample of the pile with a shovel.

### **FS 2443. *Sample Compositing and Size Reduction***

See FS 2420 for a general discussion of sample types. The permit or work plan will specify if composite samples are to be collected and under what conditions. Sample size reduction

is often needed when collecting biosolid samples since the individual aliquots collected are usually large in size. The nature of the sample may also make it necessary to reduce particle sizes in order to obtain a representative sample.

## 1. SAMPLE COMPOSITING AND SIZE REDUCTION

1.1. Do not use automatic composite samplers for the collection of biosolids because of the solids content and viscosity of the sludges.

1.1.1. Automatic samplers, which use pumps to draw samples up a suction tube, will cause solids separation if the flow velocity in the suction and discharge tubes is too low.

1.1.2. The tubing and pump structure will become fouled contaminating subsequent aliquots.

1.1.3. Tubing blockages will occur frequently.

1.2. Use manual composite sampling.

1.3. Compositing and Size Reduction Methods: Collect sample aliquots in individual bottles and composite at the site or back in the laboratory.

### 1.3.1. Freely Flowing Sludges

1.3.1.1. Accomplish compositing of smaller samples of freely flowing liquids by pouring them into a larger container with adequate headspace and shaking the sample thoroughly or stirring with a sterile paddle.

1.3.1.2. Pouring off the contents of a larger container into a smaller container is not acceptable. Using a pipet with a wide bore is acceptable as long as the sludge is stirred and the pipet does not restrict any of the particles. Draw the sample into the pipet slowly and move the tip through the sample to minimize selective collection of liquid over solid particles.

1.3.2. Thick Sludges: Compositing and sample size reduction for thick sludges is difficult because shaking cannot mix them.

1.3.2.1. Collect subsamples with a spoon, scoop, or spatula for compositing.

- Hand mix each individual sample. Stirring with a mechanical mixer or paddle is often inadequate.
- Take equal amounts of each well mixed individual sample and combine to make one composite sample.

### 1.3.3. Dry Solid Samples

1.3.3.1. Homogeneous Samples: Mix the sample by shaking the container. Remove subsamples with a spoon, scoop, or spatula to make up the composite sample.

### 1.3.3.2. Heterogeneous Samples

- If the particles are large and a number of subsamples must be combined into one composite sample, then shredders, choppers, or grinders may be needed to obtain a representative sample. The laboratory must conduct this activity.
- It is important that the lab and samplers communicate effectively regarding the handling of the samples since particle size reduction is not appropriate if large pieces in the sample are not sewage sludge but materials added for processing the sludge.

## 2. COMPOSITE DURATION

2.1. For bacteriological, vector attraction or viral analyses the maximum time for compositing is one hour, since a longer time may cause microbiological changes in the first sample aliquot.

2.2. Composite sampling over 24 hours may be done for *Helminth ova* as long as the samples are not exposed to chemical or thermal stress (temperatures not to exceed 40°C, or exposed to such chemicals as ammonia, hydroxides or oxidants).

### **FS 2450. SAMPLING FOR CRYPTOSPORIDIUM AND GIARDIA**

Samples collected for the analysis of Cryptosporidium and Giardia in wastewater are to follow the procedures in EPA Method 1623. In order to meet reporting criteria for certain projects the required sample volumes may need to be modified, where possible, to meet the project data quality objectives.

1. Samples are collected in 10 L plastic carboys or other containers large enough to meet the project data quality objectives.
2. Follow restrictions concerning bacteriological sampling in FS 2005.

### **FS 2460. DOCUMENTATION**

1. Immediately following sample collection, identify each sample container with a unique field identification code.
2. Record sampling information specific to the site while still at the site and meet all of the requirements specified in FD 1000.

### **FS 2470. SAMPLE TRANSPORT AND HANDLING**

1. For information on sample preservation and holding time requirements see FS 1000, Tables FS 1000-4, FS 1000-5, and FS 1000-9. See the exceptions for the biosolids samples in section 3 below.
2. FS 1000, Table FS 1000-4 includes allowances for automatic samplers. In addition to the requirement of keeping samples cooled with ice or refrigerated during the sampling event (where cooling is applicable to the analytes of interest), there are several considerations to be presented for chemical preservation:
  - 2.1. If discrete aliquots are collected into separate bottles, prepreserve the containers with the appropriate chemical preservative or preserve the samples immediately after sampling has been completed.
  - 2.2. If a large compositing jug is used, preserve samples immediately after sampling has been completed.

- 2.3. If samples are collected with a composite sampler, the only analyte of interest is Total Phosphorus and the project is unrelated to an NPDES permit, then chemically preserve the sample with H<sub>2</sub>SO<sub>4</sub> (it need not be cooled to 4°C with wet ice). The acid must be in the container prior to sample collection.
3. BIOSOLIDS SAMPLES (maximum holding times, preservation and container type): See FS 1000, Table FS 1000-9.
4. CRYPTOSPORIDIUM AND GIARDIA SAMPLES
- 4.1. See FS 1000, Table FS 1000-9 for holding times, preservation and container types.
- 4.2. Ship samples to the laboratory the day they are collected.
- 4.3. Samples must arrive at the laboratory within 24 hours of sample collection.
- 4.4. Maintain samples at 0 – 8°C between collection and the time of filtration at the laboratory. Do not allow the samples to freeze.
- 4.5. Transporting Infectious Materials: The U.S. Department of Transportation (DOT) regulations (49 CFR 172) prohibit interstate shipment of more than 4 L of solution known to contain infectious materials. Check state regulations for similar shipping restrictions for intrastate commerce. This method requires a minimum sample volume of 10 L. Unless the sample is known or suspected to contain Cryptosporidium, Giardia, or other infectious agents (e.g., during an outbreak), samples should be shipped as noninfectious and should not be marked as infectious. If a sample is known or suspected to be infectious, and the sample must be shipped to a laboratory by a transportation means affected by DOT or state regulations, it is recommended that the sample be filtered in the field, and that the filter be shipped to the laboratory to avoid violating transport regulations.

**APPENDIX FS 2400**  
**Tables, Figures and Forms**

Table FS 2400-1. Wastewater Sampling Equipment

**Table FS 2400-1  
 Wastewater Sampling Equipment**

<b>EQUIPMENT</b>	<b>USE</b>
Unpreserved sample container Pond Sampler Scoops Beakers Buckets Dippers Other container types	Surface sampling using an intermediate vessel
Peristaltic pump and tubing Sample container	Surface sampling directly into, or pumped into, sample container
Kemmerer Van Dorn Nansen Alpha Bottle Beta Bottle Niskin Equivalent devices Double check-valve bailer Pole and attached container (removable top) Peristaltic pump and tubing	Specific-depth grab sampling
Automatic composite samplers	Composite sampling
Sample Containers Buckets Scoops Dippers Beakers Vacuum flask Weighted bottle sampler	Free flowing sludges
Thief sampler Weighted bottle sampler	Thick sludges
Spoon Scoop Shovel Auger	Sludges from dewatering equipment
Auger Shovel Sample thief	Dry sludges

## **FS 3000. SOIL**

See also the following Standard Operating Procedures:

- FA 1000 Administrative Procedures
- FC 1000 Cleaning/Decontamination Procedures
- FD 1000 Documentation Procedures
- FM 1000 Field Planning and Mobilization
- FQ 1000 Field Quality Control Requirements
- FS 1000 General Sampling Procedures
- FT 1000 – FT 2000 Field Testing and Calibration

### 1. Introduction and Scope

1.1. Use these SOPs during field investigations to collect soil samples that are representative of current site conditions. It is very important to ensure that the collected samples are neither altered nor contaminated by sampling and handling techniques.

1.2. The following topics include: equipment choice, equipment construction materials, grab and areal or depth composite sampling techniques. Sample collection methods fall into three general depth classifications: surface, shallow subsurface, and deep subsurface. Once the samples are acquired, the handling procedures are very similar and are described below.

### 2. GENERAL

2.1. Select sampling equipment based on the type of sample to be collected and the analytes of interest. Choose soil sampling locations such that a representative portion of the soil is collected with minimal disturbance. Locations where natural vegetation is stressed or dead and/or areas that have surficial soil staining may be indicative of improper waste disposal practices.

2.2. If background and/or quality control sampling is warranted and feasible as determined in the site's work plan or by the project manager, select an up gradient, undisturbed location for obtaining the background and/or quality control samples. Be aware that differences in soil types may affect these background samples (e.g., sands vs. clays).

2.3. **Do not collect** samples for chemical analysis from auger flights or cuttings from hollow stem auger flights, except for waste characterization purposes for disposal.

2.4. Do not use samples that are collected for geological/lithological or vapor meter determinations for chemical analyses.

### 3. EQUIPMENT AND SUPPLIES

3.1. All equipment must be constructed of materials consistent with the analytes of interest. Refer to FS 1000, Tables FS 1000-1, FS 1000-2 and FS 1000-3 for selection of appropriate equipment and materials.

3.2. For information on sample container size and construction, see FS 1000, Table FS 1000-6.

3.3. For information on sampling equipment cleaning requirements, see FC 1000.

3.4. For information on preservation and holding time requirements, see FS 1000, Table FS 1000-6.

3.5. For information on documentation requirements, see FD 1000.

#### 4. PROCEDURES FOR COMPOSITING

4.1. The following is not a complete discussion regarding all available sampling protocols nor the appropriateness or inappropriateness of compositing soil samples. The appropriateness of compositing soil samples will depend on the data quality objectives of the project. However, it is sometimes advantageous to composite soil samples to minimize the number of samples to be analyzed when sampling highly contaminated areas. Obtain permission from the DEP program.

4.1.1. Select sampling points from which to collect each aliquot.

4.1.2. Using the appropriate sampling technique, collect equal aliquots (same sample size) from each location and place in a properly cleaned container.

4.1.3. **Combine the aliquots of the sample directly in the sample container with no pre-mixing.**

4.1.4. Record the amount of each aliquot (volume or weight).

4.1.5. Label container, preserve on wet ice to 4°C and complete field notes.

4.1.6. Notify the laboratory that the sample is an unmixed composite sample, and request that the sample be thoroughly mixed before sample preparation or analysis.

#### 5. SPECIFIC PROCEDURES FOR VOLATILE ORGANIC COMPOUNDS

Follow the procedures specified in EPA Method 5035 for sample collection and sample preparation. The protocols listed below **do not replace Method 5035** but clarify and/or modify certain method procedures. Therefore, it is essential that all organizations have a copy of Method 5035 as a reference document.

##### 5.1. Container Preparation

5.1.1. All containers must be cleaned according to the FC 1000 sample container cleaning procedures for volatile organics.

5.1.2. Sample Vials: If sample vials are filled in the field, they must be provided with all reagents, stirring devices, label **and vial cap** to be used during sample analysis. These vials must be preweighed by the laboratory and records must be maintained so that there is an unambiguous link between the tare weight and the filled sample vial.

##### 5.2. Collection Procedure

5.2.1. The sample vials (when used) will contain a premeasured amount of liquid. The laboratory must weigh the vials before sending into the field, and must weigh them again after receipt. Therefore:

- Do not lose any of the liquid either through evaporation or spillage
- Do not use a vial if some of the contents has spilled, or if it appears that some has leaked during transport
- Use the laboratory-supplied container label for identification information. **DO NOT apply any additional labels to the container**

- Do not interchange vial caps or septa
- 5.2.2. Minimize exposure to air by obtaining the sample directly from the sample source, using a coring device or a commercially designed sampling tool.
- 5.2.2.1. The sample collection device must be designed to fit tightly against the mouth of the vial or be small enough to be inserted into the vial. Use:
- EnCore or equivalent sampling devices or
  - Disposable plastic syringes with the syringe end cut off prior to sampling (use **once** per sampling location).
- 5.2.2.2. Extrude the sample directly into the sample container.
- 5.2.3. Follow the method procedures for field transfer into the vial.
- 5.2.4. Procedures for determining the sample weight in the field are not required unless the project manager requires an accurate determination of the 5-gram sample size.
- 5.2.4.1. If the vials are returned to the laboratory for weighing, the sampler must be proficient in estimating the requisite 5-gram weight necessary for each sample.
- 5.2.4.2. If an accurate estimate of the 5-gram sample size is desired prior to starting sample collection activities, use a balance with a sensitivity of 0.1 gram. Check the balance calibration before each day's use with a set of weights that have been calibrated against NIST-traceable weights at least annually.
- 5.2.5. If the sampling device is transported to the laboratory with a sample, make sure the seals are intact, especially if collecting samples from sandy soils.
- 5.2.6. Collect at least two replicate samples from the same soil stratum and within close proximity to the original sample location.
- 5.2.7. Collect an additional aliquot of sample for screening and dry weight determinations.
- 5.3. Preservation (see FS 1000, Table FS 1000-7)
- 5.3.1. Low Level ( $\leq 200 \mu\text{g}/\text{kg}$  volatile organics)
- 5.3.1.1. Method 5035 discusses the use of sodium bisulfate, which is an acid. Since Florida soils contain significant amounts of calcium carbonate that reacts with acids, DEP does not recommend using this preservative.
- 5.3.1.2. Properly pack the samples (see FS 2004, section 5), and place all samples on wet ice.
- 5.3.1.3. Analyze unpreserved samples (no acid) within 48 hours.
- 5.3.1.4. Analyze acid-preserved samples within the specified 14-day holding time.
- 5.3.1.5. Analyze unpreserved samples that have been collected in a septum vial with premeasured analyte-free water within 48 hours.
- 5.3.1.6. If unpreserved samples collected in a septum vial with premeasured analyte-free water are frozen to  $-10^{\circ}\text{C}$  at the laboratory within 48 hours of sample collection, analyze the samples within 14 days.
- 5.3.1.7. Analyze samples that have been collected with and transported in a sealed coring device within 48 hours.

5.3.1.8. If unpreserved samples collected in a sealed coring device are extruded from the corer into an appropriate liquid and frozen to -10°C at the laboratory within 48 hours of sample collection, analyze the samples within 14 days.

5.3.2. High Level (> 200 µg/kg volatile organics)

5.3.2.1. Properly pack the samples (see FS 2004, section 5), and place all samples on wet ice.

5.3.2.2. Analyze samples that have been collected with and transported in a sealed coring device within 48 hours.

5.3.2.3. If unpreserved samples collected in a sealed coring device are extruded from the corer into an appropriate liquid and stored at 4°C at the laboratory within 48 hours of sample collection, analyze the samples within 14 days.

5.3.2.4. Analyze samples that that have been preserved in methanol in the field within 14-days.

6. BULK SAMPLES: The collection of bulk samples will depend on the data quality objectives of the project.

6.1. Do not composite or mix VOC samples unless required by the DEP program or if mandated by a formal DEP document (permit, order or contract).

6.2. Select sampling points from which to collect each aliquot.

6.3. Using the appropriate sampling technique, collect equal aliquots (same sample size) from each location and place in a properly cleaned container.

6.3.1. **Combine the aliquots of the sample directly in the sample container with no pre-mixing..**

6.3.2. Pack soil tightly minimizing as much headspace as possible in the sample container.

6.3.3. Cap container tightly with Teflon side facing sample.

6.4. Record the amount of each aliquot (volume or weight) in the field notes.

6.5. Label container. Refer to FS 1000, Table FS 1000-7 for preservation and holding time requirements.

6.6. Notify the laboratory that the sample is an unmixed composite sample, and request that the sample be thoroughly mixed before sample preparation or analysis.

## **FS 3100. Surface Soil Sampling**

Surface soil is generally classified as soil between the ground surface and 6-12 inches below ground surface.

1. Remove leaves, grass and surface debris from the area to be sampled.
2. Collect samples for volatile organic analyses as described in FS 3000, section 5.
3. Select an appropriate precleaned sampling device and collect the sample.
4. Transfer the sample to the appropriate sample container.
5. Clean the outside of the sample container to remove excess soil.

6. Label the sample container, place on wet ice to preserve to 4°C and complete the field notes.

## **FS 3200. Subsurface Soil Sampling**

Interval begins at approximately 12 inches below ground surface.

### **FS 3210. SAMPLE COLLECTION PROCEDURE**

Use the following after the desired depth has been reached by one of the methods outlined in FS 3220.

1. Collect samples for volatile organic analyses as described in FS 3000, section 5.
2. For other analyses, select an appropriate precleaned sampling device and collect the sample.
3. Transfer the sample to the appropriate sample container.
4. Clean the outside of the sample container to remove excess soil.
5. Label the sample container, place on wet ice to preserve to 4°C and complete the field notes.

### **FS 3220. REACHING THE APPROPRIATE DEPTH**

1. **SHOVELS AND DIGGERS:** Used for soils from approximately 12 inches to a point when using the implement becomes impractical.
  - 1.1. Dig a hole or trench to the required depth.
  - 1.2. Follow the sample collection procedures outlined in FS 3210.
2. **BACKHOE:** Used for soils from approximately 12 inches to a point when using the implement becomes impractical.
  - 2.1. Dig a trench to the appropriate depth.
  - 2.2. Expose the sample, in the trench, by using a precleaned spoon, spatula or equivalent to clean away the soil that came in contact with the backhoe bucket.
  - 2.3. Use a **second** precleaned utensil to actually collect the sample from the trench.
  - 2.4. Follow the procedures outlined in FS 3210 to collect the sample.
3. **BUCKET AUGERS AND HOLLOW CORERS:** Suitable to reach soils from approximately 12 inches to a point when using the implement becomes impractical.
  - 3.1. Push and rotate the auger into the soil until the bucket is filled.
  - 3.2. Addition of a non-contaminating sleeve may allow an undisturbed soil sample to be obtained.
    - 3.2.1. The device consists of a standard auger head with a removable sleeve, which is inserted into the auger barrel. In this case it is the sleeve, which fills with soil.
    - 3.2.2. Remove the sleeve from the auger and cap.
  - 3.3. If the auger hole is prone to collapse due to low cohesion in some soils, DEP recommends inserting a temporary rigid PVC casing into the hole. The casing prevents hole collapse and minimizes cross-contamination between soil zones as the auger is advanced.

- 3.4. Remove the sample from the sampler by pushing or scraping the soil with an appropriate precleaned utensil into an appropriately precleaned tray or aluminum foil.
- 3.5. Remove any portion of the sample that has been disturbed and discard.
- 3.6. Follow the sample collection procedures outlined in FS 3210.

NOTE: If a confining layer has been breached during sampling, grout the hole to land surface with Type-1 Portland cement. This requirement may be different throughout Florida; contact the local Water Management District office for local requirements.

4. SPLIT SPOON SAMPLER: Suitable for reaching soils from approximately 12 inches to depths greater than 10 feet.

- 4.1. A split spoon sampler, useful for sampling unconsolidated soil, consists of two half cylinders (spoons) that fit together to form a tube approximately two feet in length and two inches in diameter.
  - 4.1.1. The cylindrical arrangement is maintained by a retaining head and bit rings that screw on at each end of the split spoon.
  - 4.1.2. The bit ring has beveled edges to facilitate sampling as the split spoon is forced into the ground.
  - 4.1.3. Advance the sampler using the weight of the drilling stem and rods or a mechanical hammer.
  - 4.1.4. Insert a catcher device in the head ring to prevent loss of unconsolidated sample during recovery.
- 4.2. After retrieving the split spoon sampler, expose the soil by unscrewing the bit and head rings and splitting the barrel.
- 4.3. If the recovery is enough to accommodate discarding a portion of the sample, discard the top and bottom two to three inches of the sample.
- 4.4. For volatile organic compounds collect the sample immediately from the **center portion of the split spoon** using the procedures described in FS 3000, section 5.
- 4.5. For other analyses, slice the sample from the center portion of the split spoon using a clean, decontaminated utensil.
- 4.6. Select an appropriate precleaned sampling device and collect the sample.
- 4.7. Transfer the sample to the appropriate sample container.
- 4.8. Clean the outside of the sample container to remove excess soil.
- 4.9. Label the sample container, place on wet ice to preserve to 4°C and complete the field notes.

5. DIRECT PUSH RIGS: May be used for depths greater than 10 feet below ground surface.

- 5.1. Liners: The clear liners are used with direct push rigs. This method is appropriate only for unconsolidated materials. The sampling depth that can be achieved varies depending on the rig and the lithologies that are encountered. Typically, the rig operator will:

- Place the liner inside the metal probe rod
- Select a point holder with an opening appropriate for the site lithology and screw it on the probe rod
- Advance the rod a full rod length
- Retrieve the rod
- Remove the point holder
- Remove the liner, and
- Slice the liner to expose the soil.

5.2. After the liner has been sliced, follow the procedures outlined in FS 3210, collecting volatile organic samples (if needed) immediately after the liner is sliced.

5.3. If samples for organic vapor analysis screening are required, collect them by slicing the sample(s) using a clean, decontaminated utensil and place them in 8-ounce (preferred) or 16-ounce jars, immediately cover the opening with aluminum foil and screw on the lid ring. If the contamination is derived from petroleum products, it is acceptable to use a clean gloved hand to transfer the sample(s) to the sample container(s).

5.4. For other analyses, slice the sample from the center portion of the split spoon using a clean, decontaminated utensil.

5.5. Select an appropriate precleaned sampling device and collect the sample.

5.6. Transfer the sample to the appropriate sample container.

5.7. Clean the outside of the sample container to remove excess soil.

5.8. Label the sample container, place on wet ice to preserve to 4°C and complete the field notes.

## 6. SHELBY TUBE SAMPLER

6.1. The Shelby tube sampler is used to sample unconsolidated soil and consists of a tube approximately 30 inches long and two inches (or larger) in diameter.

6.2. One end of the tube has edges beveled into a cutting edge. The other end can be mounted to an adapter, which allows attachment to the drilling rig assembly.

6.3. After drilling to the required depth with an auger or rotary drill bit, a soil sample is obtained through the auger or directly in the borehole.

6.4. Push the Shelby tube into the soil using the drilling rig's hydraulic ram or manually with a sledge hammer.

6.5. Remove the tube from the sampler head.

6.6. Extrude the sample from the Shelby tube.

6.7. Use a decontaminated utensil to remove any portion of the sample that has been disturbed.

6.8. Collect samples for volatile organics immediately from the center portion of the Shelby tube using the procedures described in FS 3000, section 5.

6.9. For other analyses, slice the sample from the center portion of the Shelby tube using a clean, decontaminated utensil.

- 6.10. Transfer the sample to the appropriate sample container.
- 6.11. Clean the outside of the sample container to remove excess soil.
- 6.12. Label the sample container, place on wet ice to preserve to 4°C and complete the field notes.

## 7. CORE BARREL

- 7.1. A standard core barrel is utilized when consolidated samples (such as limestone or dolomite) are to be sampled.
  - 7.1.1. The core barrel is a cylinder approximately three feet long and two inches in diameter.
  - 7.1.2. The barrel has a removable head ring with small embedded diamonds which allow the device to cut through rock or consolidated soil as the drilling rods are rotated.
- 7.2. Retrieve the sample core by unscrewing the head ring and sliding the sample into a precleaned container.
- 7.3. Use a decontaminated utensil to remove any portion of the sample that has been disturbed.
- 7.4. Remove the sample from the sampler (corer) with a precleaned tool.
- 7.5. Transfer the sample to the appropriate sample container.
- 7.6. Clean the outside of the sample container to remove excess soil.
- 7.7. Label the sample container, place on wet ice to preserve to 4°C and complete the field notes.

## ***FS 4000. SEDIMENT SAMPLING***

See also the following Standard Operating Procedures:

- FA 1000 Administrative
- FC 1000 Field Cleaning
- FD 1000 Documentation
- FM 1000 Field Mobilization
- FQ 1000 Quality Control
- FS 1000 General Sampling
- FS 7400 Benthic Macroinvertebrate Sampling
- FT 1000 – 2000 Field Testing

### 1. INTRODUCTION AND SCOPE

Sediments occur in freshwater and marine environments such as streams/rivers, ponds/lakes, canals, ditches, wetlands, lagoons, and estuaries. Recently exposed sediment (due to low water levels) may also be sampled, but exposure to air could affect the characteristics of the sediment (for example, redox) and hence, the interpretation of the results of chemical or other analyses. The following methods are for physical, chemical, and toxicological sampling. See FS 7400 for benthic invertebrate sampling.

1.1. Select sampling locations for sediments depending upon the project objectives.

Collect:

1.1.1. Sediment samples as an adjunct to surface water samples;

1.1.2. A series of sediment samples for compositing to determine water or sediment quality in a system;

1.1.3. Sediment samples above and below an outfall to document degradation due to a point source discharge; or

1.1.4. Sediment samples if stressed shore vegetation or visible surface water contamination is evident.

1.2. Decisions related to the selection of sampling locations will not be discussed in this document.

1.3. Collect, preserve and containerize surface water samples prior to collecting sediment samples (see FS 2100).

### 2. EQUIPMENT AND SUPPLIES

2.1. Refer to Table FS 4000-1 and FS 1000, Tables FS 1000-1, 1000-2 and 1000-3, for selection of sampling equipment and construction.

2.2. For information on the selection of appropriate sample containers, see FS 1000 Table FS 1000-6.

2.3. For information on cleaning requirements for sample containers, equipment and utensils, see FC 1000.

2.4. For information on documentation requirements, see FD 1000.

2.5. For information on preservation and holding time requirements, see FS 1000 Table FS 1000-6.

### 3. SAMPLE COLLECTION PROTOCOLS

Take sediment samples using one of three different types of equipment: scoops, corers and dredges or grab samplers.

3.1. Soil sampling equipment is generally not applicable to sediments because of the low cohesion of the medium.

3.2. When selecting the appropriate sampling equipment, consider sampling location (edge or middle of lagoon), depth of water and sediment, sediment grain size (fineness), water velocity and analytes of interest.

3.3. Direct collection with the appropriate sample container may be appropriate in very low water or where sediment is exposed.

3.4. Use dredges for hard or rocky substrates. They are heavy enough to use in high velocity streams.

3.5. Use coring devices in quiescent waters, unless water depth precludes effective sample collection.

#### 3.6. Scoops or Similar Equipment

3.6.1. Scooping is generally most useful around the margin or shore of the water body or by wading in shallow waters.

3.6.1.1. Stand facing the direction of flow and approach the location from the downstream direction.

3.6.1.2. Take precautions not to disturb the bottom prior to scooping.

3.6.1.3. Scoop the sample in the upstream direction of flow.

3.6.2. For obtaining samples several feet from shore or from a boat, DEP recommends attaching the scoop to an extendible pole.

3.6.3. Transfer sample to the appropriate sample container(s), using a clean non-reactive utensil.

3.6.4. Label, preserve to 4°C with wet ice and complete field notes.

#### 3.7. Corers

3.7.1. Coring devices can be easily fabricated from many materials. Although stainless steel, glass or Teflon must be used for sampling extractable organics, volatile organics and inorganics, aggregate organics, petroleum hydrocarbons and oil & grease, other inexpensive material (e.g., PVC, carbon steel, etc.) may be used for inorganic non-metallics and metals.

3.7.2. Some corers are simple "push tubes," whereas other more sophisticated models may be finned, gravity driven devices.

3.7.3. A core may be useful for preserving the historical layering of sediments.

3.7.4. Upon descent, water displacement is minimal with core samplers, which minimizes the shock wave produced by other equipment such as dredges.

3.7.5. The corer is an acceptable choice for sampling fine sediments in static waters, especially those containing trace organics and metals.

3.7.6. Corer diameter, grain size and sample consistency will determine if the sample will remain in the corer upon withdrawal.

3.7.7. Sample washout can be a problem and there are several ways to reduce or prevent it.

3.7.7.1. Fit the leading edge of the corer with a nosepiece or core catcher that physically keeps the sample from slipping back out of the corer. The core catcher material must also be compatible with the analytes of interest.

3.7.7.2. A second option is fit the top or back end with a check valve which creates negative pressure on the back of the sample as it is being pulled from the substrate and prevents surface water from washing out the top portion of the sample.

3.7.8. Rotate the corer, if needed, as it is pushed into the sediment.

3.7.8.1. Rotate be around its axis (do not rock the coring device back and forth).

3.7.8.2. Rotation improves penetration and prevents compaction of the sample as it is pushed to the full length of the corer.

3.7.9. Upon withdrawal from the water surface, place a cap on the bottom to prevent the sample from sliding out.

3.7.10. Corers can also be fitted with liners. This is advantageous if a complete core is desired that has not been in contact with the atmosphere. It is also advantageous if the coring device is not constructed of the proper material (e.g., PVC) and one of the analytes requires a sampler of inert construction (glass, stainless steel or Teflon).

3.7.11. As the core is extruded, carefully remove the sample with a clean, non-reactive utensil and transfer into the appropriate sample container(s).

3.7.12. Label, preserve to 4°C with wet ice and complete field notes.

### 3.8. Dredges or Grab Samplers

3.8.1. The three main types of devices used in freshwater are the Ekman, Peterson and Ponar. Heavier oceanographic dredges are used in marine and estuarine waters.

3.8.2. Refer to Table FS 4000-1 for additional types of dredges. The Peterson and Ponar dredges are suitable for hard or rocky substrates or deep water bodies.

3.8.2.1. The Peterson and Ponar are virtually the same, except that the Ponar has been adapted with a top screen and side plates to prevent sample loss upon ascent. For this reason, the Ponar is the dredge of choice for rocky substrates. These dredges are heavy enough to use in streams with fast currents.

3.8.2.2. Open the jaws and place the cross bar into the proper notch.

3.8.2.3. Lower the dredge to the bottom, making sure it settles flat.

3.8.2.4. When tension is removed from the line, the cross bar will drop, enabling the dredge to close as the line is pulled upward during retrieval.

3.8.2.5. Pull the sampler to the surface. Check to make sure the jaws are fully closed and that no sample was lost while lifting the dredge.

3.8.2.6. Carefully open the jaws, remove the sample with a clean, non-reactive utensil and transfer the sample into the appropriate sample container(s), label, preserve to 4°C with wet ice and complete field notes.

3.8.3. The Ekman is designed for sampling soft substrates (e.g., sand, silt or mud) in areas with little current.

3.8.3.1. Open the spring-loaded jaws and attach the chains to the pegs at the top of the sampler.

3.8.3.2. Lower the dredge to the bottom, making sure it settles flat.

3.8.3.3. Holding the line taut and send down the messenger to close the jaws of the dredge.

3.8.3.4. Pull the sampler to the surface. Check to make sure the jaws are fully closed and that no sample was lost while lifting the dredge.

3.8.3.5. Carefully open the jaws, remove the sample with a clean, non-reactive utensil and transfer the sample into the appropriate sample container(s).

3.8.3.6. Label, preserve to 4°C with wet ice and complete field notes.

#### 4. PROCEDURES FOR COMPOSITING

4.1. The following is not a complete discussion regarding all available sampling protocols nor the appropriateness or inappropriateness of compositing sediment samples. The appropriateness of compositing sediment samples will depend on the data quality objectives of the project. However, it is sometimes advantageous to composite sediment samples to minimize the number of samples to be analyzed when sampling highly contaminated areas. Obtain permission from the DEP program.

4.1.1. Select sampling points from which to collect each aliquot.

4.1.2. Using the appropriate sampling technique, collect equal aliquots (same sample size) from each location and place in a properly cleaned container.

4.1.3. **Combine the aliquots of the sample directly in the sample container with no pre-mixing.**

4.1.4. Record the amount of each aliquot (volume or weight).

4.1.5. Label container, preserve on wet ice to 4°C and complete field notes.

4.1.6. Notify the laboratory that the sample is an unmixed composite sample, and request that the sample be thoroughly mixed before sample preparation or analysis.

#### 5. COLLECTION OF INTERSTITIAL OR PORE WATER SAMPLES

5.1. ASTM identifies interstitial water or pore water as the “water occupying the space between sediment...particles.” It “is often isolated to provide either a matrix for toxicity testing or an indication of the concentration and partitioning of contaminants with a sediment matrix.” See American Society for Testing and Materials, Annual Book of ASTM Standards, Standard Guide for Collection, Storage, Characterization and Manipulation of Sediments for Toxicological Testing and for Selection of Samplers Used to Collect Benthic Invertebrates, Section E 1391-03, Volume 11-05. Collect pore water using available technology that will preserve the integrity of the analytes of interest during collection. Pore water may be extracted in the laboratory from field-collected sediments. Consult the detailed discussion in the ASTM guidance if pore water is to be extracted and analyzed as part of the sampling design. Use of pore water wells (e.g., shallow PVC wells) or pore water equilibrators (e.g., Plexiglas plates with built-in wells or other appropriate construction) is also acceptable.

5.2. Collect adequate amounts of sample in the field to obtain desired quantities of pore water for testing. Sandy sediments retain less water than fine sediments do; thus, the

DEP-SOP-001/01  
FS 4000 Sediment Sampling

substrate type will dictate the amount of additional sample needed. In all cases, consult the laboratory conducting the analyses to provide estimates of the amount of sediment necessary to obtain the desired quantity of pore water.

**Appendix FS 4000**  
**Tables, Figures and Forms**

Table FS 4000-1: Summary of Bottom Sampling Equipment [from ASTM E 1391-94]

DEP-SOP-001/01  
FS 4000 Sediment Sampling

**TABLE FS 4000-1 Summary of Bottom Sampling Equipment [from ASTM E 1391-94]**

<b>Device</b>	<b>Use</b>	<b>Advantages</b>	<b>Disadvantages</b>
Teflon or glass tube	Shallow wadeable waters or deep waters if SCUBA available. Soft or semi-consolidated deposits.	Preserves layering and permits historical study of sediment deposition. Rapid - samples immediately ready for laboratory shipment. Minimal risk of contamination.	Small sample size requires repetitive sampling.
Hand corer with removable teflon or glass liners	Same as above except more consolidated sediments can be obtained.	Handles provide for greater ease of substrate penetration. Above advantages.	Careful handling necessary to prevent spillage. Requires removal of liners before repetitive sampling. Slight risk of metal contamination from barrel and core cutter.
Box corer	Same as above.	Collection of large sample undisturbed, allowing for subsampling.	Hard to handle.
Gravity corers, such as Phleger Corer	Deep lakes and rivers. Semi-consolidated sediments.	Low risk of sample contamination. Maintains sediment integrity relatively well.	Careful handling necessary to avoid sediment spillage. Small sample, require repetitive operation and removal of liners. Time consuming.
Young grab (Teflon or kynar-lined, modified 0.1-m <sup>2</sup> Van Veen)	Lakes and marine areas.	Eliminates metal contamination. Reduced bow wake.	Expensive. Requires winch.
Ekman or box dredge	Soft to semi-soft sediments. Can be used from boat, bridge, or pier in waters of various depths.	Obtains a larger sample than coring tubes. Can be subsampled through box lid.	Possible incomplete jaw closure and sample loss. Possible shock wave, which may disturb the "fines". Metal construction may introduce contaminants. Possible loss of "fines" on retrieval.
PONAR grab sampler Petite PONAR grab sampler	Deep lakes, rivers and estuaries. Useful on sand, silt, or clay.	Most universal grab sampler. Adequate on most substrates. Large sample obtained intact, permitting subsampling.	Shock wave from descent may disturb "fines." Possible incomplete closure of jaws results in sample loss. Possible contamination from metal frame construction. Sample must be further prepared for analysis.
BMH-53 piston corer	Waters of 4 to 6 ft deep when used with extension rod. Soft to semi-consolidated deposits.	Piston provides for greater sample retention.	Cores must be extruded on-site to other containers. Metal barrels introduce risk of metal contamination.
Van Veen dredge	Deep lakes, rivers and estuaries. Useful on sand, silt, or clay.	Adequate on most substrates. Large sample obtained intact, permitting subsampling.	Shock wave from descent may disturb "fines." Possible incomplete closure of jaws results in sample loss. Possible contamination from metal frame construction. Sample must be further prepared for analysis.
BMH-60 grab sampler	Sampling moving waters from a fixed platform.	Streamlined configuration allows sampling where other devices could not achieve proper orientation.	Possible contamination from metal construction. Subsampling difficult. Not effective for sampling fine sediments.
Petersen grab sampler	Deep lakes, rivers and estuaries. Useful on most substrates.	Large sample; can penetrate most substrates.	Heavy. May require winch. No cover lid to permit subsampling. All other disadvantages of Ekman and Ponar.
Shipek grab sampler	Used primarily in marine waters and large inland lakes and reservoirs.	Sample bucket may be opened to permit subsampling. Retains fine-grained sediments effectively.	Possible contamination from metal construction. Heavy. May require winch.
Orange-Peel grab Smith-McIntyre grab	Deep lakes, rivers and estuaries. Useful on most substrates.	Designed for sampling hard substrates.	Loss of fines. Heavy. May require winch. Possible metal contamination.
Scoops Drag Buckets	Various environments, depending on depth and substrate.	Inexpensive, easy to handle.	Loss of fines on retrieval through water column.

## **FS 5000. WASTE SAMPLING**

1. INTRODUCTION: Use the procedures in FS 5000 to sample media and matrices of industrial origin.

1.1. Use the following DEP SOPs in conjunction with FS 5000:

- FA 1000 Regulatory Scope and Administrative Procedures for Use of DEP SOPs
- FC 1000 Cleaning / Decontamination Procedures
- FD 1000 Documentation Procedures
- FM 1000 Field Planning and Mobilization
- FQ 1000 Field Quality Control Requirements
- FS 1000 General Sampling Procedures
- FT 1000 – FT 2000 General Field Testing and Measurement

1.1.1. Use additional DEP SOPs as required for specific applications.

2. EQUIPMENT AND SUPPLIES: Refer to Table FS 5000-1 for approved waste sampling equipment.

3. PRESERVATION, TRANSPORT AND HANDLING OF WASTE SAMPLES

3.1. Do not preserve waste samples with chemical preservatives or cool waste samples where the potential for an inadvertent chemical reaction of samples with the preservative might occur, or where cooling might otherwise alter the original sample characteristics. Protect samples from sunlight in order to minimize any potential reaction due to possible light sensitivity of samples. Appropriate handling and storage precautions should be taken if samples have the potential to be shock sensitive.

3.2. After the samples have been collected and containerized, clean the outside of the containers with water, paper towels or other absorbent materials to remove any spilled sample from the exterior of the container.

3.3. Place each labeled container in a separate, resealable plastic bag and then repackage in a second resealable plastic bag. Apply an evidentiary custody seal to container closure before bagging, if applicable. If transporting the samples presents a possibility for breaking glass sample containers, pack the sample containers with non-combustible, absorbent cushioning material and place in a shipping container that has been lined with plastic. Waste samples that are suspected of being acutely toxic or extremely hazardous must be packed in paint cans or other suitable containers and filled with absorbent materials prior to being placed in a cooler.

3.4. See Table FS 1000-6 for preservation procedures.

4. DOCUMENTATION

4.1. See FD 5300 for a complete listing of documentation requirements specific to waste sampling.

4.2. Additional guidance on documentation requirements specific to each type of waste sampling is included in the associated DEP SOPs below.

## **FS 5010. SAMPLING HAZARDS AND PERSONNEL SAFETY**

Waste sampling requires specialized training, safety protocols and personal protective equipment (PPE). The degree and type of safety measures and PPE required depends on the unique characteristics of the waste to be sampled.

1. **REFERENCE FOR REQUIRED SAFETY PROTOCOLS, TRAINING AND PPE:** As applicable, adhere to safety procedures, training requirements and prescribed PPE described in Occupational Safety and Health Administration (OSHA) Rule 29 CFR 1910.120 (Hazardous Waste Operations and Emergency Response).
2. **MINIMUM SAFETY PLANNING AND PROCEDURES:** It is beyond the scope of this field sampling SOP to describe safety protocols for every contingency. Follow the listed minimum safety procedures below, where applicable:
  - 2.1. Ensure that all personnel are appropriately trained and qualified per OSHA requirements.
  - 2.2. Ensure that sampling personnel meet employer and OSHA medical requirements.
  - 2.3. Conduct site reconnaissance and identify hazards.
  - 2.4. Produce a written site safety plan and review with all personnel.
  - 2.5. Designate a site safety and health officer.
  - 2.6. Produce a written sampling plan and review with all personnel.
  - 2.7. Provide appropriate PPE and sampling equipment to all samplers.
  - 2.8. Establish site control (exclusion zones, access corridors, etc.).
  - 2.9. Conduct preliminary and continuous on-site air monitoring (combustible gases, oxygen deficiency, toxic gases, radiation).
  - 2.10. Establish decontamination areas for samplers.
  - 2.11. Prepare for emergencies (backup personnel, spill containment, fire equipment, first aid, evacuations, etc.).
  - 2.12. Follow additional health and safety procedures developed by the facility owner, as applicable.

## **FS 5020. PRELIMINARY WASTE CHARACTERIZATION**

1. Conduct a preliminary waste characterization prior to collecting samples for laboratory analysis. Use the waste characterizations to establish proper safety protocols and protections for sampling personnel, to make decisions regarding staging, bulking, compositing, segregation, shipping and disposal of wastes and to refine the selection of appropriate laboratory analyses for collected waste samples.
2. Classify the wastes into the following general categories: reactive wastes, explosives, acids, bases, ignitable wastes, heavy metals, pesticides, halogenated compounds, cyanides and oxidizers. In cases where sufficient information is not available, conduct further analyses to identify the material.
3. The field waste characterization tests listed below are designed to gain a quick, preliminary assessment of the types and levels of chemicals in the wastes. Perform the field methods below according to the manufacturers' instructions.

- HazCat Chemical Identification System
  - Dräger Tubes
  - Clor-N-Oil Test Kit
  - Spill-fyter Chemical Classifier Strips
  - Setaflash (ignitability)
4. Record the results of the preliminary characterization, including the results of any field waste characterization tests performed.

## **FS 5100. Drum Sampling**

### 1. PRECAUTIONS FOR DRUM SAMPLING

1.1. Opening closed containers and drums of unknown content is a hazardous activity. Give maximum attention to sampling team safety by establishing and following clear and proper procedure and wearing appropriate personal protection equipment. *Remote sampling technique may be required for some situations. **Conduct all sampling activities using appropriate personal protective equipment (PPE) for the level of hazard encountered. See FS 5010. If the contents of drums or their hazards are unknown, use Level B protection at a minimum.***

1.2. Exercise caution when excavating, inspecting, staging and sampling drums because of the potential presence of explosive or flammable gases, toxic vapors or other hazardous materials. Assume that labeled drums are mislabeled. In general, assume that all drums contain hazardous material until the contents have been independently characterized.

1.3. Refer to 29 CFR Part 1910.120(j) for OSHA standards required for drum and container handling.

### 2. DRUM EXCAVATION: **All excavation activities must include appropriate personal protective equipment for the level of hazard encountered. See FS 5010. If the contents of drums or their hazards are unknown, wear Level B protection, at a minimum.**

2.1. Utilize geophysical techniques to approximate buried drum locations and depths.

2.2. Locate all utility lines, poles and pipes above and below ground. Ensure adequate clearance between all utilities or structures and the drum excavation area.

2.3. Use heavy equipment and equipment operators with drum removal experience to excavate, remove or handle drums. Avoid digging directly into drums. Final excavation must be done manually, using non-sparking hand tools.

2.4. Monitor the area around exposed drums for volatile organic compounds, explosives or radioactive materials before proceeding.

2.5. Identify each drum that will be opened. Use paint sticks, spray paint, traffic cones, etc.

### 3. DRUM INSPECTION: **All inspection activities must include appropriate personal protective equipment for the level of hazard encountered. See FS 5010. If the contents of drums or their hazards are unknown, wear Level B protection, at a minimum.**

3.1. Visually inspect all drums that are being considered for sampling for the following:

- Pressurization (bulging/dimples)
- Crystals around the drum opening
- Leaks, holes, stains
- Labels, markings, hazard warnings
- Composition and type (steel/plastic and open/bung)
- Dead vegetation around drum
- Condition, age, rust, potential shock sensitivity
- Sampling accessibility

3.1.1. Drums showing evidence of pressurization and crystals must be furthered assessed to determine if remote drum opening is needed. Do not tap or knock the drums to determine drum contents or volume.

3.2. Uniquely identify each drum with a tag, label, bands, spray paint or other means. Indicate drum category, as determined by visual inspection. Use color-coding as needed to distinguish categories of drums.

3.3. Record all observations made during drum inspection.

4. DRUM STAGING: ***All staging activities must include appropriate personal protective equipment for the level of hazard encountered. See FS 5010. If the contents of drums or their hazards are unknown, wear Level B protection, at a minimum.***

4.1. Use heavy equipment and qualified equipment operators with drum handling experience to stage drums, if necessary.

4.2. If ignitable, explosive or reactive characteristics are indicated by initial characterization of drum contents, locate the staging area away from the drum-opening area to prevent chain reaction should an opened drum explode or ignite.

4.3. The procedures for handling and sampling drums differ by drum category. Separate drums into the following categories, based on determination of contents:

- Liquids
- Lab packs
- Solids
- Empty

4.3.1. Segregate drums containing radioactive, explosive or shock-sensitive material from other drums and the drum-opening area. Place drums containing these hazards in a diked and fenced area where practical.

4.3.2. Separate drums containing acids or bases from each other. Similarly separate drums containing other wastes known to react with each other.

4.4. Move drums from the staging area to the opening area one at a time using forklift trucks equipped with drum grabbers or barrel grapples or, move by roller conveyor or other means.

5. DRUM OPENING PROCEDURES:

5.1. General Considerations:

5.1.1. ***Wear personal protective equipment (PPE) as prescribed in the reference cited in FS 5010 for the level of hazard encountered with each drum.***

5.1.2. Use remote drum-opening procedures when possible to maximize personnel safety.

5.1.3. Use manual bung wrench or deheader drum-opening procedures only with structurally sound drums that are capable of withstanding the forces applied during bung opening or deheading.

5.1.4. Do not attempt to use a manual bung wrench or deheader on drums that contain shock-sensitive, reactive, explosive or flammable materials.

5.2. Procedures Required Prior to Drum Opening: Before opening, ground each metal drum that is not in direct contact with the earth using grounding wires, alligator clips and a grounding rod or metal structure. If a metal drum is in an overpack drum, ensure the metal drum is grounded.

5.2.1. Touch the drum opening equipment to the bung or lid and allow an electrically conductive path to form. Slowly remove the bung or drum ring and/or lid with spark resistant tools (brass/beryllium).

5.2.2. Screen drums for explosive gases and toxic vapor with air monitoring instruments as bung or drum lid is removed.

5.2.3. Record the results of all monitoring of drums.

5.3. Tools for Opening Drums: See specific instructions below for use of various drum opening tools.

***All manual procedures require appropriate personal protective equipment (PPE) for all personnel working with the drum. The puncture or deheading of any drum may present a chemical splash hazard. The level of protection required is described in the reference cited in FS 5010 for the type of hazards encountered with each drum. If drum contents or hazards are unknown, wear Level B protection, at a minimum.***

5.3.1. Manual Bung Wrench

5.3.1.1. ***Wear appropriate protective gear per FS 5010.***

5.3.1.2. Position top or side mounted bungs in upright position.

5.3.1.3. Pull slowly and steadily across the drum.

5.3.1.4. Use a handle extension for increased wrench leverage where necessary.

5.3.1.5. Watch for sparking even when using non-sparking bung wrenches.

5.3.2. Manual Drum Deheader

5.3.2.1. Position the cutting edge of the deheader just inside the top chime and tighten the deheader adjustment screw to hold the device tight against the side of the drum.

5.3.2.2. Slowly make an initial cut into the drumhead to release pressure (or use remote techniques to relieve pressure prior to deheading procedures).

5.3.2.3. Move the deheader handle up and down while sliding the device along the chime.

5.3.2.4. Decontaminate the drum deheader between drums, if contact between the deheader and drum contents have occurred. See FC 1000.

5.3.3. Hand Pick, Pickaxe and Hand Spike

5.3.3.1. Anticipate potential splashing with the use of these tools. ***Wear proper personal protective gear per FS 5010.***

5.3.3.2. Use these devices where the bung cannot be opened or the drumhead cannot be removed.

5.3.3.3. Decontaminate hand tools between drums. See FC 1000.

5.3.4. Remote Opening Using a Backhoe Spike: Use this procedure for greater personal safety. Mount a splash shield in front of the backhoe operator cage. ***The operator must wear appropriate personal protection gear per FS 5010.*** Provide air supply gear to the operator, if applicable.

5.3.4.1. Place drums in rows such that the backhoe can be maneuvered between them.

5.3.4.2. Punch a hole in the drumhead with the backhoe spike.

5.3.4.3. Decontaminate the backhoe spike between drums. See FC 1220.

5.3.5. Remote Opening Using Hydraulic Devices

5.3.5.1. Follow manufacturer's instructions to puncture the drum.

5.3.5.2. ***This procedure presents a splash hazard. Wear personal protective gear per FS 5010, as applicable.***

5.3.6. Remote Bung Opening Using Pneumatic Devices: ***This procedure does not allow slow release of accumulated pressure in the drum. Wear personal protective gear per FS 5010 and take safety precautions during this procedure, as applicable.***

5.3.6.1. Do not attempt to remove rusted bungs with this device.

5.3.6.2. Place drums in level, upright position.

5.3.6.3. Follow manufacturer's instructions to fit the opener to the bung, remotely remove the bung and detach the device.

5.4. Inspecting Drum Contents

5.4.1. Note the state, quantity, phases, and color of the drum contents.

5.4.2. Review the screening results with any pre-existing data to determine which drums will be sampled.

5.4.3. Monitor headspace gases from opened drums. Use an oxygen meter and explosimeter first, followed by organic vapor analyzer (OVA) monitoring.

5.4.4. Record all results from the inspection of drums.

5.5. General Instructions for Drum Sampling

5.5.1. If applicable for the sampling plan, account for any stratification of drum contents by appropriate choice of sampling tools and techniques. If the entire depth of the drum must be represented by the sample(s), collect all phases and strata of the drum either as a composite or as discrete phase and stratum samples, as required. Only profiling

samplers such as COLIWASA (COMPOSITE LIQUID WASTE SAMPLER), thieves, sludge judges, etc. allow proportional sampling of strata and phases.

5.5.1.1. Filling Multiple Sample Containers Where Strata or Phases are Composited: Using a proportional sampler, dispense an entire sampler volume of waste into each required sample container in succession until all containers are adequately filled.

5.5.1.2. Filling Multiple Sample Containers Where Discrete Stratum or Phase Samples are Required: Fill the required number of containers in succession using a discrete sampler to collect samples from the appropriate phase or stratum.

5.5.2. Account for sludge depth in the drum by measuring depth to apparent bottom and subtracting from drum total depth (height).

5.5.3. Select the appropriate sampling equipment based on the physical state of the material and the type of container. Sampling equipment must be made of non-reactive materials that will not alter the chemical or physical properties of the material that is to be sampled.

5.5.4. Place absorbent pads, sampling equipment and sample containers near drum(s) to be sampled.

5.5.5. Record all observations made during sampling. Document sampling per FD 5300.

**CONDUCT AIR MONITORING FOR TOXIC VAPORS, EXPLOSIVE GASES AND OXYGEN-DEFICIENT ATMOSPHERES DURING DRUM SAMPLING.**

## **FS 5110. SAMPLING LIQUIDS FROM DRUMS**

### **1. GLASS THIEF (TUBE)**

#### **1.1. General Considerations for Glass Thief**

1.1.1. Use disposable glass tubes only.

1.1.2. Typical dimension for the glass thief is 6mm-16mm I.D. and 48 inches long.

#### **1.2. Sampling Procedure for Glass Thief**

1.2.1. Remove cap from sample container.

1.2.2. Insert thief into drum almost to bottom or until solid layer is reached. Allow one foot of tubing to extend out of the top of the drum.

1.2.3. Let the waste in the drum rise to its natural level in the thief.

1.2.4. Cap the top of the thief with a stopper or gloved thumb. Do not let waste liquid contact the stopper or thumb.

1.2.5. Withdraw the thief from the drum.

1.2.6. Insert open end of thief into the sample container and allow thief contents to drain into the container. Fill container 2/3 full.

1.2.7. When finished with the thief, break the thief into pieces and insert into the drum (if permitted by the sampling and disposal plans).

### **2. COLIWASA (COMPOSITE LIQUID WASTE SAMPLER)**

2.1. General Considerations for COLIWASA Sampling

2.1.1. Use the COLIWASA to collect representative multiphase samples from the full depth of a drum, as applicable.

2.1.1.1. If it is not a disposable model, the COLIWASA may be too expensive for some applications and cannot be easily decontaminated in the field.

2.1.1.2. Variations in design of this sampling device may be available from different vendors but the operational principle is the same.

2.2. Sampling Procedure for COLIWASA

Follow manufacturer's directions for use if different from the following:

2.2.1. Configure the COLIWASA in the open position by lifting the stopper rod several inches above the closed position.

2.2.2. Slowly lower the sampler into the liquid waste at a rate that permits the levels of liquid inside and outside the sampler tube to rise to about the same heights. Failure to maintain equal heights inside and outside the tube will affect the representativeness of the sample. If the liquid level inside the tube is lower than the waste level outside the tube, the sampling rate is too fast.

2.2.3. When the sampler stopper hits the bottom of the drum, push the stopper rod to the closed position.

2.2.4. Slowly withdraw the sample from the waste liquid and simultaneously wipe the outside of the device with a disposable wipe.

2.2.5. Position the lower end of the COLIWASA in the sample container. Lift the stopper rod and carefully drain the waste liquid into the container.

2.3. Sampling Procedures for Other Devices: (Reserved)

**FS 5120. SAMPLING SOLIDS AND SLUDGES FROM DRUMS**

1. GENERAL CONSIDERATIONS

1.1. Use a long-handled dipper, push tube or other coring device, scoop, spoon, bucket auger, screw auger or, if conditions necessitate, a pneumatic hammer/drill to obtain samples of solids in drums.

1.2. If necessary for the sampling plan, take multiple samples from different areas of the drum.

2. PROCEDURE FOR CORING DEVICE OR PUSH TUBE

2.1. Insert device to bottom of drum. T-handle and extension attachments, where applicable, must extend above the top of the drum.

2.2. Rotate the corer or push the sampling tube to cut a core of material.

2.3. Slowly withdraw the device to retain the sample.

2.4. Use stainless steel laboratory spatulas or scoops to transfer the sample to containers.

3. PROCEDURES FOR OTHER SAMPLING DEVICES: (Reserved)

### **FS 5130. CLOSING DRUMS AND SEGREGATION OF EQUIPMENT AND WASTES AFTER SAMPLING**

1. Close each drum when sampling of the drum is complete.
2. Segregate contaminated sampling equipment and investigation-derived wastes (IDW) containing incompatible materials as determined by the drum screening procedure.
3. Handle and dispose of IDW and contaminated disposable equipment according to local, state and federal regulations.
4. As required, wrap or bag contaminated reusable equipment in protective material or store in containers until cleaned.

### **FS 5200. Tank, Sump and Leachate Sampling**

1. INTRODUCTION: Some procedures for tank, sump and leachate sampling will be identical to those for drum sampling. The depth or physical configuration of some waste units will prevent the use of some equipment or techniques, depending on the unit to be sampled.
2. EQUIPMENT AND SUPPLIES: See Table FS 5000-1 for approved sampling equipment.

### **FS 5201. *Presampling Considerations and Procedures for Tanks***

#### 1. PRESAMPLING CONSIDERATIONS FOR TANKS

1.1. Sampling tanks is considered hazardous due to the potential for tanks to contain large volumes of hazardous materials. Follow appropriate safety protocols. Some tank sampling requires physical agility and manual dexterity in order to access the tank sampling points, carry equipment and supplies, open tank hatches and collect and containerize samples while wearing personal protective equipment. Personnel must be able to perform the appropriate procedures under these conditions.

**1.1.1. *Wear personal protective equipment (PPE) as prescribed in the reference cited in FS 5010 for the level of hazard encountered with each tank. If the contents of a tank or its hazards are unknown, wear Level B protection while working in proximity to the tank.***

1.2. Unlike drums, tanks may be compartmentalized or have complex designs. Review preliminary information about the tank contents and configuration prior to the sampling operation to ensure the safety of sampling personnel and to ensure that study design objectives can be achieved.

1.3. In addition to having discharge valves near the bottom, most tanks and bulk storage units have hatches at the top. Collect samples from the top hatch because of the potential for tank contents to be stratified. *Do not collect samples from valves unless necessary and only if part of the sampling plan. See section 1.4 below.*

1.4. When sampling from the discharge valve, there is a possibility of a stuck or broken valve that could cause an uncontrolled release. Do not utilize valves on tanks or bulk storage devices unless the owner or operator of the facility operates them, or a containment plan is in place should the valve stick or break. If a tank must be sampled from a discharge valve, clearly understand the valving arrangement of the particular tank to ensure that the compartment of interest is sampled. Make sure that sampling from valves is specified in the sampling plan. *Valve sampling will not allow sampling of individual strata in the tank.*

1.5. If stratification of tank contents must be accounted for, choose appropriate sampling tools and techniques so that the entire depth of the tank is represented by the sample(s) collected. Sample all phases and strata of the tank either as a composite or as discrete phase and stratum samples, as required by the sampling plan. Only profiling samplers such as COLIWASA, thieves, sludge judges, etc. allow proportional composite sampling of strata and phases. If proportional composite sampling of a tank is not practical, collect discrete samples from each phase or stratum in order to characterize the entire contents of the tank. If the sampling plan requires only approximate sampling or screening, collect a simple grab sample from the contents of the tank.

## 2. PRESAMPLING PROCEDURES FOR TANKS

2.1. Perform a structural integrity survey of the tank. Inspect the ladder, stairs, and catwalk that will be used to access the top hatch of larger tanks to ensure that they will support the combined weight of personnel and equipment.

2.2. Evaluate tank sampling points for safety, accessibility and sample quality.

2.3. Before opening, ground each metal tank using grounding wires, alligator clips and a grounding rod or metal structure.

2.4. Remove all sources of ignition from the immediate area.

2.5. Open any vents or pressure release valves slowly to allow the unit to vent to atmospheric pressure.

**2.5.1. Monitor for explosive or flammable gases and toxic vapors during venting. If dangerous concentrations of gases evolve from the vent or the pressure is too great, close the system and leave the area immediately.**

2.6. Touch tank opening equipment to the bolts in the hatch lid and allow an electrically conductive path to form. Slowly remove bolts and/or hatch with spark resistant tools (brass/beryllium).

**2.6.1. If a pressure build up is encountered or detected, cease opening activities and leave the area.**

**2.7. Screen the interior of tanks for explosive or flammable gases and toxic vapors with air monitoring instruments.**

2.8. Depending on the study objectives and site conditions, conduct characteristic screening (e.g., pH, halogen, etc.) as required. Collect a small volume of sample for flash point testing, if warranted.

2.8.1. Note the state, quantity, number of phases and color of the tank contents.

2.8.2. Compare the screening results with any pre-existing data to determine if the tank should be sampled.

2.9. Determine depth of any and all liquids, solids and liquid/solid interfaces. Measure depth of any sludge. Use weighted tape measures, probe lines, sludge judges or other appropriate equipment to characterize tank stratification with depth.

2.10. Determine the inside diameter of the tank and calculate the volume of wastes in the tank using the depth measurements above. Do not assume that the external diameter of the tank approximates the inside diameter, since the tank construction may have insulation or support structures hidden under the external surface.

2.11. Record all observations, measurements and calculations made at the time of tank inspection. See FD 5300.

## **FS 5210. GENERAL SAMPLING INSTRUCTIONS FOR TANKS**

1. GENERAL CONSIDERATIONS: Because of the many different types of designs and materials that may be encountered, only general sampling procedures that outline sampling a tank from the top hatch are listed below:

### **CONDUCT CONTINUOUS AIR MONITORING FOR TOXIC VAPORS, EXPLOSIVE GASES AND OXYGEN DEFICIENT ATMOSPHERES DURING TANK SAMPLING**

1.1. Select the appropriate sampling equipment based on the physical state of the material and the type of tank. Use sampling equipment constructed of non-reactive materials that will not alter the chemical or physical properties of the material that is to be sampled. See Table FS 5000-1.

1.2. ***Wear required personal protective equipment (PPE) as prescribed in the reference cited in FS 5010 for the level of hazard encountered with each tank. If tank contents or hazards are unknown, wear Level B protection, at a minimum.***

1.3. Where tanks are compartmented, collect at least one sample from each compartment.

1.4. Place absorbent pads, sampling equipment and sample containers near tanks(s) to be sampled.

1.5. Document all observations and procedures associated with sample collection per FD 5300.

## **2. SAMPLING LIQUIDS FROM TANKS**

2.1. Collect liquid samples according to the objectives of the sampling plan, using appropriate samplers.

2.2. Slowly lower the bailer, bacon bomb, Dipstick™, COLIWASA, or Teflon® tubing to the desired sampling depth. ***In work areas where explosive or flammable atmospheres could occur, do not use peristaltic pumps powered by batteries.***

2.2.1. Close the sampling device or start pump.

2.2.2. Slowly remove the sampling device from the tank.

2.2.3. Release or pump the sample from the device into the sample container(s).

2.2.4. Repeat the procedure until a sufficient sample volume is obtained.

2.3. Inspect samples for phase differences or stratification.

2.3.1. If separate phases or strata are observed in any sample container, perform repeated iterative sampling, if discrete phase or stratum sampling is required by the sampling plan. Systematically collect additional samples by halving the depth between two discreet sampling points to determine the next sampling depth. Repeat this procedure until no phase difference or stratification is noted in the sample. Calculate phase and stratum boundary depths from these samplings.

2.3.2. If discrete phase or stratum sampling is not required by the sampling plan, collect composite samples using appropriate profiling samplers or collect simple grab samples, depending on sampling plan objectives.

2.4. If additional sampling ports are available, verify phase and stratum information with additional samples from the other ports, if practical.

2.5. If more than one sample container will be used to collect for the analytes of interest, use the following procedures for filling multiple sample containers.

2.5.1. Filling Multiple Sample Containers Where Strata or Phases are Composited: Using a proportional sampler, dispense an entire sampler volume of waste into each required sample container in succession until all containers are adequately filled.

2.5.2. Filling Multiple Sample Containers Where Discrete Stratum or Phase Samples are Required: Fill the required number of containers in succession using a discrete sampler to collect samples from the appropriate phase or stratum.

### 3. SAMPLING SOLIDS/SEMI-SOLIDS FROM TANKS

3.1. Use a long-handled dipper, push tube, bucket auger, screw auger, Mucksucker™, or if conditions permit, a pneumatic hammer/drill to obtain the sample. See specific instructions for each applicable sampling device in FS 5211 below.

3.2. Carefully extrude the sample from the sampling device or use a clean stainless steel spoon to place the sample into containers for analyses.

3.3. Close the tank when sampling is complete.

### 4. WASTE DISPOSAL AND CONTAMINATED EQUIPMENT

4.1. Segregate contaminated sampling equipment and investigation-derived wastes containing incompatible materials.

4.2. Manage all waste according to applicable local, state and federal regulations.

### **FS 5211.** *Tank Sampling Instructions for Specific Sampling Devices*

Select the equipment described below for use based on the specific sampling requirements of the tank.

1. BACON BOMB SAMPLER: Use the bacon bomb sampler for discrete depth sampling in a tank.

1.1. Attach sampler retrieval line and plunger line, if necessary. The sampling line must be measured and marked for the predetermined collection depth required.

1.2. Slowly lower the bacon bomb to the required depth in the tank and pull and hold the plunger line to actuate filling of the sampler. Release the plunger line to stop filling and seal the sampler closed.

1.3. Retrieve the sampler by the sample line. Do not pull on the plunger line, or the sample will be lost or exchanged with the contents of the tank or a different phase or stratum. Wipe or rinse the exterior of the sampler before filling sample containers. Collect any rinsate for proper disposal.

1.4. Release contents into the sample container by pulling on the plunger line.

2. SLUDGE JUDGE: Use the sludge judge to obtain an accurate reading of the depth of settleable solids in any liquid and for collection of the sample for laboratory analysis.

2.1. Lower the sludge judge to the bottom of the tank and allow the sampler to fill to surface level and seat the check valve on the sampler.

- 2.2. Retrieve the sludge judge and raise it completely out of the tank liquid for determination of sludge depth.
- 2.3. Actuate release pin at the bottom of the sampler to release contents or fill a sample container.
3. SUBSURFACE GRAB SAMPLER: Use the subsurface grab sampler to collect samples at discreet depths in the tank.
  - 3.1. Screw sample bottle onto the sampler head assembly.
  - 3.2. Lower the sampler to the required depth and actuate the plunger mechanism.
  - 3.3. Release the plunger to close the sampling head after filling the sample bottle and retrieve the sampler from the tank.
  - 3.4. Remove and cap the sample bottle.
  - 3.5. Decontaminate the exterior of the sample bottle.
4. GLASS THIEF (TUBE)
  - 4.1. General Considerations for Glass Thief
    - 4.1.1. Use disposable glass tubes only.
    - 4.1.2. Typical dimension for the glass thief is 6mm - 16mm I.D. and 48 inches long.
    - 4.1.3. Tanks greater than about 3 feet in depth cannot be sampled with a glass thief.
  - 4.2. Sampling Procedure for Glass Thief
    - 4.2.1. Remove cap from sample container.
    - 4.2.2. Insert thief into tank almost to bottom or until solid layer is reached. Allow one foot of tubing to extend out of the top of the tank.
    - 4.2.3. Let the waste in the tank rise to its natural level in the thief.
    - 4.2.4. Cap the top of the thief with a stopper or gloved thumb. Do not let waste liquid contact the stopper or thumb.
    - 4.2.5. Withdraw the thief from the tank.
    - 4.2.6. Insert open end of thief into the sample container and allow thief contents to drain into the container. Fill container 2/3 full.
    - 4.2.7. When finished with the thief, break the thief into pieces and insert into the tank (if permitted by the sampling and disposal plans).
    - 4.2.8. Close tank cover.
5. BAILER
  - 5.1. Slowly lower bailer into tank contents using non-reactive bailer line. Do not splash bailer into the liquid.
  - 5.2. Retrieve the bailer after the bailer fills completely.
  - 5.3. Slowly pour bailer contents into the sample container.
  - 5.4. Close tank cover.
6. COLIWASA:

Follow manufacturer's directions for use if different from the following:

- 6.1. Configure the COLIWASA in the open position by lifting the stopper rod several inches above the closed position.
- 6.2. Slowly lower the sampler into the liquid waste at a rate that permits the levels of liquid inside and outside the sampler tube to rise to about the same heights. Failure to maintain equal heights inside and outside the tube will affect the representativeness of the sample. If the liquid level inside the tube is lower than the waste level outside the tube, the sampling rate is too fast.
- 6.3. When the sampler stopper hits the bottom of the drum, push the stopper rod to the closed position.
- 6.4. Slowly withdraw the sample from the waste liquid and simultaneously wipe the outside of the device with a disposable wipe.
- 6.5. Position the lower end of the COLIWASA in the sample container. Lift the stopper rod and carefully drain the waste liquid into the container.

7. ADDITIONAL SAMPLING DEVICES: Reserved

### **FS 5220. LEACHATE AND SUMP SAMPLING**

1. As applicable, follow DEP SOP procedures for tank, drum, groundwater, surface water and sediment sampling. See FS 5100 and FS 5200 above, as well as FS 2100, FS 2200 and FS 4000.
2. Document leachate and sump sampling according to the documentation requirements for the respective DEP SOPs employed to collect samples, per the above. Document additional items per FD 1000.

### **FS 5300. Waste Pile Sampling**

1. The number of samples, the type of sample(s) and the sample location(s) or sampling point(s) for waste pile sampling will be based on sampling plan objectives as determined by permitting or other regulatory criteria and according to the size, shape, material composition, compactness or other characteristics of the pile and the distribution of analytes, analyte concentrations and strata in the waste pile.
2. Follow directives of the sampling plan specific to the project.
3. Document waste pile sampling according to associated regulatory requirements for the project. Document additional items per FD 1000, as applicable.
4. Refer to FS 3000 for soil sampling procedures applicable to waste pile sampling.

### **FS 5400. Impoundment and Lagoon Sampling**

1. Surface impoundments vary in size, shape, and waste content, and may vary in distribution of hazardous constituents and characteristics (strata). The number of samples, the type of sample(s), and the sample location(s) will be based on the sampling design objectives.
2. Commonly used equipment to collect samples from surface impoundments are listed in Table FS 5000-1. All equipment must be compatible with the waste to prevent any alteration of the sample.

- 3. Because of the potential danger of sampling waste units suspected of containing elevated levels of hazardous constituents, do not attempt to sample surface hazardous waste impoundments from a boat. Conduct all sampling from the banks or piers of surface impoundments. Any exception must be approved per specific provisions in the applicable health & safety plans and sampling plans.**
4. Refer to FS 2100 and FS 4000 for general surface water and sediment sampling procedures applicable to waste impoundment sampling.
  - 4.1. Additionally, some procedures and equipment applicable to drum and tank sampling may be useful for waste impoundment sampling. See FS 5100 and FS 5200 above.
5. Document impoundment and lagoon sampling procedures and observations per FD 1000 for the applicable procedures employed.

**Appendix FS 5000**  
**Tables, Figures and Forms**

Table FS 5000-1 Waste Sampling Equipment

**Table FS 5000-1 Waste Sampling Equipment**

Equipment	Construction Material <sup>1</sup>	Phases	Waste Units or Sources	Limitations
Scoop with bracket and handle	Stainless Steel	Liquids, Solids, Sludges	Impoundments, Piles, Drums and Containers, Tanks	Depth constraint. Cannot collect deeper phase or stratum in stratified waste
Spoon	Stainless Steel	Solids, Sludges	Impoundments, Piles, Drums and Containers, Tanks	Depth constraint. Cannot collect deeper strata
Push Tube	Stainless Steel	Cohesive Solids, Sludges	Impoundments, Piles, Drums and Containers, Tanks	Depth constraints. Do not use to sample solids with dimensions >½ the diameter of the tube
Auger	Stainless Steel	Solids	Piles	Unusable for solidified wastes
Sediment Sampler	Stainless Steel	Solids, Sludges, Sediment	Impoundments, Piles	Do not use to sample solids with dimensions >½ the diameter of the tube
Ponar Dredge	Stainless Steel	Solids, Sludges, Sediments	Impoundments	Deployment constraints. Must have means to position equipment to desired sampling location. Difficult to decontaminate
COLIWASA, Drum Thief	Glass	Liquids, Sludges	Impoundments, Drums and Containers, Tanks	Depth constrained to length of sampling device. Not effective with viscous wastes
Mucksucker™ Dipstick™	Teflon	Liquids Sludges	Impoundments, Drums and Containers, Tanks	Not recommended for tanks >11 feet deep
Bacon Bomb	Stainless Steel	Liquids	Impoundments, Tanks	Not effective with viscous wastes
Bailer	Stainless Steel Teflon	Liquids	Impoundments, Tanks	Do not use with heterogeneous wastes. Not effective with viscous wastes
Peristaltic Pump with Vacuum Trap Assembly <sup>2</sup>	Teflon Glass	Liquids	Impoundments, Drums and Containers, Tanks	Do not use in flammable atmospheres. Not effective with viscous wastes
Backhoe Bucket	Steel	Solids Sludges	Piles	May be difficult to access desired sampling location. Difficult to clean. Loss of VOCs possible
Split Spoon	Stainless Steel	Solids	Piles	Requires drill rig
Roto-Hammer	Steel	Solids	Piles, Drums, Containers	Physically breaks up sample. May release volatiles. Not for flammable atmospheres

<sup>1</sup> If disposable equipment of alternative material construction is used, ensure that the equipment is compatible with the chemical composition of the waste and will not alter the characteristics of the waste sample in any way.

<sup>2</sup> A peristaltic pump may be used without an optional vacuum trap assembly if the flexible tubing used in the pump head is one foot or less in length. Do not pump samples for VOCs through the pump head or into a vacuum trap.

## **FS 6000. GENERAL BIOLOGICAL TISSUE SAMPLING**

### 1. INTRODUCTION

1.1. The assessment of contaminant bioaccumulation and biomagnification may require analysis of the tissues of various plant or animal organisms. Top predators may be at risk if their food bioaccumulates toxic contaminants. If these organisms are also part of the human food chain, it is very important to monitor them for human health reasons. This may be a concern as, for example, in the contamination of sport fish by methyl mercury. The presence of contaminants in biological tissues is also important when assessing pollution impact across environmental media (e.g., air, water, soil and sediment). Because of biomagnification and bioaccumulation, tissue analysis can be a useful surrogate for investigating the extent of contamination and bioavailability in a more dilute medium such as water or sediment.

1.2. “The bioavailability of contaminants in sediment is a function of the type of chemical and the chemical speciation, as well as the behavior and physiology of the organism. The two basic routes of exposure for organisms are transport of dissolved contaminants in pore water across biological membranes and ingestion of contaminated food or sediment particles with subsequent transport across the gut. For upper-trophic-level species, ingestion of contaminated prey is the predominant route of exposure, especially to hydrophobic chemicals. Uptake through ingestion of or direct exposure to water or sediment can also be important depending on the trophic level of the organism and the physical-chemical characteristics of the contaminant (EPA 2000).”

1.3. The most common target analytes in animal tissues are the toxic metals (e.g., arsenic, lead, mercury, tin, copper, cadmium, nickel, zinc, etc.), their organic compounds (e.g., methyl mercury, tributyltin, etc.), chlorinated phenols, polycyclic aromatic hydrocarbons (PAHs), pesticides, dioxins, furans and PCBs. The levels commonly found in these matrices are in the ppt to low-ppb range. A principal concern in sampling and processing tissues is avoiding sample contamination and degradation.

1.4. Tissues commonly used for analysis are those of algae, vascular plants, shellfish (e.g. oysters, clams and mussels), finfish, birds and mammals. In general, the kind of sample analyzed depends upon study or program objectives. Some of the variables are:

- The target species, e.g., largemouth bass, Florida gar, redear sunfish, bowfin, alligator, raccoon, etc.
- Size, age, sex or other characteristic of the target species, e.g., largemouth bass are often standardized to age 3
- Specific tissues, e.g., edible tissue, entire organism, blood, brain, liver or other organs
- Whole tissue homogenate, composites, or a discrete portion of a dissected organ

### 2. SELECTION OF APPROPRIATE PROTOCOLS

2.1. In general, obtain the tissue sample from a specimen that was captured alive and take the necessary precautions to avoid contamination and degradation of the sample. These precautions are discussed in each of the specific sampling SOPs in this compendium. These SOPs cover sampling of Shellfish Tissue (FS 6100) and Finfish Tissue (FS 6200). The SOPs for shellfish and finfish were adapted from EPA 1995 and DER 1984 references.

2.2. Study design and the choice of the other parameters mentioned above in section 1.4, although important, are not further discussed in this compendium, but are established as a part of the Data Quality Objectives (DQOs) by the program area that oversees the collection of tissue data. The choice of protocols is also dictated by the nature of the monitoring program, i.e., if for screening studies or for intensive studies (EPA 1995). The procedures - described in FS 6100 and FS 6200 - are comprehensive enough to satisfy the needs of the current monitoring programs requiring tissue analysis in Florida.

**NOTE: In general, a 20 g sample is required for the analysis of metals (including Hg) and a 200 g sample is required for the analysis of organics. The sample size must also include enough tissue for QC analyses per laboratory methods. Always check with the laboratory on their specific requirements.**

## **FS 6100. SHELLFISH TISSUE SAMPLING**

### **1. INTRODUCTION**

1.1. Procedures are described here for the collection and processing of tissues from oysters, clams, and mussels. Although not required, it is recommended that the processing of the shellfish to extract the tissue from the shell be carried out at the laboratory or at a field office with appropriate conditions for this work. This step, however, is also described in this SOP. In general, only the edible tissue is submitted for analysis and compositing is employed because single organisms do not provide enough tissue mass to satisfy the analytical requirements (EPA 1995).

1.2. The shellfish collection methods can be divided into two major categories, active and passive. Each collection method has advantages and disadvantages. Various types of sampling equipment, their use, and their advantages and disadvantages, are summarized in Table FS 6100-1.

1.3. The procedures described in this SOP may also be adapted for collection of tissues from shrimp, scallops, crabs, crayfish, spiny or clawed lobsters, and turtles. Specific procedures for these animals are not provided in these SOPs.

1.4. Unless specifically exempted in research projects, the collection of shellfish for these purposes must always satisfy any legal requirements of harvest size or weight, or at least be of consumable size if no legal harvest requirements are in effect.

### **2. EQUIPMENT AND SUPPLIES**

2.1. Boat and Supplies- A boat may be required, and the following supplies must be available:

- Fuel supply (primary and auxiliary)
- Spare parts kit
- Life preservers (USCG approved)
- First aid kit (including emergency phone numbers of local hospitals and family contacts for each member of the sampling team)
- Spare oars
- Nautical charts with sampling site locations
- GPS or Loran instrumentation

2.2. Shellfish Collection Equipment- See Table FS 6100-1. Examples of equipment include:

- Nets
- Grabs
- Rakes
- D-traps

2.3. Recordkeeping and Documentation Supplies:

- Field notebook or field forms (waterproof paper is recommended)

DEP-SOP-001/01  
FS 6100 Shellfish Tissue Sampling

- Specimen identification labels
- Indelible pens
- Digital camera (optional)

2.4. Sample Processing Equipment and Supplies:

- Holding trays
- Shucking knife (SS)
- DI water for rinsing (in plastic or Teflon bottles)
- Non-powdered latex surgical gloves
- Calipers (metric units)
- Balance to weigh representative specimens and tissues (metric units)
- Aluminum foil (extra heavy duty)
- Freezer tape
- String (to tie plastic bags)
- Several sizes of plastic bags for holding discrete or composite samples
- Resealable watertight plastic bags for storage of field records, COC forms, sample request forms

2.5. Sample Preservation and Shipping Supplies:

- Ice (wet ice, blue ice packets, or dry ice)
- Ice chests
- Wide-mouth sample containers (100 mL, plastic) w/ plastic caps
- Wide-mouth sample containers (250 mL, glass) w/ Teflon-lined plastic caps
- Filament-reinforced tape to seal ice chests

3. COLLECTION OF SHELLFISH

3.1. Equipment Selection:

3.1.1. Select the appropriate sampling equipment from Table FS 6100-1 that is compatible with the plan of study, the measurement program and the site conditions.

3.1.2. Conduct any needed field measurements and collect sample(s) from other matrices (water, sediment) for laboratory analyses first.

3.2. Sampling:

3.2.1. Evaluate the catch immediately after the organisms are retrieved from the sampling device, and select those appropriate for analysis.

3.2.1.1. Keep only organisms of target species and discard the remainder.

3.2.1.2. Measure the dimension of each organism to a precision of 0.1 cm; the relevant dimension for bivalves is the height, which is the distance from the umbo to the anterior (ventral) shell margin.

DEP-SOP-001/01  
FS 6100 Shellfish Tissue Sampling

3.2.1.3. Weigh each selected organism to a precision of 0.01 g. Record these measurements in the appropriate form. Collect a minimum of 200 g for the composite sample.

3.2.1.4. For the purpose of determining compliance with the methylmercury standard in Rule 62-302, at least twelve organisms of the species under consideration must be collected.

3.2.1.5. Regardless of the number, the shellfish should all be of similar size so that the height of the smallest individual is no less than 75% of the height of the largest individual in the composite sample.

3.2.1.6. Place all shellfish in plastic bags and into ice chests containing wet ice immediately after collection or measurement. The maximum holding time on ice is 24 hours.

3.3. Tissue Extraction: If the sampling program requires that only the tissues be shipped to the laboratory, follow these procedures in a suitable location, with a large stainless steel sink/counter and a source of tap water.

3.3.1. Place the organisms to be composited in the sink, rinse profusely with tap water and transfer them to the holding tray.

3.3.2. Use one tray for each sampling site.

3.3.3. Cover a portion of the counter with the heavy-duty aluminum foil and place the sample container(s) on it.

3.3.4. Wear the latex gloves at this point.

3.3.5. Using the shucking knife, carefully open each shellfish, extract the tissue and transfer it directly to the wide-mouth container.

3.3.6. If the tissue happens to fall in the counter, rinse it with analyte-free water before placing it in the container.

3.3.7. Rinse the shucking knife with tap and analyte-free water after each organism is processed.

3.3.8. Cap each sample container and write the field ID number on the label attached to it.

3.3.9. Glass containers may be used for all analytes (metals and extractable organics); do not use plastic containers for extractable organics.

3.3.10. After you have completed all extractions, place the labeled containers in the ice chest and prepare for shipping (see section 5.2, below).

4. FIELD MEASUREMENTS AND RECORDS: All information associated with the sampling event must be recorded in the appropriate field sheets or field notebook using indelible pens. These records are the required minimum:

4.1. Names of field personnel, date, time, waterbody name and type (river, lake, estuary), tide cycle (if applicable), site location (latitude/longitude), and weather conditions.

4.2. Field measurements commonly associated with shellfish sampling, e.g., depth, salinity, temperature, turbidity and pH of the water at the sampling site.

4.3. Number and size of organisms in each composite sample, and the collection method.

4.4. Any other relevant information if water chemistry samples are also collected.

DEP-SOP-001/01  
FS 6100 Shellfish Tissue Sampling

5. SAMPLE PACKAGING AND SHIPPING

Prior to shipping samples, notify the analytical laboratory and confirm the amount of sample required for sample analysis. The maximum holding time on ice is 24 hours. Freeze the samples if they will be held longer than 24 hours. To freeze, place the samples in air tight glass or plastic containers (wide-mouth bottles or vials) and freeze at -20°C. Ship the samples using an overnight courier service. Use dry ice or wet ice for shipping. Frozen samples must arrive at the laboratory in the frozen state.

5.1. Whole Organisms:

5.1.1. Place all shellfish, presorted or not, into plastic bags, tied with string, and inside the shipping cooler with plenty of wet ice (see 5.1.4 below).

5.1.2. Attach an ID label to the string of each plastic bag.

5.1.3. The volume of ice should be at least as large as the volume of the bagged samples.

5.1.4. Place all documentation (field sheets; COC, sample request, and shipping forms) in a resealable plastic bag and attach it to the inside of the cooler's cover using the freezer tape.

5.1.5. Seal the cooler with reinforced tape and proceed with shipment.

5.2. Dissected Tissues:

5.2.1. Place each sample container inside a plastic bag and seal it.

5.2.2. Place all containers inside the shipping cooler.

5.2.3. Use enough wet ice so that samples arrive at the analyzing laboratory at 4 °C or if shipped frozen maintain a frozen state.

5.2.4. Dry ice is optional if allowed by the shipping company.

5.2.5. Place all documentation (field sheets; COC, sample request, and shipping forms) in a resealable plastic bag and attach it to the inside of the cooler's cover using the freezer tape.

5.2.6. Seal the cooler with reinforced tape and proceed with shipment.

DEP-SOP-001/01  
FS 6100 Shellfish Tissue Sampling

**Appendix FS 6100**  
**Tables, Figures and Forms**

Table FS 6100-1 Summary of Shellfish Sampling Equipment

DEP-SOP-001/01  
FS 6100 Shellfish Tissue Sampling

**TABLE FS 6100-1. SUMMARY OF SHELLFISH SAMPLING EQUIPMENT**

Device	Use	Advantages	Disadvantages
<b>ACTIVE METHODS</b>			
Seines	Shallow shoreline areas in estuaries.	Relatively inexpensive and easy to operate. Mesh size selection available for crustaceans.	Cannot be used in deep water or over substrates with an irregular contour. Not completely efficient for crustaceans.
Trawls	Various sizes can be used from boats in 10 to >70 m depths	Efficient in deep waters not accessible by other methods. Allows collection of large number of samples.	Requires boat and trained operators.
<b>MECHANICAL GRABS:</b>			
Bucket Type/ Double-Pole	Used from boat or pier. Most useful in shallow waters (lakes, rivers and estuaries)	Very efficient for bivalves that are located or buried in bottom sediments.	Difficult to operate at depths greater than 6 m.
Tongs/Double- Handed Grab Sampler	Most useful in shallow waters (lakes, rivers and estuaries). Used generally from a boat.	Very efficient for oysters, clams, and scallops. Allows washing of collected specimens to remove sediments.	Difficult to operate at depths greater than 6 m.
<b>LINE OR CABLE-OPERATED GRAB BUCKETS:</b>			
Ekman Grab	Used from boat or pier to sample soft to semi- soft substrates.	Can be used in lakes, rivers and estuaries of varying depths.	Possible incomplete closure can result in sample loss. Grab is small and not effective for large bivalves.
Petersen Grab	Deep lakes, rivers and estuaries; for most substrates.	Large sample can be obtained; grab can penetrate most substrates.	Grab is heavy, may require winch for deployment. Possible incomplete closure can result in sample loss. Must be repeatedly deployed.
Ponar Grab	Deep lakes, rivers and estuaries; for sand, silt, or clay substrates.	Most universal grab sampler. Adequate for most substrates. Large sample is obtained intact.	Possible incomplete closure can result in sample loss. Must be repeatedly retrieved and deployed.
Orange Peel Grab	Deep lakes, rivers and estuaries; for most substrates.	Designed for hard substrates.	Grab is heavy, small, and not effective for large bivalves.
Biological or Hydraulic Dredges	Dragged along bottom of deep-water bodies to collect large stationary invertebrates.	Qualitative sampling of large area of bottom substrate. Length of tows can be relatively short if high density of shellfish exists in the collection area.	If the length of tow is long, it is difficult to know the exact sample location. Because of scouring, some bivalve shells may be damaged during collection.
Scoops /Shovels	Used in shallow areas for soft or hard-shell clams, and bay scallops.	Does not require a boat; sampling can be done from shore.	Care must be taken not to damage the shells while digging in the substrate.
Scrapers	Used in shallow areas for oysters or mussels.	Does not require a boat; sampling can be done from shore.	Care must be taken not to damage the shells while digging in the hard substrate.
Rakes	Used in shallow areas by wading or can be used from a boat.	Does not require a boat; sampling can be done from shore. Can be used in soft sediments for clams or scallops. Can be used for oysters or mussels attached to rocks or pier pilings.	Care must be taken not to damage the shells while raking or dislodging them from the substrate.
<b>PASSIVE METHODS</b>			
D-traps	Used to capture slow- moving crustaceans (crabs and lobsters).	Can be used in a variety of environments. Useful to capture bottom dwelling organisms in deep water or inaccessible areas. Rather inexpensive to make.	Catch efficiency is highly variable. Not a good choice for a primary sampling device, but valuable as a backup method.

## **FS 6200. FINFISH TISSUE SAMPLING**

1. INTRODUCTION: These procedures describe the collection and processing of fish tissues.
  - 1.1. Perform fish processing activities under conditions that prevent contamination by or degradation of the analytes in question.
  - 1.2. Although not required, DEP recommends that the processing of the fish to extract the tissue for analysis be carried out at the laboratory or at a field office with appropriate conditions for this work. Follow these procedures regardless of the location.
  - 1.3. In general, submit only the edible tissue for analysis. There are, however, occasions where whole fish analysis is required and this procedure is also addressed in this SOP.
  - 1.4. Samples may consist of tissue dissected from a single organism, the entire organism, composite of dissected tissues, or composite of many organisms.
    - 1.4.1. Composite samples are homogeneous mixtures of samples from two or more individual organisms of the same target species collected at a particular site and analyzed as a single sample. Because the analytical costs are usually higher than those of collection and preparation of samples, composite samples are cost-effective for some programs. The use of composites, however, depends upon the Data Quality Objectives (DQOs) of the program.
    - 1.4.2. DEP recommends compositing samples of fish fillets (edible portion) for analysis of target analytes in screening studies.
    - 1.4.3. For health risk assessments, a composite sample must represent the portion of the individual organism that is commonly consumed by the population at risk. Florida fish consumption health advisories for mercury are based upon 3-year old largemouth bass, because that is the most common fish in creel census. In this case, the edible portions of individual fish must be analyzed. "Skin-on fillets (with the belly flap included) are recommended for most scaled finfish. Skinless fillets are recommended for scaleless finfish, such as catfish" (EPA 1995).
    - 1.4.4. For the purpose of determining compliance with the methylmercury standard in Rule 62-302, at least twelve fish of the species under consideration must be collected. Game fish must be of legal size and within a size or weight range that represents fish most likely to be caught and eaten as determined by the Florida Fish and Wildlife Conservation Commission (FWCC).
    - 1.4.5. To assess risks to other predators, analyze whole fish of the species and size range common to their diet. Depending upon the study design and DQOs, compositing may not be appropriate. Note that it may be difficult to homogenize the whole fish.
  - 1.5. Fish collection methods can be divided into two major categories, active and passive. Each collection method has advantages and disadvantages. Various types of sampling equipment, their use, and their advantages and disadvantages are summarized in Table FS 6200-1.
  - 1.6. Unless specifically exempted in research projects, the collection of fish for these purposes must always satisfy any legal requirements of harvest size or weight, or at least be of consumable size if no legal harvest requirements are in effect.
2. EQUIPMENT AND SUPPLIES

DEP-SOP-001/01  
FS 6200 Finfish Tissue Sampling

2.1. Boat and Supplies- A boat may be required, and the following supplies must be available:

- Fuel supply (primary and auxiliary)
- Spare parts kit
- Life preservers (USCG approved)
- First aid kit (including emergency phone numbers of local hospitals and family contacts for each member of the sampling team)
- Spare oars
- Nautical charts with sampling site locations
- GPS or Loran instrumentation (recommended)

2.2. Fish Collection Equipment- e.g., nets, traps, electroshocking device (see Table FS 6200-1).

2.3. Recordkeeping and Documentation Supplies:

- Field notebook or forms (waterproof paper is recommended)
- Specimen identification labels
- Indelible pens
- Digital camera (optional)

2.4. Sample Processing Equipment and Supplies:

- Holding trays
- Fish measuring board (metric units)
- Small Teflon cutting board (about 5 x 10 inches)
- Fish de-scaler or blunt knife (stainless steel)
- Non-powdered latex surgical gloves
- DI water for rinsing (in plastic or Teflon bottles)
- Dissection kit w/ disposable sterile surgical blades of stainless steel or carbon steel (recommended is rib-back No. 21 by Bard-Parker or equivalent) and a steel holder (such as the Bard-Parker No. 4)
- Balance to weigh representative specimens and tissues (metric units)
- Aluminum foil (extra heavy duty)
- Freezer tape
- String (to tie plastic bags)
- Several sizes of plastic bags for holding discrete or composite samples
- Resealable watertight plastic bags for storage of field records, COC forms, sample request forms

2.5. Sample Preservation and Shipping Supplies:

DEP-SOP-001/01  
FS 6200 Finfish Tissue Sampling

- Ice (wet ice or dry ice)
- Ice chests
- Wide-mouth sample containers (100 mL, plastic) w/ plastic caps
- Wide-mouth sample containers (250 mL, glass) w/ Teflon-lined plastic caps
- Pyrex culture tubes (25 x 200 mm) w/ Teflon-lined plastic caps [**pre-weighed**]
- Filament-reinforced tape to seal ice chests

3. COLLECTION OF FISH

3.1. Equipment Selection: Select the appropriate sampling equipment from Table FS 6200-1 that is compatible with the plan of study, the measurement program and the site conditions. Conduct field measurements and/or collection of other matrices (water, sediment) for laboratory analyses first.

3.2. Sampling:

3.2.1. Make sure the collecting area is free of grease spilled engine fuel, engine exhaust and dust.

3.2.2. Immediately after the organisms are retrieved from the sampling device, evaluate the catch and select those appropriate for analysis (section 3.3, below). Keep only organisms of target species and discard the remainder.

3.2.3. Measure the dimension of each organism to a precision of 0.5 cm; the relevant dimension for finfish is the maximum body length, which is the distance from the anterior-most part of the fish to the tip of the longest caudal fin.

3.2.4. Weigh each selected organism to a precision of 0.01 g. For small fish (length < 10 cm), the precision of these measurements must be increased to 0.2 cm and 0.001 g, respectively.

3.2.5. Record these measurements in the appropriate form.

3.2.6. Place all fish in plastic bags and into ice chests containing wet ice immediately after collection or measurement. The maximum holding time on ice is 24 hours. With small fish such as *Gambusia*, water loss or gain may affect the apparent weight. **Do not allow the fish to freeze prior to the next processing step.**

3.3. Initial Inspection and Sorting:

3.3.1. Select fish of the target species that do not have lacerated skin.

3.3.2. Rinse each individual fish of the selected target species in ambient water to remove any foreign material from the external surface.

3.3.3. If you are familiar with the physiology of the target species, you may evaluate the sex of the collected individuals and record it in the field sheet along with the other measurements (length and weight).

3.3.4. Place fish immediately in the ice chest if the sorting will be done later.

3.4. Tissue Extraction – Resections: If the sampling program requires that only the tissues be shipped to the laboratory, follow these procedures in a suitable location with a large stainless steel sink/counter and a source of tap water.

DEP-SOP-001/01  
FS 6200 Finfish Tissue Sampling

- 3.4.1. Place the organisms to be composited in the sink, rinse profusely with tap water and transfer to the holding tray.
  - 3.4.2. Use one tray for each sampling site.
  - 3.4.3. Cover a portion of the counter with the heavy-duty aluminum foil and place the sample container(s) on it.
  - 3.4.4. Wear the latex gloves at this point. **The dissection is better performed when the sample is still cool; do not allow the fish to reach room temperature.**
  - 3.4.5. Using the surgical knife, carefully open each fish, extract the target tissue (see below) and transfer it directly to the wide-mouth container.
  - 3.4.6. If the tissue happens to fall in the counter, rinse it with analyte-free water before placing it in the container.
  - 3.4.7. Rinse the surgical knife with tap and analyte-free water after each organism in a composite sample is processed.
  - 3.4.8. Cap each sample container and write the field ID number on the label attached to it.
  - 3.4.9. Use glass containers for all analytes (metals and extractable organics); use plastic containers if only metals will be analyzed.
  - 3.4.10. After completing all dissections, place the labeled containers in the ice chest and prepare for shipping (see section 5.2, below).
  - 3.4.11. Always use a new knife when dissecting a new fish of a discrete sample or the first fish of a composite sample.
  - 3.4.12. Determine the sex and age of each specimen during this step and record on the field sheet, if it is necessary to confirm the presumed sex that was determined during the initial inspection and sorting.
- 3.5. Muscle Tissue Resections (Fillets): Depending on the study design, obtain only a portion of the muscle tissue, or obtain entire fillets from both sides of the fish, with or without the skin attached to the muscle tissue.
- 3.5.1. If the skin is to be included, place the fish in the lined counter top, wear the latex gloves, and carefully remove the scales from both sides using a blunt stainless steel knife-edge or a commercial de-scaler.
    - 3.5.1.1. Be very careful not to puncture or rupture the skin of the fish.
    - 3.5.1.2. Rinse the fish well with tap and analyte-free water and replace the aluminum foil liner of the counter top with a clean sheet.
    - 3.5.1.3. Return the fish to the counter and proceed with filleting using the surgical knife.
    - 3.5.1.4. For scaleless fish, remove the skin from each fillet after you have dissected the entire edible muscle tissue still attached to the skin.
    - 3.5.1.5. Rinse each fillet with analyte-free water, shake the excess water, wrap each one tightly in aluminum foil and place inside a resealable plastic bag.
    - 3.5.1.6. If the sample is a composite, place all fillets into one single bag. Prepare for shipping.

DEP-SOP-001/01  
FS 6200 Finfish Tissue Sampling

3.6. Muscle Tissue Resections (Sub-sample): If only a portion of the muscle tissue is to be used for metals analysis, follow these procedures.

- 3.6.1. Using the surgical knife make a 1½-inch incision along the dorsal edge of the fish (see diagrams in Figures FS 6200-1 and FS 6200-2).
- 3.6.2. Make two other incisions, perpendicular to the dorsal incision and forming a U-shaped cut, reaching over about 2/3 of the lateral ventral distance.
- 3.6.3. Extract only the scales necessary for the blade cuts.
- 3.6.4. Carefully separate the fish skin from the muscle tissue in the incised section.
- 3.6.5. Lift the skin, remove the portion of the underlying tissue, and rinse slightly with analyte-free water. This procedure removes any foreign material that may have contaminated the tissue from the skin surface.
- 3.6.6. Gently shake the excess analyte-free water from the tissue sample and place it on the Teflon cutting board.
- 3.6.7. Rinse the surgical knife with analyte-free water and cut the tissue into 0.5-inch strips in the cross-wise direction (across the muscle fibers).
- 3.6.8. Finally, insert the strips into the pre-weighed culture tube and cap it.
- 3.6.9. Prepare for shipping.

4. FIELD MEASUREMENTS AND RECORDS: All information associated with the sampling event must be recorded in the appropriate field sheets or field notebook using indelible pens. These records are the required minimum:

- 4.1. Names of field personnel, date, time, waterbody name and type (river, lake, estuary), tide cycle (if applicable), site location (latitude/longitude), and weather conditions.
- 4.2. Field measurements commonly associated with finfish sampling, e.g., depth, salinity, temperature, turbidity and pH of the water at the sampling site.
- 4.3. Size, sex and age of each individual organism in discrete or composite samples.
- 4.4. Number and size of organisms in each composite sample, and the collection method.
- 4.5. Any other relevant information if water chemistry samples are also collected.

5. SAMPLE PACKAGING AND SHIPPING

Prior to shipping samples, notify the analytical laboratory and confirm the amount of sample required for sample analysis. The maximum holding time on ice is 24 hours. Freeze the samples at -20°C if they will be held longer than 24 hours. Ship the samples using an overnight courier service. Use dry ice or wet ice for shipping. Frozen samples must arrive at the laboratory in the frozen state.

5.1. Whole Organisms:

- 5.1.1. Place all fish, pre-sorted or not, into plastic bags, tied with string, and inside the shipping cooler with plenty of wet ice.
- 5.1.2. Attach an ID label to the string of each plastic bag.
- 5.1.3. The volume of ice must be at least as large as the volume of the bagged samples.

DEP-SOP-001/01  
FS 6200 Finfish Tissue Sampling

5.1.4. Place all documentation (field sheets; COC, sample request and shipping forms) in a resealable plastic bag and attach it to the inside of the cooler's cover using the freezer tape.

5.1.5. Seal the cooler with reinforced tape and proceed with shipment.

5.2. Dissected Tissues:

5.2.1. Place each sample container inside a plastic bag and seal it.

5.2.2. Place all containers inside the shipping cooler.

5.2.3. Use enough wet ice so that samples arrive at the analyzing laboratory at less than 4°C or if shipped frozen maintain the frozen state.

5.2.4. The use of dry ice is optional if allowed by the shipping company.

5.2.5. Place all documentation (field sheets; COC, sample request and shipping forms) in a resealable plastic bag and attach it to the inside of the cooler's cover using the freezer tape.

5.2.6. Seal the cooler with reinforced tape and proceed with shipment.

**Appendix FS 6200**  
**Tables, Figures and Forms**

Table FS 6200-1 Summary of Fish Sampling Equipment

Figure FS 6200-1 Dissection Guide for Largemouth Bass, Redear Sunfish, and Bowfin

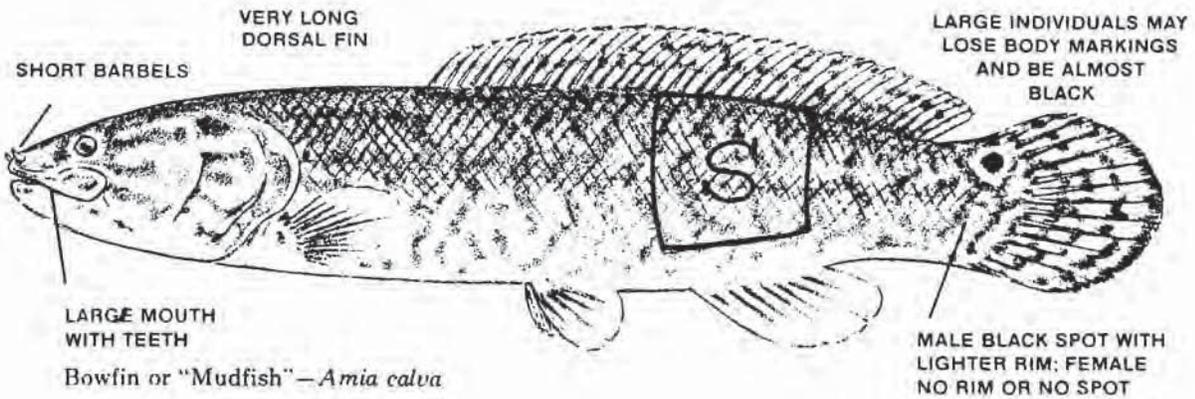
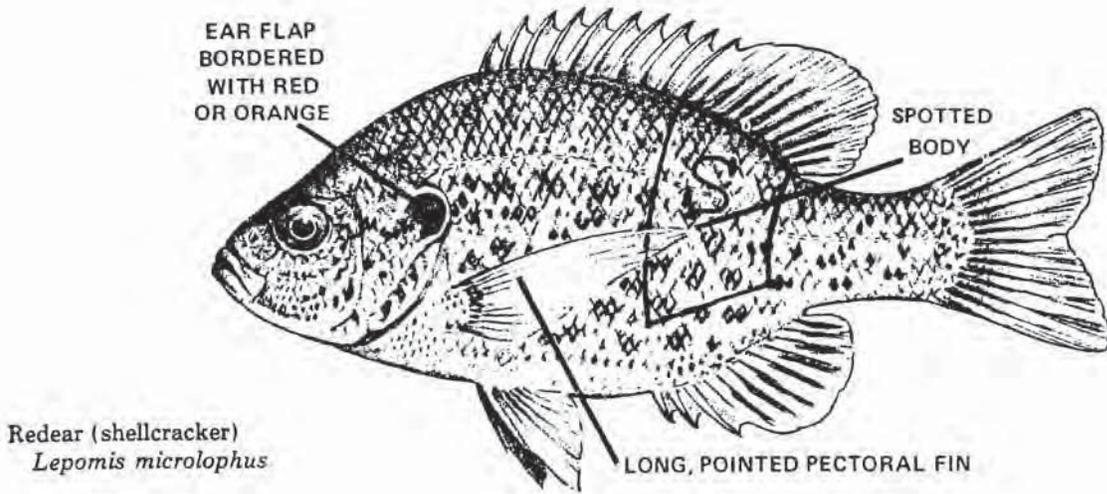
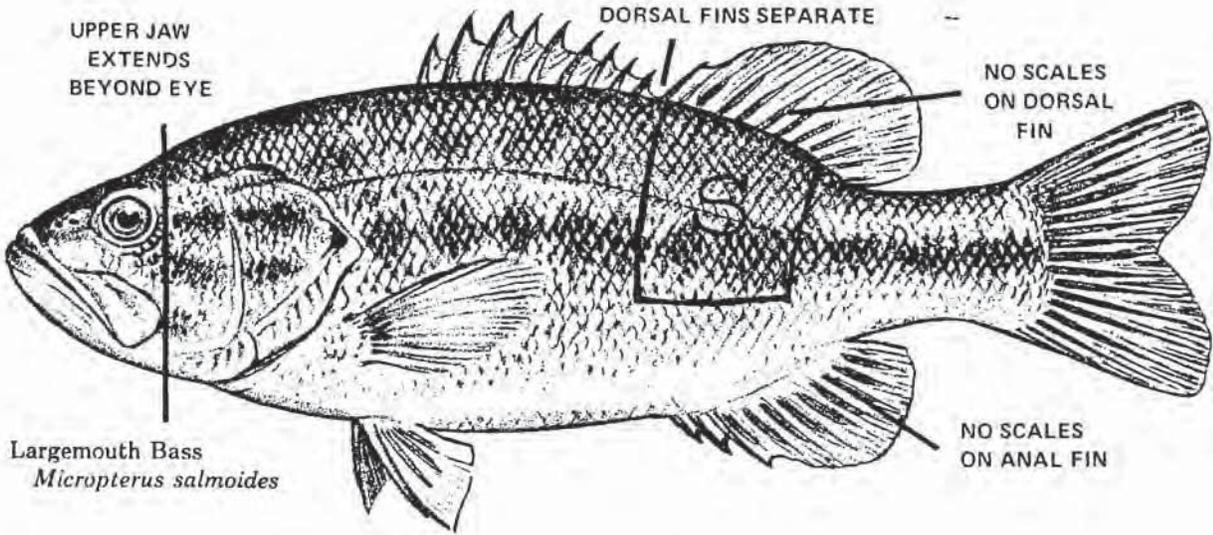
Figure FS 6200-2 Dissection Guide for Spotted Gar, Florida Gar, and White Catfish

DEP-SOP-001/01  
FS 6200 Finfish Tissue Sampling

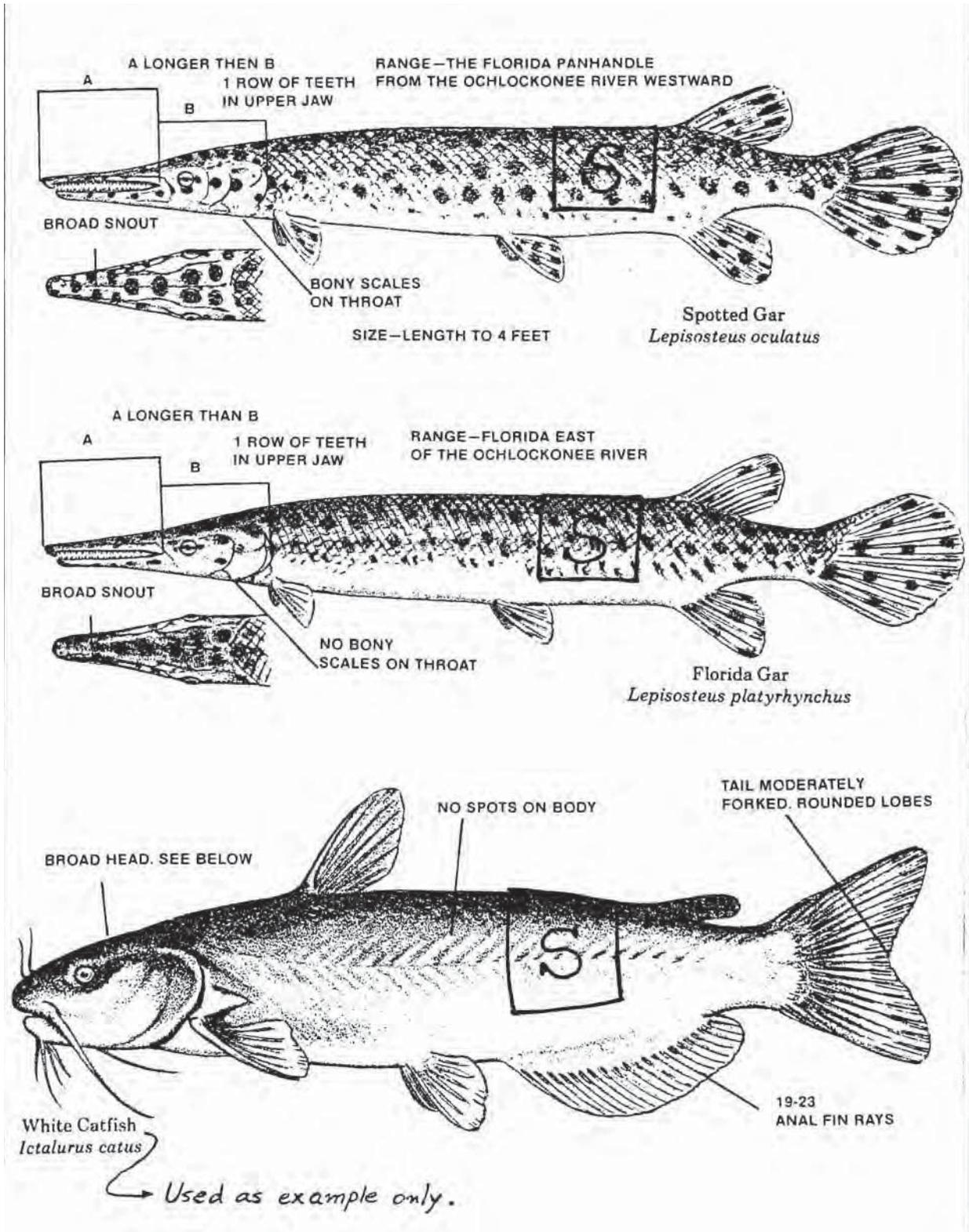
**TABLE FS 6200-1. SUMMARY OF FISH SAMPLING EQUIPMENT**

Device	Use	Advantages	Disadvantages
<b>ACTIVE METHODS</b>			
Electrofishing	Shallow rivers, lakes and streams.	Most efficient nonselective method. Minimal damage to fish. Adaptable to a number of sampling conditions. Useful when other active methods cannot be used.	Nonselective (stuns or kills most fish). Cannot be used in brackish, salt, or extremely soft water. Requires extensive operator training. Can be DANGEROUS.
Seines	Shallow rivers, lakes and streams; or shore line of estuaries.	Relatively inexpensive and easily operated. Mesh size selection is available.	Cannot be used in deep water or over substrates with an irregular contour. Not completely efficient (fish can evade the net while seining).
Trawls	Used from boats in moderate to deep open bodies of water (10 to >70 m depths).	Various sizes available. Effective in deep waters not accessible by other methods. Collects large number of fish.	Requires boat and trained operators.
Angling	Generally species selective using hook and line.	Most selective method. Does not require large number of personnel. Inexpensive.	Inefficient and not always dependable.
<b>PASSIVE METHODS</b>			
Gill Nets	Used in lakes, rivers and estuaries; where fish movement can be expected or anticipated.	Effective for pelagic fish. Selectivity by mesh size. Relatively easy to operate.	Not effective for bottom dwellers or populations that do not exhibit movement patterns. Nets are prone to tangling or damage by fish spines. Will kill captured specimens that may undergo physiological changes if left unattended for extended periods of time.
Trammel Nets	Used in lakes, rivers and estuaries; where fish movement can be expected or anticipated. Used where fish may be scared into the net.	Slightly more efficient than a straight gill net.	(Same as gill nets.) Tangling problems may be more severe. Method may require more personnel to scare the fish, and possibly boats in deep water.
Hoop, Fyke and Pound Nets	Used in shallow rivers, lakes and estuaries, where currents are present and predictable.	Unattended operation. Very efficient in regard to long-term return and expended effort. Useful when active methods are impractical.	Inefficient for short term. Difficult to set up and maintain.
D-traps	Used for long-term capture of slow-moving fish, particularly bottom species. Can be used in all environments.	Easy to operate and set up. Particularly useful for bottom dwelling fish in deep waters. Relatively inexpensive.	Efficiency is highly variable. Not effective for pelagic fish or fish that are visually oriented. Not a good choice as a primary sampling device but valuable as a backup method.

**Figure FS 6200-1**  
**Dissection Guide for Largemouth Bass, Redear Sunfish and Bowfin**



**Figure FS 6200-1**  
**Dissection Guide for Spotted Gar, Florida Gar and White Catfish**



**FS 6300. MISCELLANEOUS ANIMAL TISSUE SAMPLING  
(Reserved)**

**FS 6400. PLANT TISSUE SAMPLING (Reserved)**

## **FS 7000. GENERAL BIOLOGICAL COMMUNITY SAMPLING**

See also the following sections:

- 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 1000 General Sampling Procedures
- FT 1000 – 2000 General Field Testing and Measurement
- LD 7000 Documentation of Biological Laboratory Procedures
- LQ 7000 Quality Control for Biological Community Analysis
- LT 7000 Determination of Biological Indices

### 1. GENERAL CAUTIONS

1.1. Many of these biological sampling procedures require specific training and a demonstration of competency due to the expert judgment exercised during field sampling. It is recommended that individuals conducting physical/chemical characterization, habitat assessment, qualitative periphyton, Biorecon, Stream Condition Index, Lake Vegetation Index and Lake Condition Index sampling should train with DEP staff (via workshops and/or participating in field sampling) and pass a field performance test to demonstrate competence. (See FA 5710, section 2.)

1.2. When performing impact assessment in a stream, the contaminant plume from a point source or tributary may flow along one bank of the stream for some distance. Make sure the benthic biota are sampled within the influence of the plume. If nutrients are a problem in the discharge, the phytoplankton may be impacted farther downstream where the water slows down. Therefore, two locations may be needed to best characterize the effects of the discharge.

1.3. A freshwater effluent discharged to marine receiving waters may float at the surface until it mixes at some distance from the boil. Benthic biota beneath the discharge boil may not come in contact with the effluent very often. Checking conductivity or salinity at several depths, or performing a dye study, may aid in determining the degree of mixing and fate of an effluent. Sample the benthos at a point where the effluent is sufficiently mixed for it to contact the organisms.

### FS 7001 Solution Preparation

#### 1. Buffered Formalin

##### 1.1. Equipment and Supplies

- Sodium bicarbonate
- 37% formaldehyde (formalin)

- pH meter
- Small containers
- Balance

## 1.2. Methods

1.2.1. Calibrate the pH meter according to FT 1000 and FT 1100.

1.2.2. Place a clean weigh pan on the balance. Tare the balance.

1.2.3. Weigh out approximately 5.0 grams of sodium bicarbonate.

1.2.4. Gradually add the sodium bicarbonate to your container of formalin. In general, one gram of bicarbonate will buffer about one liter of formalin, but it is necessary to check the pH of the buffered solution, as individual batches of formalin may vary in pH. Close the container and shake vigorously after each addition. Check the pH at each interval until reaching a pH between 7.5-8.0 S.U. The sodium bicarbonate may not all dissolve into the formaldehyde, as this is a supersaturated solution.

1.2.5. Transfer solution to smaller containers for field and laboratory use.

## 2. LUGOL'S SOLUTION

### 2.1. Equipment and Supplies

- Balance
- Weigh boat
- Spatula
- Magnetic stirrer
- Teflon stirbar
- Spatula
- 500-mL glass amber bottle
- 20 g potassium iodide (KI)
- 10 g iodine crystals
- 20 mL glacial acetic acid
- 200 mL deionized (DI) water in a 250-mL or larger Erlenmeyer flask
- Dropper bottle

### 2.2. Methods

2.2.1. Add acetic acid to DI water. Place on magnetic stir plate with stir bar.

2.2.2. Weigh out 20 g of KI and 10 g of iodine crystals.

2.2.3. Dissolve KI and iodine crystals into the above solution. This process may take from 30-45 minutes, and a small amount of residue may remain at the bottom of the flask.

2.2.4. Pour mixed solution into a 500-mL glass amber bottle and store in an air-conditioned part of the lab. Transfer to dropper bottle for use in the laboratory or field.

Before you transfer the solution to the dropper bottle, swirl to mix any material that settled out during storage.

## **FS 7100. Phytoplankton Sampling**

For more information on sample collection, see also the following section:

- FS 2100 Surface Water Sampling

### 1. EQUIPMENT AND SUPPLIES

- 1 L Nalgene wide-mouth dark sample bottle
- Van Dorn Bottle
- Lugol's solution
- Buffered formalin
- Cooler with ice

### 2. METHODS

2.1. When sampling from a boat, rinse the bottle on the side of the boat opposite from where samples are collected in order to avoid disturbance of the surface algal community. When not sampling from a boat, collect samples upstream from where you are standing.

2.2. When the algae are mostly near the surface, collect the grab sample by scooping the bottle through the top 0.3 m of the surface water. Swirl the bottle to evenly mix the contents. Collect samples from the top 0.3 meters to estimate algal populations that would represent the "worst case" scenario. Algal populations are usually most dense near the surface. When the algae are dispersed through the water column, compositing samples from different depths is acceptable. When a fuel-powered boat is used, collect samples from the bow to avoid contamination from the motor or from sediment sampling activities at the rear of the boat.

2.3. Collect samples directly with the sample bottles for surface collection or with the additional equipment for various water depths.

### 3. SAMPLE PRESERVATION AND HANDLING

3.1. Place sample on ice.

3.2. Preserve the 1 L sample with 3 mL of Lugol's solution (see FS 7001, section 2) within 8 hours of collection time. For long-term storage, add buffered formalin (see FS 7001, section 1) to achieve a minimum of 2.5% final concentration (approximately 25 mL). Depending on the study objectives and the organisms present, samples can be initially preserved with buffered formalin.

## **FS 7200. Periphyton Sampling**

### **FS 7210. QUANTITATIVE PERIPHYTON SAMPLING**

#### 1. EQUIPMENT AND SUPPLIES

- Periphytometer
- Eight 25 x 75 mm glass microscope slides

- Acetone
- Kimwipes
- Nylon twine
- Two 50-mL screw-top centrifuge tubes
- Deionized (DI) water
- 100% buffered formalin (dilute to 5% during sample preservation)
- Cooler with ice
- Permanent marker

## 2. METHODS

2.1. Briefly soak slides in acetone (5 minutes is sufficient). Remove slides from acetone rinse and clean on both sides with Kimwipes to remove any oily residue. Rinse slides with DI water.

2.2. Place the eight slides in the periphytometer. When you pack for a field trip, place periphyton racks carefully in a cooler to prevent slide breakage.

2.3. In the field, find a suitable location for periphyton incubation; take care to place samplers from stations to be compared in areas with similar light and flow regimes. (Use this method in freshwater systems only.) Because periphytometers float at the surface, they are often subject to vandalism. Degree of isolation is another consideration when determining periphytometer placement. Light penetration through the canopy is also very important.

2.4. Using the nylon twine, attach periphytometer to some stable substrate, such as a tree branch or log. Orient the sampler with the shield directed upstream. Do not tie rack below water or "diving" may result. Take care to not attach the rack too high, to prevent it from drying-out with water level fluctuations.

2.5. After the 28-day incubation period, collect slides and split for determination of periphyton chlorophyll-*a* and taxonomic analysis. If growth is sparse, place four slides (assuming none are lost or broken) in each of the two centrifuge tubes. When periphyton growth is extensive, place fewer slides in centrifuge tubes, as it is difficult to process (filter, etc.) a dense algal slurry. This decision is made in the field, as slides cannot be removed from a sample later (due to sloughing of algal material into the tube). Fill the centrifuge tubes (for chlorophyll-*a* and taxonomic analysis) with DI water.

2.6. Use the permanent marker to label the centrifuge tubes with the station, date collected, and the intended analysis. It is helpful to have this information filled out in advance, if possible. Place the sample tube directly on wet ice.

## 3. SAMPLE PRESERVATION AND HANDLING

3.1. If slides will not be scraped within 24 hours, add 5 mL of buffered formalin (see FS 7001, section 1) to the sample. As long as samples are kept on ice and in the dark, this step is not necessary most of the time. It is preferable to wait until after slides are scraped to fix the sample with formalin, since scraping slides in formalin solution is unpleasant and potentially dangerous.

3.2. Store samples for chlorophyll-*a*/biomass in DI water.

## **FS 7220. QUALITATIVE PERIPHYTON SAMPLING**

Adapted from *Stevenson, R. J. and L. L. Bahls. 1999. Periphyton protocols. Pages 6-1 through 6-22 in: M. T. Barbour, J. Gerritsen, and B. D. Snyder, editors. Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition. EPA 841-B-99-002 U. S. Environmental Protection Agency, Office of Water, Washington.*

This sampling procedure requires specific training and a demonstration of competency due to the expert judgment exercised during field sampling. It is recommended that individuals conducting this procedure should train with DEP staff (via workshops and/or participating in field sampling) and pass a field performance test. See also the following section: FT 3000 Aquatic Habitat Characterization

### 1. EQUIPMENT AND SUPPLIES

- Disposable pipettes (2 mL)
- Preservative (buffered formalin, Lugol's solution, or M3)
- Permanent marker
- Plastic container with approximate 8-cm inner diameter lid
- Scissors or knife for removing pieces of plants, roots, or snags (optional)
- 50-mL plastic tube to hold final sample
- Completed Physical/Chemical Characterization Field Sheet (FD 9000-3)
- Completed Stream/River Habitat Sketch Sheet (FD 9000-4) or site map
- Completed Habitat Assessment Field Sheet (FD 9000-5 or FD 9000-6)

### 2. METHODS

2.1. Complete the Physical/Chemical Characterization Field Sheet (FD 9000-3), Stream/River Habitat Sketch Sheet (FD 9000-4) or site map, and Habitat Assessment Field Sheet (FD 9000-5 or FD 9000-6) forms appropriate to the water body in which you are sampling (see FT 3000-FT 3400). Visually determine the substrates where algae will be collected within 0.5 m of the surface. Targeted substrates include removable portions of vascular plants or mosses, snags, roots, leaf packs or mats, and rock. All sampled substrates are combined into a single, composite sample for a particular site. For sampling, target substrates in flow and sunlight conditions that are representative of the aquatic system being sampled. If algae are visible on a substrate, preferentially include that substrate for sampling, as opposed to sampling an adjacent substrate of the same type where algae are not visible. A thin film of algae (usually diatoms) may be present on some substrates, but not visible to the naked eye, although this algal film may feel somewhat slimy to the touch. If algae is not visible at a site, sample in areas where algae would be expected to grow (stable, "seasoned" substrates) in the top 0.5 m of the water column, where incident light should be available. Avoid depositional areas or substrates with excessive silt or sand. Do not sample the sediments.

2.2. Collect algae from approximately an 8-cm diameter area from each targeted substrate within a 100 m reach (in a stream) or 100 m diameter (in a wetland). After carefully removing (to avoid loss of algae) a measured amount of substrate (approximately an 8-cm diameter portion) from the water, place it into a jar containing 100 mL of site water. Using your fingers, rub algae from the substrate into the water, rinsing your fingers in the

same jar. Agitate this slurry sufficiently to homogenize the aliquot. Then, using a pipette, transfer 4 mL of the slurry into the 50-mL tube. Collect a total of 10 of these aliquots from points spaced throughout the site, representing a cross-section of the kinds of algae expected to be present. Sample all removable habitats where periphyton growth is expected, such as snags, roots, leaf packs/mats, vascular plants/mosses, and rock. Apportion the 10 aliquots as equally as possible among productive substrates (as defined by the habitat assessment; see FT 3100) according to the following:

1 productive substrate = 10 aliquots

2 productive substrates = 5 aliquots each

3 productive substrates = 4 from most abundant substrate, 3 from each of the remaining substrates

4 productive substrates = 3 from the two most abundant substrates, 2 from each of the remaining substrates

5 productive substrates = 2 aliquots from each substrate

Note: For a targeted substrate consisting of less than 2 m<sup>2</sup>, (i.e., not a major productive habitat according to Habitat Assessment SOP FT 3100), collect a single periphyton aliquot from that substrate, and follow the above apportioning rule as closely as possible in the remaining major (greater than 2 m<sup>2</sup>) habitats.

When collecting each aliquot, it is important to keep the amount of water placed into the jar (100 ml) and the amount of slurry transferred into the tube (4 ml) consistent for all 10 aliquots.

3. Removable hard substrates (snags, rocks): Remove substrate from water and rub algae from an approximately 8- cm diameter area into jar filled with 100 mL of site water. Pipette 4 mL of resulting slurry into sample container. Discard remaining slurry.

3.1. Removable soft substrates (plants, mosses, leaf packs, macro-algal mats- if representative of the site, roots): Remove approximately 8-cm diameter area of substrate from water, place into jar containing 100 mL of site water, and rub algae (using fingers) from substrate. Pipette 4 mL of resulting slurry into sample container. Discard remaining slurry. When sampling plants, sample algae from the dominant plant species, including both emergent and submerged varieties.

3.2. Sequentially place all 10 of the 4 mL aliquots from the sampled substrates, as described in Section 2.2, into the 50-mL tube sample container, which should be clearly marked with the permanent marker. Include site, date, collector, sample type (qualitative periphyton), and preservative information.

4. SAMPLE PRESERVATION AND HANDLING

4.1. Add 2 mL of buffered formalin (see FS 7001, section 1) or M3 per 40 mL of periphyton slurry for samples for taxonomic identification.

## **FS 7230. RAPID PERIPHYTON SURVEY**

1. INTRODUCTION This sampling procedure requires specific training and a demonstration of competency due to the expert judgment exercised during field sampling. It is recommend that individuals conducting this procedure should train with DEP staff (via workshops and/or

participating in field sampling) and pass a field performance test. See also the following section:  
FT 3000 Aquatic Habitat Characterization

## 2. Equipment and Supplies

- Implement to measure a 5 cm distance
- Rapid Periphyton Data Sheet (FD 9000-8)
- Completed Physical/Chemical Characterization Field Sheet (FD 9000-3)
- Completed Stream/River Habitat Sketch Sheet (FD 9000-4) or site map
- Completed Habitat Assessment Field Sheet (FD 9000-5 or FD 9000-6)

## 3. Method

3.1. Measure a 100m segment of stream, placing flags every 10m.

3.2. Conduct a standard stream habitat assessment. If desired, the following algal observations can be done during the habitat mapping process.

3.3. Beginning at the "0" flag, establish a transect of 9 approximately equidistant points across the stream. Point 1 would be located approximately 0.1 m from the right bank, point 5 is at the middle, and point 9 located 0.1 m from the left bank. The remaining points are sequentially distributed between these points, approximately equidistantly.

3.4. Each observation point, within the above distance parameters, should be chosen haphazardly. That is, choose the actual point without looking (thereby potentially biasing your selection).

3.5. After selecting the observation point:

3.5.1. If the substrate can be reached, grab a handful of material at the observation point, being careful not to lose material when bringing it to the surface. Examine the material, first out of the water, and then with the hand located approximately 2 cm below the surface. Note on the datasheet if algae are visible and measure its average thickness, perpendicular to the substrate, with a ruler. Record these data using the rank thickness classifications on the data sheet as follows; "0" indicates a rough surface with no algae, "1" for algae less than 0.5 mm OR no algae visible but surface is slimy (including muck), "2" for 0.5 mm to 1 mm, "3" indicates an algal cover of greater than 1 mm but less than 6 mm, "4" for 6-20 mm and "5" for algae over 20 mm. NOTE: examine the first substrate you encounter, which may not always be the stream bed (e.g., snag, plants, roots). Make your observations at the point where the hand encounters the substrate (i.e., if a 0.5 m long snag is grabbed, record the algal thickness based on where the hand touches it, not elsewhere). Take the measurement where the algae is representative of the entire amount in your hand (i.e. avoid measuring a single long filament when most of substrate has only a thin coating).

3.5.2. Record the type of algae seen (filamentous, diatoms, or other).

3.5.3. If the substrate can not be seen (e.g., in tannic waters) and can not be reached with the hand, record an "X", for that point, indicating observations are not possible using this method.

3.5.4. If algae can be seen but not reached, then record as "visible" and visually estimate the average thickness perpendicular to the substrate.

3.5.5. If the substrate cannot be brought to the surface (e.g., a large rock or snag) but it is reachable, then rub the surface of the substrate and visually inspect to determine the presence/absence of algae and approximate thickness.

3.6. Additionally, at point 5 on each of the 11 transects, canopy cover should be measured using a spherical densiometer. The densiometer consists of a concave mirror with gridwork that creates 24 ¼-inch etched boxes. Each box can be subdivided into 4 smaller squares, via an imaginary dot in the center of each box, to create a total of 96 smaller squares that can be counted within the entire densiometer. Hold the instrument far enough away from the body so the operator's head is just outside the grid. Count the number of small squares (out of a total of 96) that DO NOT have tree canopy. Subtract this number from 96 to determine the number of dots WITH tree cover. Record this number (number of dots WITH canopy cover) for each transect under the Canopy column for point 5.

3.7. Repeat of the above procedures every 10m, including the 100m mark, for a total of 99 periphyton observation points.

## **FS 7300. Macrophyte Sampling**

### **FS 7310. LAKE VEGETATION INDEX (LVI) SAMPLING**

#### 1. INTRODUCTION

This method is a rapid screening tool for ecological condition; it determines how closely a lake's flora resembles that of an undisturbed lake. The LVI is applicable for use from April 1 to November 30 of each year, due to impacts of freezing events on the macrophyte community.

This sampling procedure requires specific training and a demonstration of competency, as outlined in FA 4330, due to the expert judgment exercised during field sampling. It is recommend that individuals conducting this procedure should train with DEP staff (via workshops and/or participating in field sampling) and pass a field performance test. Each sampling entity must maintain a plant reference collection. See also the following procedures:

- FT 3001 Physical/Chemical Characterization
- FT 1000 General Field Testing and Measurement
- LQ 7310 Lake Vegetation Index
- FA 4330 Proficiency Criteria for Lake Vegetation Index (LVI) Sampling

#### 2. EQUIPMENT AND SUPPLIES

- Aquatic and wetland plant identification manuals
- GPS unit
- Hand lens
- Binoculars
- Map of lake separated into 12 sections
- Boat
- Implement to measure a 5 m distance

- Frotus
- Plastic bags
- Permanent marker
- Cooler
- Ice
- Lake Vegetation Index Data Sheet (FD 9000-7)
- Completed Physical/Chemical Characterization Field Sheet (FD 9000-3)

### 3. Methods

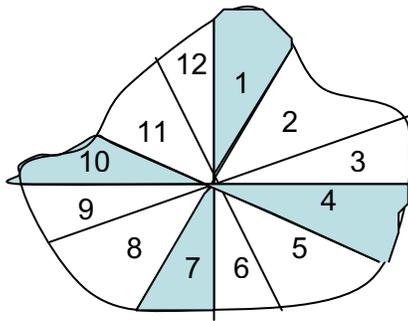
#### 3.1. Prior to visiting the lake:

3.1.1. Generate a GIS map of the lake. (An aerial photo is most helpful for locating features on the lake). Divide the lake into four quadrants by drawing a north-south midline and an east-west midline. Then, logically divide the entire lake into twelve total sections (three in each quadrant), with approximately equal shoreline distances and known latitude/longitude coordinates generated from the GIS mapping effort.

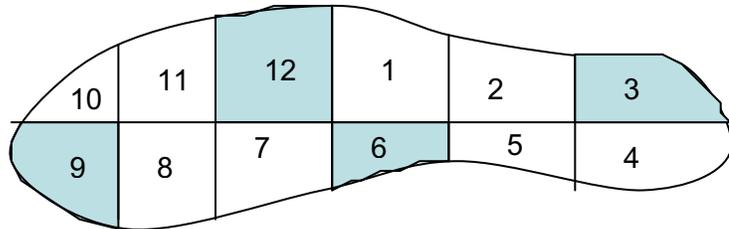
3.1.2. Number the sections 1-12 in a clockwise fashion, starting with 1 as the section immediately clockwise from the north-south line in the northeast quadrant.

3.1.3. Select section 1, 2, or 3 as the starting section by using a random numbers table or some other random number generator (e.g. rolling a die).

3.1.4. If section 1 is selected as the starting section, sections 1, 4, 7, and 10 will be sampled. If section 2 is selected, sections 2, 5, 8, and 11 are sampled. If section 3 is selected, sections 3, 6, 9, and 12 are sampled. On the Lake Vegetation Index Data Sheet, record the sections of the lake associated with each sampling unit (data column). There are four sampling units per lake. See figure below for examples of different sampling strategies.



Sampling strategy if 1 is randomly selected. Plants identified in sections 1, 4, 7, and 10 are recorded in individual columns on the data sheet.



Sampling strategy if 3 is randomly selected. Plants identified in sections 3, 6, 9, and 12 are recorded in individual columns on the data sheet.

### 3.2. In the field:

3.2.1. Note that four data columns will be used on the Lake Vegetation Index Data Sheet for this LVI sampling procedure, resulting in four species lists for the lake. Record the total species from each “drive-by” effort combined with its associated transect portion (to include all five frotus deployments) for each sampling unit as one cumulative species list for the sampling unit. Mark each column on the data sheet to match the sampling unit (see section 3.1.4).

3.2.2. Use the map of the lake and GPS unit to go to the emergent zone of the first sampling unit. Travel at idle or slow speed and record the presence of aquatic and wetland plant species seen from the boat on the Lake Vegetation Index Data Sheet. Identify aquatic and wetland plants to species level. If this not possible, bring the plant back for expert identification. Binoculars may be used to aid in observation. Collect any specimens within easy reach that are not identifiable by observation from the boat. Identify collected specimens, or bag them for return to the lab. Do not leave the boat or spend effort on difficult to access areas. This is a quick “drive-by” survey. Continue this sampling throughout the section.

3.2.3. Identify a location within the sampling unit to set up a transect 5 m in width. Choose a location where you will be able to navigate the boat approximately perpendicular to the shoreline. Where possible, choose a location that is species rich and/or contains species which were not identified in the “drive-by” survey. Within the emergent zone, measure 5 m for the width of the transect. Orient the transect perpendicular to the shoreline, with the boat being the centerline of the transect. Record the presence of all aquatic and wetland plant species within the 5 m belt transect, from the point where aquatic and wetland plants begin, to the estimated ordinary high water mark of the lake. If practical, get out of the boat and wade, to identify plants that are

small, hidden or in areas too shallow to reach by boat. Record the presence of species in the transect (as described in 3.2.1) on the Lake Vegetation Index Data Sheet.

3.2.4. Deploy the frotus five times per section within the 5 m transect, moving from the shoreline to open water. Record the presence of species from the frotus deployments (as described in 3.2.1) on the Lake Vegetation Index Data Sheet.

3.2.5. Repeat steps 3.2.2-3.2.4 for the three other sampling units.

3.2.6. Determine one dominant or two co-dominant species for the sampling unit by estimating the plant with the largest areal extent. (Dominance can be by emergent, floating, or submersed species.) Record dominance or co-dominance on the Lake Vegetation Index Data Sheet. If no one dominant or two co-dominant species are present, do not assign a dominance code for that sampling unit. Return all dominant and co-dominant species to the laboratory for verification by an independent taxonomist.

3.2.7. Place any specimens that can not be readily identified in the field in plastic bags. Label each bag so that the species name can later be added to the correct sampling unit species list(s). Store bags on ice while returning to the laboratory. Plants kept refrigerated can be identified fresh within a few days.

3.3. After visiting the lake:

3.3.1. Prepare unknowns for herbarium identification or verification by a consulting botanist as voucher specimens.

3.3.2. Identify and record the correct names of the unknown specimens on the Lake Vegetation Index Data Sheet.

3.3.3. Calculate the LVI score for the lake as described in LT 7500.

4. Recommended references for plant identification:

4.1. Godfrey, R. and J. Wooten. 1979. Aquatic and Wetland Plants of Southeastern United States: Monocotyledons. Univ. Ga. Press, Athens.

4.2. Godfrey, R. and J. Wooten. 1979. Aquatic and Wetland Plants of Southeastern United States: Dicotyledons. Univ. Ga. Press, Athens.

4.3. Wunderlin, Richard P. 1998. Guide to the Vascular Plants of Florida. University Press of Florida, Gainesville.

4.4. Tobe, John T. et. al. 1998. Florida Wetland Plants: An Identification Manual. Florida Department of Environmental Protection, Tallahassee.

4.5. Langeland, K.A. and K. Burks. 1998. Identification and Biology of Non-Native Plants in Florida's Natural Areas. Florida Department of Environmental Protection, Tallahassee.

## **FS 7400. Benthic Macroinvertebrate Sampling**

### **FS 7410. *Rapid Bioassessment (Biorecon) Method***

This sampling procedure requires specific training and a demonstration of competency due to the expert judgment exercised during field sampling. It is recommend that individuals conducting this procedure should train with DEP staff (via workshops and/or participating in field sampling), complete the training requirements outlined in FA 5710 and pass a field performance test. See also the following sections:

- FT 3000 Aquatic Habitat Characterization
- LT 7100 Biorecon Determination

1. INTRODUCTION

1.1. This method was designed to be primarily a screening tool.

2. EQUIPMENT AND SUPPLIES

- Completed Physical/Chemical Characterization Field Sheet (FD 9000-3)
- Completed Stream/River Habitat Sketch Sheet (FD 9000-4)
- Completed Stream/River Habitat Assessment Field Sheet (FD 9000-5)
- Biorecon Field Sheet (FD 9000-1)
- Forceps
- Transfer pipettes
- White picking pans
- 10X hand lens
- Jars filled with alcohol (80% ethanol)
- D-frame dip net with No. 30 mesh and handle marked in 0.1-m increments
- Meters (DO, pH, Conductivity)
- Wide-mouth jug
- Cooler with ice

3. METHODS

3.1. Visually examine the area or reach to be sampled. Either walk or boat throughout the aquatic system, paying close attention to its physical and habitat characteristics. Be very careful when walking through the system not to disturb aquatic habitats. Such disturbances could lead to inaccurate biorecon and/or habitat assessment results. In fairly small (1st to 4th order) streams, the length of a discrete station consists of a 100-m stretch of stream, and the width is from bank to bank. In very large systems it may be necessary to establish more than one station to adequately characterize the biota. Do not sample during flood stage or recently dry conditions.

3.1.1. If the stream is known to have been dry recently, wait a minimum of three months (90 days) after dry conditions have abated and the stream returns to normal flow before performing a Biorecon.

3.1.2. If flood conditions (water level >0.5 meters above normal) prevent access to substrates that are inhabited by invertebrates, delay sampling until those substrates are accessible or wait 28 days for the invertebrates to colonize the newly inundated substrates. If water levels are  $\leq$  0.5 meter above normal, sample habitats at the normal stream shoreline, not the flooded shoreline.

3.2. Complete the Physical/Chemical Characterization Field Sheet (FD 9000-3), Stream/River Habitat Sketch Sheet (FD 9000-4), and Stream/River Habitat Assessment Field Sheet (FD 9000-5; see FT 3000-FT 3400). The percent coverage of substrate type refers to how much of each habitat type is actually present at the sampling site. Take care

to accurately determine the spatial extent of each substrate type (in a three-dimensional context) for habitat scoring procedures.

3.3. Determine the “best” or “most productive” habitats, which, when sampled, will provide an accurate estimate of the site’s maximum biological diversity. Generally, the most productive habitat types are as follows: leaf packs, snags, aquatic vegetation, roots, and rocky outcrops, all can be considered “productive” habitat. Sand and mud/muck are sampled as “minor” habitats. For sampling purposes, habitats receiving good water velocity (>0.2 m/sec) should be selected over those in more sluggish areas. If fewer than four productive habitats are available, select a particularly productive habitat (based on the number of taxa obtained in earlier sweeps) sampled in the earlier sweeps until completing four sweeps.

3.4. Perform four separate 0.5-meter sweeps with the D-frame dip net in the “most productive” habitats as determined by the above procedures. Sort and remove all organisms between each sweep. If conditions pose a hazard (e.g., severe weather), the material from all four sweeps may be stored in jugs, placed on ice, and sorted at the laboratory within a 24-hour period. Several passes (three or more) over the same 0.5 meter area are recommended in an attempt to capture all organisms. This sampling effort in a discrete 0.5 meter spot is considered to be one sweep. Catch organisms by allowing them to flow into the net and also by sweeping the net towards disturbed material. Where a continuous 0.5 m sweep is not possible, take two 0.25 m sweeps in the same area to obtain a full 0.5 m sweep. It is recommended, due to the potential spatial heterogeneity in the distribution of the organisms, that two separate 0.25 m sweeps be taken in two separate areas of a given productive habitat to comprise the 0.5 m “sweep.” If you are sampling from a boat, you can get out of the boat and wade in shallow shore areas to obtain the sweeps. You can also approach a habitat with the boat from downstream, agitate and sweep the reachable portion of the habitat (typically by leaning from the bow of the boat), to capture organisms. See FS 7420 section 2.4 for further discussion on proper sweeping techniques.

3.5. There are two picking options for this step. Use the field sorting method unless field conditions are such that the laboratory sorting method is more appropriate. Read both methods and decide if the laboratory sorting method is allowed. For both options, refer to Table FS 7000-1 to determine the number of individual specimens in each target taxonomic group to retain for laboratory identification. Do not retain more than the specified number of individuals. For both options, perform a QC Check as outlined in 3.5.3.

3.5.1. Field Picking Biorecon Method: This is the preferred sorting method for the Biorecon procedure. Return to a comfortable spot on the bank with the dip net containing the sampled material. Place small aliquots of the detritus plus organism matrix in a picking pan diluted with a small amount of site water. Make sure the density of detritus is low enough so organisms are easily seen and captured. Scan the entire pan for organisms. When an organism is found, remove it with forceps or a pipette, examine it with the hand lens, determine its identity to the lowest possible taxonomic level (usually family or genus), record on the Biorecon Field Sheet (FD 9000-1), and place the organism in an alcohol-filled jar. Repeat these procedures until **all** the material in the net has been examined. Repeat until material from four sweeps has been processed. Record all data on FD 9000-1. In the jar filled with alcohol, **save up to, but do not exceed, the target number of specimens as indicated in Table FS 7000-1** for laboratory verification. Examining habitats separately helps the investigator learn which taxa are found in which habitat type and aids in future Biorecon sampling. Examining habitats separately also helps determine which habitat(s) to target for the fourth sweep if only three productive habitats are available. If field conditions are tolerable (e.g., no

hard rain that would interfere with sorting efficiency) and time spent in the field is not a limiting factor, this option helps the investigator gain a better understanding of aquatic ecology. Organisms from all habitat types may be combined in the jar for laboratory verification. Store samples in ethanol, on ice.

**3.5.2. Laboratory Picking Biorecon Method:** If conditions are hazardous at the site (e.g., severe weather), this option may be used, but it is not recommended for routine use. To employ this option, sorting must be done within 24 hours on iced samples (do not formalin preserve). Transfer the material in the net to a wide-mouth jug, performing a cursory examination of the diversity of organisms collected in that given habitat. Repeat until material from four sweeps has been collected and placed into a wide-mouth jug. If fewer than four productive habitats are available, select a particularly productive habitat sampled in the earlier sweeps until four sweeps have been completed (see section 3.3). Store on ice and sort within 24 hours. Do not store with formalin. After returning to the laboratory, sort the material with the naked eye, and save up to, but do not exceed, the target number of specimens as indicated in Table FS 7000-1 for identification.

**3.5.3.** Perform a quality control check on all samples sorted in the field or laboratory.

**3.5.3.1.** Have a second taxonomist randomly select a minimum of 10% of the sorted aliquots and perform a QC check by examining the aliquot and retrieving and counting any new taxa found. The sorting and QC check can be performed simultaneously by the sampling team. The aliquot can be discarded after the team reaches a consensus that no new taxa are present.

4. A result of fewer than 100 individuals in the four D-frame dip net sweeps suggests that conditions are fairly inhospitable to invertebrates. This could be due to recent desiccation, habitat limitation, toxicity, and/or other factors. If you encounter fewer than 100 individuals, it is recommended that you perform a follow-up Stream Condition Index sampling (see FS 7420) to further evaluate the stream.

5. See LT 7100 for laboratory verification of organism identification, Biorecon score determination, and Biorecon score evaluation.

## **FS 7420. STREAM CONDITION INDEX (D-FRAME DIP NET) SAMPLING**

*(Based on Plafkin, et al., 1989, Rapid bioassessment protocols for use in streams and rivers: benthic macroinvertebrates and fish, EPA/444/4-89-001. See also Barbour, et al., Rapid Bioassessment Protocol Manual, EPA/841/B-99-002.)*

This sampling procedure requires specific training and a demonstration of competency due to the expert judgment exercised during field sampling. It is recommended that individuals conducting this procedure should train with DEP staff (via workshops and/or participating in field sampling), complete the training requirements outlined in FA 5710 and pass a field performance test. See also the following sections:

- FT 3000 Aquatic Habitat Characterization
- LT 7200 Stream Condition Index (SCI) Determination

### **1. EQUIPMENT AND SUPPLIES**

- Completed Physical/Chemical Characterization Field Sheet (FD 9000-3)
- Completed Stream/River Habitat Sketch Sheet (FD 9000-4)

- Completed Stream/River Habitat Assessment Field Sheet (FD 9000-5)
- D-frame Dip net with No. 30 mesh and handle marked in 0.1-m increments
- Two 4-liter wide-mouth plastic jugs (Take extra in case more are needed.)
- Buffered formalin (See FS 7001, section 1.)
- Brush
- Permanent marker

## 2. METHODS

2.1. Visually examine the area or reach to be sampled. Walk or boat throughout the aquatic system, paying close attention to its physical and habitat characteristics. Be very careful when walking through the system not to disturb aquatic habitats. Such disturbances could lead to inaccurate SCI and/or habitat assessment results. In fairly small (1st to 4th order) streams, the length of a discrete station consists of a 100 m stretch of stream, and the width is from bank to bank. In very large systems it may be necessary to establish more than one station to adequately characterize the biota. Do not sample during flood stage or recently dry conditions.

2.1.1. If the stream is known to have been dry recently, wait a minimum of three months (90 days) after dry conditions have abated and the stream returns to normal flow before performing an SCI.

2.1.2. If flood conditions (water level >0.5 meters above normal) prevent access to substrates that are inhabited by invertebrates, delay sampling until those substrates are accessible or wait 28 days for the invertebrates to colonize the newly inundated substrates. If water levels are  $\leq 0.5$  meter above normal, sample habitats at the normal stream shoreline, not the flooded shoreline.

2.2. Complete the Physical/Chemical Characterization Field Sheet (FD 9000-3), Stream/River Habitat Sketch Sheet (FD 9000-4), and Stream/River Habitat Assessment Field Sheet (FD 9000-5; see FT 3000-FT 3400). The percent coverage of substrate type refers to how much of each habitat type is actually present at the sampling site.

2.3. Determine the number of sweeps to perform in each habitat type out of the twenty total sweeps per station. First, use the Stream/River Habitat Sketch Sheet (FD 9000-4) and the Physical/Chemical Characterization Field Sheet (FD 9000-3) to determine the number of productive habitats at the site. Then, use the following conventions to determine the number of sweeps to perform in each habitat type:

2.3.1. If one productive habitat is present, perform 10 sweeps in that habitat and 10 sweeps in a minor habitat (e.g., sand).

2.3.2. If two productive habitats are present, perform 7 sweeps in each of those habitats and 6 sweeps in a minor habitat (e.g., sand).

2.3.3. If three productive habitats are present, perform 5 sweeps in each of those habitats and 5 sweeps in a minor habitat (e.g., sand).

2.3.4. If four productive habitats are present, perform 4 sweeps in each of those habitats and 4 sweeps in a minor habitat (e.g., sand).

2.3.5. If five productive habitats are present, perform 3 sweeps in each of those habitats and 5 sweeps in a minor habitat (e.g., sand).

Generally, the most productive habitat types are as follows: leaf packs, snags, aquatic vegetation, roots, and rocky outcrops. Sand and mud/muck are sampled as “minor” habitats. If sufficient material is not available for performing the specified number of sweeps in a given productive habitat, do as many as possible in that habitat type, and perform extra sweeps in the other habitats to total 20. Proper interpretation of benthic collections requires that samples be collected from multiple habitats that are representative of the site.

2.4. Perform 20 discrete 0.5 m sweeps with the D-frame dip net. Sample the available substrates as determined by the above procedures.

2.4.1. In streams with sufficient water velocity, the most effective way to capture invertebrates is to place the bottom rim of the dip net directly downstream of the area to be sampled. Disturb, agitate or dislodge organisms (with hands and/or feet, or brush, where appropriate) from substrates (snags, etc.) working as closely to the net as possible. When performing an upstream/downstream type of study, sample the downstream station first to prevent upstream invertebrates from drifting into a location they did not originally inhabit. If you are sampling from a boat, you can get out of the boat and wade in shallow shore areas to obtain the sweeps. You can also approach a habitat with the boat from downstream, agitate and sweep the reachable portion of the habitat (typically by leaning from the bow of the boat), to capture organisms.

2.4.2. For areas with little to no flow, disturb an area of substrate that is one dip net width wide and approximately 0.5 m long and create flow into the net to ensure the capture of organisms which were living there. Several passes (three or more) over the same 0.5 m area are required to make sure all organisms are captured. This sampling effort in a discrete 0.5 m area is considered as one sweep.

2.4.3. For heavily vegetated areas place the net at the base of the vegetation and dislodge organisms using your hand or a 0.5 m sweeping motion with the net. Where a continuous 0.5 m sweep is impossible, take two 0.25 m sweeps of the same habitat to attain a full 0.5 m sweep.

2.4.4. Sample leaf packs (if present) by disturbing leaf pack areas with hands or feet before scooping 0.5 m worth of material into the net. When sampling leaf mats, make sure that only the top 2 cm of material is collected, and especially make sure that anaerobic leaf material is not included.

2.4.5. Sand, muck, mud, and silt (non-major habitats) can be “swept” or sampled by agitating the top 2 cm of substrate (with hands, feet, or brush). Take three 0.5 m passes over the same area for one sweep. If the net is pushed into coarse sand or coarse detritus, very little of the sand or detritus will be washed through the net, resulting in a sample that contains few organisms and is hard to process, thus compromising the quality of the entire sample.

2.5. Record the number of sweeps for each habitat on the Physical/Chemical Characterization Field Sheet (FD 9000-3).

2.6. Reduce the sample volume after each discrete sample by dislodging organisms from larger debris (but retaining invertebrates in the net) and discarding the debris. Save finer debris plus organism mixture in large wide-mouth jugs. Make every effort to reduce enough of the sample volume in the field so that no more than four liters of material are collected. If this is not possible, put the material into additional jugs. Additional sample reduction will occur in the laboratory. The relative proportions of the organisms collected must be maintained intact to calculate many community metrics. Indicate on the label in how many jugs the entire sample is contained, e.g., “1 of 2,” “2 of 2.”

### 3. SAMPLE PRESERVATION AND HANDLING

3.1. Preserve with 10% buffered formalin (do this by adding one part of 100% buffered formalin to the jug with nine parts ambient water or filling up the entire jug with 10% buffered formalin). During laboratory processing, remove the organisms from the detritus and place them into 70% ethanol.

3.2. If samples are immediately iced and can be sorted within 24 hours, the use of formalin is optional. Use 10% formalin, per section 3.1 above, to preserve iced samples that will not be sorted within 24 hours.

3.3. See LT 7200 for laboratory and calculation procedures for Stream Condition Index determination.

## **FS 7430. HESTER-DENDY SAMPLING FOR THE BIOLOGICAL INTEGRITY CRITERION**

### 1. EQUIPMENT AND SUPPLIES

- Three or four Hester-Dendy (HD) artificial substrates
- Customized HD block, with coupling nuts for attachment of HD samplers and eye bolts for attachment of cable are to be block mounted, or
- Customized HD floating platform with coupling nuts for attachment of HD samplers underneath the platform and eye bolts for attachment of cable, if HD's are to be floated.
- Buoys
- Stainless steel cable or nylon rope of appropriate strength
- Nico-Press tool or two hammers with fasteners
- Whirl-Pak bags or other appropriate containers
- Permanent marker
- Cooler with ice

### 2. METHODS

2.1. Deploy Hester-Dendys via special Hester-Dendy concrete blocks with coupling nuts, via custom floating platforms, or by tying weighted Hester-Dendys to an overhanging object. For the Hester-Dendy (HD) block method, attach at least three Hester-Dendy artificial substrates (HDs) to the HD block, and place the block at a depth of one meter (or the deepest spot available if shallower than one meter). Take care to place control and test site blocks in areas of similar flow, depth and habitat type. The block has space for four HDs for use in studies requiring additional replication. Knowledge of the system's hydrologic regime is important to make sure samplers will not go dry during the 28 day incubation period. For example, if there is high water and you expect the water to drop one meter in the next few weeks, place the sampler so that it will be one meter deep at the end of incubation. In shifting sand substrates, place the block so that existing snags will deflect sand from being deposited on the samplers. This can be determined by close examination of the bottom topography. If the mean depth of the water body is greater than one meter, and/or there is a chance of the HD samplers that are placed on the bottom being smothered by sand or silt, a floating platform with attachment points for four Hester-Dendys may be used instead. For the HD floating platform method, attach three or four Hester-Dendys to the floating platform. Then attach the platform to a buoy using one meter of stainless steel cable (or less than one meter in shallow streams). Attach the buoy/platform configuration to an anchor (typically a

concrete block). Use a length of stainless steel cable appropriate for the depth of the stream or river. Alternatively, suspend Hester-Dendys one meter (or less in shallow streams) below the water level by attaching them to an overhanging object via string or monofilament, and weighting the bottom of the Hester-Dendy (by tying approximately 250 g of weight to the bottom of the artificial substrate).

2.2. If using the HD block, attach stainless steel cable or nylon rope to a point on the bank sufficiently high to enable recovery even if the water level increases. Wrap the cable or rope around the base of a tree on the bank and use the Nico-Press tool and fasteners to secure the block. If vandalism is a potential problem, attempt to conceal the cable so that no one but you can find it. If the Nico-Press tool is unavailable, the fasteners may be crimped by hammering (two hammers are needed).

2.3. After a 28-day incubation period, recover the HD samplers. Approach the block mounted, floating, or suspended samplers carefully, without disturbance, from the downstream position. Without touching the HDs or any other substrate, place a dip net either downstream or below the samplers to capture escaping organisms. In a deliberate, gentle manner, lift the block straight up from the bottom and immediately place on a flat surface. Wade or use a boat; **do not** pull the block up from the shore. If retrieving suspended or floating HDs, gently lift and place immediately in Whirl-Pak bags.

2.4. Once out of the water, quickly place the Whirl-Pak bags over all the HDs, and detach them from the block or floats. If an organism is observed crawling off a HD, capture it and put it in the appropriate Whirl-Pak. If organisms are found in the dip net, randomly and sequentially place them in one of the Whirl-Paks. Fill the Whirl-Paks with ambient water (so that all the plates are wet), secure them (twirl three times and twist the ends), and place on ice. Whirl-Paks should be pre-labeled with the station, sample date, and replicate number, using the permanent marker.

### 3. SAMPLE PRESERVATION AND HANDLING

3.1. **Do not** preserve samples until after organisms are scraped from the HD plates unless the HD samplers are not going to be reused. Preservatives will poison the plates, preventing them from being used again.

## FS 7440. CORE SAMPLING

### 1. INTRODUCTION

1.1. Use of coring devices is restricted to sampling fairly soft substrates (silt or muck, with only small amounts of sand or shell), usually in marine systems. Take enough cores so that an area of approximately 675 cm<sup>2</sup> is sampled. Place all replicates in separate sample containers (for statistical analyses). Depending on the study objectives, replicates may also be composited, as long as the number of replicates is equal for each station and clearly recorded so that the number of organisms per square meter can be calculated.

### 2. EQUIPMENT AND SUPPLIES

- Coring device
- U.S. 30 mesh box sieve (constructed of fiberglass-coated wood and U.S. 30 mesh screen) or dip net with U.S. 30 mesh sieve material
- White enamel pan
- Plastic squeeze bulb

- Small bucket
- Wide-mouth plastic sample containers
- Permanent marker
- Buffered formalin
- Long pole (if needed)
- Rose Bengal dye (optional)

### 3. METHODS

3.1. When sampling from a boat, use a coring device with a valve near the top attached to a long pole. Collect core samples from the rear and downstream of the vessel to avoid contamination of other types of samples with disturbed sediments. Rinse the box sieve with ambient water and tie it to the side of the boat where samples will be collected. When placed in the water, it will float at the surface. If a box sieve is not available, wash the dredged material in a dip net, provided it is fitted with a U.S. 30 mesh sieve material. The disadvantage of using the dip net is that it requires two people (one to hold the net, one to manipulate the coring device).

3.2. Lower the coring device to the bottom with the valve open. After quickly pushing the device into the sediments, close the valve. The resulting vacuum will keep the material in the tube as it is raised up to the boat. Many clean water organisms are somewhat motile and will elude capture if you are not quick during sampling.

3.3. When collecting samples in wadeable waters, a smaller coring device can be used. This corer utilizes a flapper-valve equipped stopper that is inserted into the top of the pipe. Vacuum inside the pipe holds the material until the stopper is removed. This small corer should be used primarily for non-biological sediment sampling (grain size, metals, etc.), as it is thought to be too small to effectively capture many organisms (e.g., crustaceans or tubicolous worms which are generally large in size) considered useful in impact determination.

3.4. Pull the sampler to the surface, open the valve or remove the stopper, and place it immediately into the box sieve. Disgorge the contents into the sieve, rinsing to assure complete sample purging.

3.5. Swirl the box sieve in the water with a back-and-forth motion to wash the fine sediments through. Concentrate the remaining sample into one corner of the sieve. If a sediment type is especially clayey or mucky, it may be necessary to use a hand to break up clumps and agitate the sample to reduce it. Make sure you rinse any detritus from your hand back into the sieve.

3.6. Fill the small bucket with ambient water and use this water to fill the squeeze bulb. Using the squeeze bulb, rinse the sample from the sieve to the enamel pan. Take care to rinse the entire contents of the sample into the pan. Some organisms may stick to the screen.

3.7. Use the squeeze bulb to transfer the sample from the enamel pan into the pre-marked wide-mouth jug, making sure the location, date, and replicate number are accurate.

### 4. SAMPLE PRESERVATION AND HANDLING

4.1. Preserve the sample with 10% buffered formalin (see FS 7001, section 1) by adding a 9 to 1 ratio of water to 100% formalin. If laboratory processing is possible within eight

hours, the samples may be stored on ice, without addition of formalin. If desired, add a very small amount of rose bengal dye (approximately 100 mg per liter of material) to the sample as a picking aid.

## **FS 7450. DREDGE SAMPLING**

### 1. EQUIPMENT AND SUPPLIES

- Ekman or Petite Ponar dredge
- Box sieve (constructed of fiberglass-coated wood and U.S. 30 mesh screen), bucket sieve or dip net with U.S. 30 mesh sieve material
- White enamel or plastic pan
- Plastic squeeze bulb
- Small bucket
- Wide-mouth plastic sample containers
- Permanent marker
- Buffered formalin
- Rose Bengal dye (optional)

### 2. METHODS

2.1. Use of the Ekman dredge is restricted to sampling soft substrates (silt, muck) in areas with little current. The Ponar dredge may be used for sampling under these conditions and also in areas with a harder substrate (rocks, shells, sand). The number of replicates collected is dependent upon several factors, including the area sampled by the device, the purpose of the study, and the degree of patchiness in the distribution of the organisms at the site. Routinely, take three dredges. Place all replicates in separate sample containers (for statistical analyses). If you are sampling in an exceptionally depauperate area, additional replicates may be required (pilot study needed). In that case, the number of replicates must be equal at all stations to be comparable.

2.2. When you sample from a boat, collect dredge samples from the rear and downstream of the vessel to avoid contamination of other types of samples with disturbed sediments. Rinse the box sieve with ambient water and tie it to the side of the boat where samples will be collected. When placed in the water, it will float at the surface. If a box sieve is unavailable, wash the dredged material in a dip net or bucket sieve, provided it is fitted with a U.S. 30 mesh sieve material.

#### 2.3. Dredges

2.3.1. Ekman: Open the spring-loaded jaws and attach the chains to the pegs at the top of the sampler. Lower the dredge to the bottom, making sure it settles flat. Holding the line taught, send down the messenger to close the jaws of the dredge. Pull the sampler to the surface and place it immediately into the box sieve. Carefully open the jaws and empty the contents into the sieve, rinsing to assure complete sample purging. The spring-loaded Ekman can be dangerous. Hold the dredge firmly above the hinges, and take care to not get pinched by the spring-loaded jaws, which could produce serious injury. Check to make sure the jaws are fully closed and that no sample was lost while lifting the dredge. Discard the grab if the dredge is not fully closed.

2.3.2. **Petite Ponar:** Open the jaws and place the crossbar into the proper notch. Lower the dredge to the bottom, making sure it settles flat. When tension is removed from the line, the cross-bar will drop, enabling the dredge to close as the line is pulled upward during retrieval of the dredge. Pull the sampler to the surface and place it immediately into the box sieve. Carefully open the jaws and empty the contents into the sieve, rinsing to assure complete sample purging. Check to make sure the jaws are fully closed and that no sample was lost while lifting the dredge. Discard the grab if the dredge is not fully closed.

2.4. Swirl the sieve in the water with a back-and-forth motion to wash the fine sediments through. Concentrate the remaining sample into one corner of the sieve. If a sediment type is especially clayey or mucky, it may be necessary to use a hand to break up clumps and agitate the sample to reduce it. Make sure you rinse any detritus from your hand back into the sieve.

2.5. Fill the small bucket with ambient water and use this water to fill the squeeze bulb. Using the squeeze bulb, rinse the sample from the sieve to the pan. Take care to rinse the entire contents of the sample into the pan. Some organisms may stick to the screen.

2.6. Use the squeeze bulb to transfer the sample from the pan into the pre-marked wide-mouth jug, making sure the location, date, and replicate number are accurate.

### 3. SAMPLE PRESERVATION AND HANDLING

3.1. Preserve the sample with 10% buffered formalin (see FS 7001, section 1) by adding a 9 to 1 ratio of water to 100% formalin. If laboratory processing is possible within eight hours, the samples may be stored on ice, without addition of formalin. If desired, add a very small amount of rose bengal dye (approximately 100 mg per liter of material) to the sample as a picking aid.

## **FS 7460. LAKE CONDITION INDEX (LAKE COMPOSITE) SAMPLING**

(See also *Development of Lake Condition Indices for Florida, July 2000.*)

See also the following section:

- FT 3000 Aquatic Habitat Characterization

### 1. EQUIPMENT AND SUPPLIES

- Completed Physical/Chemical Characterization Field Sheet (FD 9000-3)
- Site map
- Completed Lake Habitat Assessment Field Sheet (FD 9000-6)
- Ekman or Petite Ponar dredge (with line marked in 0.1 m graduations)
- Box sieve (constructed of fiberglass-coated wood and U.S. 30 mesh screen), bucket sieve or dip net with U.S. 30 mesh sieve material
- White enamel or plastic pan
- Plastic squeeze bulb
- Small bucket
- Wide-mouth plastic sample containers
- Tape and permanent markers

- Buffered formalin
- Rose Bengal dye (optional)
- Composite Lake Sampling Sheet (FD 9000-2)

## 2. METHODS

2.1. First, conduct lake habitat assessment according to FT 3200. If the lake has a color level exceeding 20 PCU, LCI invertebrate sampling is inappropriate.

2.2. Prior to visiting the lake, study a map of the system. For lakes less than 1,000 acres, logically divide the lake into 12 sampling units. Collect one bottom grab at a depth between 2 m and 4 m from each of these 12 units. The 12 dredges will be composited into a single sample. For lakes larger than 1,000 acres, divide the lake into two to four major sampling divisions. Collect 12 composited dredge bottom grabs from each major division. Take a copy of the map on the sampling trip so you can mark the location of each benthic grab on the map. Number each major sampling division. Mark the location of each of the 12 benthic grabs within each major sampling division on the map.

2.3. When sampling from a boat, collect dredge samples from the rear and downstream of the vessel to avoid contamination of other types of samples with disturbed sediments. Rinse the box sieve with ambient water and tie it to the side of the boat where samples will be collected. When placed in the water, it will float at the surface. If a box sieve is unavailable, wash the dredged material in a dip net or bucket sieve, provided it is fitted with a U.S. 30 mesh sieve material.

### 2.4. Dredges

2.4.1. Ekman: Open the spring-loaded jaws and attach the chains to the pegs at the top of the sampler. Lower the dredge to the bottom, making sure it settles flat. Using the graduated line, check to make sure the depth is between two and four meters. Record the depth on the Composite Lake Sampling Sheet (FD 9000-2). Holding the line taught, send down the messenger to close the jaws of the dredge. Pull the sampler to the surface and place it immediately into the box sieve. Carefully open the jaws and empty the contents into the sieve, rinsing to assure complete sample purging. Record the gear type used on FD 9000-2. The spring-loaded Ekman can be dangerous. Hold the dredge firmly above the hinges, and take care to not get pinched by the spring-loaded jaws, which could produce serious injury. Check to make sure the jaws are fully closed and that no sample was lost while lifting the dredge. Discard the grab if the dredge is not fully closed.

2.4.2. Petite Ponar: Open the jaws and place the crossbar into the proper notch. Lower the dredge to the bottom, making sure it settles flat. Using the graduated line, check to make sure the depth is between two and four meters. Record the depth on FD 9000-2. When tension is removed from the line, the cross-bar will drop, enabling the dredge to close as the line is pulled upward during retrieval of the dredge. Pull the sampler to the surface and place it immediately into the box sieve. Carefully open the jaws and empty the contents into the sieve, rinsing the dredge to assure complete sample purging. Record the gear type used on FD 9000-2. Check to make sure the jaws are fully closed and that no sample was lost while lifting the dredge. Discard the grab if the dredge is not fully closed.

2.5. Examine the sediment and document its visual characteristics on FD 9000-2. Swirl the box sieve in the water with a back-and-forth motion to wash the fine sediments through. Concentrate the remaining sample into one corner of the sieve. If a sediment type is

DEP-SOP-001/01  
FS 7000 General Biological Community Sampling

especially clayey or mucky, it may be necessary to use a hand to break up clumps and agitate the sample to reduce it. Make sure you rinse any detritus from your hand back into the sieve.

2.6. Fill the small bucket with ambient water and use this water to fill the squeeze bulb. Using the squeeze bulb, rinse the sample from the sieve to the pan. Take care to rinse the entire contents of the sample into the pan. Some organisms may stick to the screen.

2.7. Use the squeeze bulb to transfer the sample from the pan into the pre-marked wide-mouth jug, making sure the location and date are accurate.

2.8. Repeat steps 2.2-2.6 until 12 benthic grabs have been taken, as determined during step 2.2. If material from all 12 dredges will not fit in one jug, use additional jugs, clearly marked as being part of the same sample (jug 1 of 2, jug 2 of 2).

3. SAMPLE PRESERVATION AND HANDLING

3.1. Preserve the sample with 10% buffered formalin (see FS 7001, section 1) by adding a 10 to 1 ratio of water to 100% formalin. If desired, add a very small amount of rose bengal dye (approximately 100 mg per liter of material) to the samples as a picking aid.

**Appendix FS 7000**  
**Figures, Tables and Forms**

Form FD 9000-1: Biorecon Field Sheet

Form FD 9000-2: Composite Lake Sampling Sheet (< 1000 ACRES)

Form FD 9000-7: Lake Vegetation Index Data Sheet

Form FD 9000-8: Rapid Periphyton Survey Sheet

Table FS 7000-1: Maximum Number of Specimens Retained for Biorecon Identification

DEP-SOP-001/01  
FS 7000 General Biological Community Sampling

**Form FD 9000-1: Biorecon Field Sheet**

<b>STORET Station</b>	<b>Location</b>
<b>Latitude: N</b> ° ' " <b>Longitude: W</b> ° ' "	<b>Watershed / Basin</b>
<b>Date/Time Collected</b>	<b>Collected, &amp; Sorted By:</b>
<b>types of habitats sampled</b>	<b>QC'd By:</b>

\*\* Rare (1-3), Common (4-10), Abundant (11-100), Dominant (>100).

Taxa	Tally	Abun Code	Taxa	Tally	Abun Code	Taxa	Tally	Abun Code
<b>Diptera</b>			<b>Trombidiformes</b>			<b>Ephemeroptera</b>		
Ceratopogonidae			Acarina			Acerpenna pygmaea		
Culicidae			<b>Oligochaeta</b>			Baetidae		
Empididae			Naiidae			Baetis sp.		
Chironomidae			Lumbriculidae			Baetisca sp.		
Simulium sp.			Tubificidae			Brachycercus sp.		
Stratiomyidae			<b>Hirudinea</b>			Caenis sp.		
Tipulidae			<b>Pelecypoda</b>			Callibaetis sp.		
			Corbicula fluminea			Centroptilum sp.		
			Elliptio sp.			Heptagenia sp.		
			Pisidiidae			Hexagenia sp.		
						Isonychia sp.		
<b>Gastropoda</b>			<b>Megaloptera</b>			Leptophlebia sp.		
Ancylidae			Corydalus cornutus			Neophemera sp.		
Elimia sp.			Sialis sp.			Stenacron sp.		
Physella sp.						Stenonema sp.		
Pomacea sp.			<b>Hemiptera</b>			Tricorythodes sp.		
Planorbella sp.			Belostoma sp.					
Hydrobiidae			Corixidae					
Viviparus sp.			Gerridae			<b>Plecoptera</b>		
Melanoides tuberculata			Hydrometra sp.			Acroneuria sp.		
			Pelocoris sp.			Amphinemura sp.		
			Pleidae			Hydroperla sp.		
<b>Odonata</b>			Ranatra sp.			Isoperla sp.		
Argia sp.			Velidae			Leuctra sp.		
Aeschnidae						Neoperla sp.		
Boyeria vinos.			<b>Other (name groups)</b>			Paragnetina sp.		
Calopteryx sp.						Perlesta sp.		
Enallagma sp.						Perlinella sp.		
Epitheca sp.						Pteronarcys sp.		
Erythemis simplicicollis						Taeniopteryx sp.		
Gomphus sp.						Talloperla sp.		
Hetaerina sp.								
Ischnura sp.								
Libellulidae						<b>Trichoptera</b>		
Macromia sp.						Anisocentropus sp.		
Neurocordulia sp.						Brachycentrus sp.		
Progomphus sp.						Cernotina sp.		
Pachydiplax longipennis						Cheumatopsyche sp.		
			<b>Decapoda</b>			Chimarra sp.		
			Palaemonetes sp.			Diplectrona sp.		
<b>Coleoptera</b>			Procambarus sp.			Hydroptila sp.		
Ancyronyx variagata						Hydropsyche sp.		
Curculionidae						Lype diversa		
Dineutus sp.			<b>Amphipoda</b>			Macrostemum sp.		
Dubiraphia vittata			Gammarus sp.			Nectopsyche sp.		
Dytiscidae			Hyalella azteca			Oecetis sp.		
Gyretes sp.			Crangonyx sp.			Oxyethira sp.		
Microcylloepus pusillus						Polycentropus sp.		
Stenelmis sp.			<b>Isopoda</b>			Trienodes sp.		
			Caecidotea (Asellus) sp.					
<b>Column Total: Taxa</b>			<b>Column Total: Taxa</b>			<b>Column Total: Taxa</b>		

**NOTE:** The Biorecon field data sheet is to be used as an aid during sampling and organism field sorting. The calculated metrics should be retrieved from the Florida Statewide Biological Database or the same counting and collapsing procedures used, as described in LT 7100.

DEP-SOP-001/01  
FS 7000 General Biological Community Sampling

**Form FD 9000-2: COMPOSITE LAKE SAMPLING SHEET (< 1000 ACRES)**

<b>Date:</b>		<b>Name of Lake:</b>		<b>Gear used:</b>		<b>PONAR</b>	<b>EKMAN</b>	<b>OTHER</b>
<b>Comments:</b>								
<b>Drop #</b>	<b>Depth (m)</b>	<b>Sediment Type (circle all that apply)</b>			<b>Drop #</b>	<b>Depth (m)</b>	<b>Sediment Type (circle all that apply)</b>	
1		sand, silt/clay, CPOM, muck, SAV			7		sand, silt/clay, CPOM, muck, SAV	
2		sand, silt/clay, CPOM, muck, SAV			8		sand, silt/clay, CPOM, muck, SAV	
3		sand, silt/clay, CPOM, muck, SAV			9		sand, silt/clay, CPOM, muck, SAV	
4		sand, silt/clay, CPOM, muck, SAV			10		sand, silt/clay, CPOM, muck, SAV	
5		sand, silt/clay, CPOM, muck, SAV			11		sand, silt/clay, CPOM, muck, SAV	
6		sand, silt/clay, CPOM, muck, SAV			12		sand, silt/clay, CPOM, muck, SAV	

CPOM = coarse particulate organic matter; SAV = submerged aquatic vegetation

Paste map here and show location of each dredge drop and where water chemistry parameters were collected.

DEP-SOP-001/01  
FS 7000 General Biological Community Sampling

**Table FS 7000-1:  
MAXIMUM NUMBER OF SPECIMENS RETAINED FOR BIORECON IDENTIFICATION**

Taxon	Target # to Pick
<b>Oligochaeta</b>	5
<b>Acarina</b>	5
<b>Hirudinea</b>	5
<b>Ephemeroptera</b>	
Baetidae	15
Baetiscidae	15
Behningiidae	5
Caenidae	15
Ephemeridae	15
Ephemerellidae	15
Heptageniidae	15
Isonychiidae	5
Leptohyphidae	15
Leptophlebiidae	15
Metretopodidae	5
Neophemeridae	15
Oligoneuriidae	5
Polymitarcyidae	5
Pseudironiidae	5
<b>Odonata</b>	15
<b>Trichoptera</b>	
Beraeidae	5
Brachycentridae	5
Calamoceratidae	5
Dipseudopsidae	5
Glossomatidae	5
Helicopsychidae	5
Hydropsychidae	15
Hydroptilidae	15
Lepidostomatidae	15
Leptoceridae	15
Limnephilidae	5
Molannidae	5
Odontoceridae	5
Philopotamidae	5
Phryganeidae	5
Polycentropodidae	15
Psychomyiidae	5
Rhyacophilidae	5
Sericostomatidae	5
Uenoidae	5

Taxon	Target # to Pick
<b>Plecoptera</b>	
Capniidae	15
Chloroperlidae	15
Leuctridae	15
Nemouridae	5
Peltoperlidae	5
Perlidae	15
Perlodidae	15
Pteroncyidae	5
Taeniopterygidae	5
<b>Hemiptera (any)</b>	5
<b>Megaloptera (any)</b>	5
<b>Neuroptera</b>	
<b>Diptera (of any other kind)</b>	5
Ceratopogonidae	5
Chaoboridae	5
Empididae	5
<b>Collembola</b>	5
<b>Amphipoda</b>	15
<b>Decapoda</b>	5
<b>Isopoda</b>	5
<b>Gastropoda</b>	15
<b>Pelecypoda</b>	5
<b>Lepidoptera</b>	5
<b>Coleoptera</b>	
Chrysomelidae	5
Dryopidae	5
Dytiscidae	15
Elmidae	15
Gyrinidae	5
Haliplidae	5
Hydraenidae	5
Hydrophilidae	15
Noteridae	5
Psephenidae	5
Ptilodactylidae	5
Scirtidae	5

DEP-SOP-001/01  
FS 7000 General Biological Community Sampling

**Form FD 9000-8: Rapid Periphyton Survey Field Sheet**

FDEP Rapid Periphyton Survey 4-19-07																	
Site:						Date:		Investigator:									
Transect (m)	Point	Algae Sampled?		Algal Thickness		Algae Type	Canopy	Transect (m)	Point	Algae Sampled?		Algal Thickness		Algae Type	Canopy		
		Y	N	NV	V					(0-1)	(1-5)	Y	N			NV	V
0	1	Y	N			F	D	O	60	1	Y	N			F	D	O
	2	Y	N			F	D	O		2	Y	N			F	D	O
	3	Y	N			F	D	O		3	Y	N			F	D	O
	4	Y	N			F	D	O		4	Y	N			F	D	O
	5	Y	N			F	D	O		5	Y	N			F	D	O
	6	Y	N			F	D	O		6	Y	N			F	D	O
	7	Y	N			F	D	O		7	Y	N			F	D	O
	8	Y	N			F	D	O		8	Y	N			F	D	O
	9	Y	N			F	D	O		9	Y	N			F	D	O
10	1	Y	N			F	D	O	70	1	Y	N			F	D	O
	2	Y	N			F	D	O		2	Y	N			F	D	O
	3	Y	N			F	D	O		3	Y	N			F	D	O
	4	Y	N			F	D	O		4	Y	N			F	D	O
	5	Y	N			F	D	O		5	Y	N			F	D	O
	6	Y	N			F	D	O		6	Y	N			F	D	O
	7	Y	N			F	D	O		7	Y	N			F	D	O
	8	Y	N			F	D	O		8	Y	N			F	D	O
	9	Y	N			F	D	O		9	Y	N			F	D	O
20	1	Y	N			F	D	O	80	1	Y	N			F	D	O
	2	Y	N			F	D	O		2	Y	N			F	D	O
	3	Y	N			F	D	O		3	Y	N			F	D	O
	4	Y	N			F	D	O		4	Y	N			F	D	O
	5	Y	N			F	D	O		5	Y	N			F	D	O
	6	Y	N			F	D	O		6	Y	N			F	D	O
	7	Y	N			F	D	O		7	Y	N			F	D	O
	8	Y	N			F	D	O		8	Y	N			F	D	O
	9	Y	N			F	D	O		9	Y	N			F	D	O
30	1	Y	N			F	D	O	90	1	Y	N			F	D	O
	2	Y	N			F	D	O		2	Y	N			F	D	O
	3	Y	N			F	D	O		3	Y	N			F	D	O
	4	Y	N			F	D	O		4	Y	N			F	D	O
	5	Y	N			F	D	O		5	Y	N			F	D	O
	6	Y	N			F	D	O		6	Y	N			F	D	O
	7	Y	N			F	D	O		7	Y	N			F	D	O
	8	Y	N			F	D	O		8	Y	N			F	D	O
	9	Y	N			F	D	O		9	Y	N			F	D	O
40	1	Y	N			F	D	O	100	1	Y	N			F	D	O
	2	Y	N			F	D	O		2	Y	N			F	D	O
	3	Y	N			F	D	O		3	Y	N			F	D	O
	4	Y	N			F	D	O		4	Y	N			F	D	O
	5	Y	N			F	D	O		5	Y	N			F	D	O
	6	Y	N			F	D	O		6	Y	N			F	D	O
	7	Y	N			F	D	O		7	Y	N			F	D	O
	8	Y	N			F	D	O		8	Y	N			F	D	O
	9	Y	N			F	D	O		9	Y	N			F	D	O
50	1	Y	N			F	D	O	<b>Algal Thickness Rank</b>								
	2	Y	N			F	D	O	0	1	2	3	4	5			
	3	Y	N			F	D	O	0 mm	<0.5 mm	0.5-1 mm	>1 to <6 mm	6-20 mm	>20 mm			
	4	Y	N			F	D	O	rough	or slimy							
	5	Y	N			F	D	O	Bottom Visible? If "N", add comment to "Notes" section whether water is dark, turbid, deep, etc.								
	6	Y	N			F	D	O	Algal Thickness: NV = Not Visible			V = Visible					
	7	Y	N			F	D	O	Algae Type: F = Filamentous			D = Diatoms					
	8	Y	N			F	D	O	O = Other								
	9	Y	N			F	D	O									
Notes:																	



DEP-SOP-001/01  
FS 7000 General Biological Community Sampling

SPECIES	C of C	1	2	3	4	Specimen collected (check)	Approx. water depth	SPECIES	C of C	1	2	3	4	Specimen collected (check)	Approx. water depth
Nuphar sp.	4.64							Solanum tampicense(1)	0.00						
Nymphaea odorata	7.18							Sparganium americanum	6.50						
Nymphoides aquatica	6.09							Spartina alterniflora	7.94						
Nyssa sylvatica var. biflora	9.04							Spartina bakeri	5.98						
Orontium aquaticum	8.39							Spirodela polyrhiza	2.95						
Osmunda cinnamomea	6.44							Spirodela punctata	none						
Osmunda regalis	8.04							Taxodium ascendens	7.21						
Panicum hemitomon	5.82							Taxodium distichum	7.21						
<b>Panicum repens(1)</b>	0.00							Thalia geniculata	7.12						
Paspalidium geminatum	6.36							Thelypteris palustris	none						
Paspalum distichum	5.54							Triadenum virginicum	8.16						
Paspalum repens	6.69							Typha sp.	1.60						
Paspalum urvillei	0.00							Utricularia biflora	6.37						
Peltandra virginica	7.31							Utricularia floridana	6.34						
<b>Pennisetum purpureum(1)</b>	0.00							Utricularia foliosa	6.44						
Phragmites australis	4.39							Utricularia inflata	5.85						
Pinus elliotii	4.21							Utricularia purpurea	6.50						
<b>Pistia stratioides(1)</b>	0.00							Utricularia cornuta	7.46						
Pluchea odorata	4.96							Utricularia radiata	6.01						
Pluchea rosea	5.45							Vallisneria americana	7.28						
Polygonum densiflorum	5.32							Websteria confervoides	none						
Polygonum hydropiperoides	4.02							<b>Wedelia trilobata(2)</b>	0.00						
Polygonum punctatum	4.02							Wolffiella spp.	4.37						
Pontederia cordata	5.38							Woodwardia virginica	6.5						
Potamogeton diversifolius	7.15							Zizania aquatica	6.69						
Potamogeton illinoensis	6.64							Zizaniopsis milacea	6.21						
Potamogeton pusillus	7.80														
Potamogeton pectinatus	7.80														
Proserpinaca pectinata	5.50														
Rhynchospora microcarpa	5.29														
Rhynchospora microcephala	6.50														
Rhynchospora tracyi	9.03														
Riccia fluitans	4.64														
Ricciocarpus natans	4.55														
Ruppia maritima	7.24														
Sabal palmetto	4.85														
Sabatia grandiflora	7.09														
Sacciolepis striata	5.35														
Sagittaria kurziana	9.75														
Sagittaria lancifolia	4.96														
Sagittaria latifolia	6.50														
Sagittaria graminea	5.53														
Salix carolina	2.95														
Salvinia minima	2.03														
Sambucus canadensis	1.48														
<b>Sapium sebiferum(1)</b>	0.00														
Saururus cernuus	7.33														
<b>Schinus terebinthifolius(1)</b>	0.00														
Scirpus americanus	6.50														
Scirpus californicus	6.01														
Scirpus cubensis	3.77														
Scirpus validus	5.55														

## **FS 8100. Contaminated Surface Sampling**

Use in conjunction with:

- FA 1000 Regulatory Scope and Administrative Procedures for Use of DEP SOPs
- FC 1000 Cleaning/Decontamination Procedures
- FD 1000 Documentation Procedures
- FM 1000 Field Planning and Mobilization
- FQ 1000 Field Quality Control Requirements
- FS 1000 General Sampling Procedures

### 1. SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) outlines the recommended protocol and equipment for collection of chip, wipe and sweep samples to monitor potential surficial contamination. Use these sampling protocols to determine if hazardous constituents have contaminated various surfaces or to evaluate the effectiveness of decontamination procedures. These sampling techniques are only applicable to non-volatile analytes.

- 1.1. Wipe samples are collected from smooth, non-absorbent surfaces.
- 1.2. Chip sampling is conducted on porous surfaces and is generally accomplished with a hammer and chisel.
- 1.3. Sweep sampling is used to collect dust or residue on porous or non-porous surfaces.

### 2. GENERAL CAUTIONS

- 2.1. Inform sampling personnel of the hazards associated with the selected solvent used for wipe samples and train them in taking appropriate precautions to prevent skin contact or inhalation of these solvents.
- 2.2. Ensure that the wipe material is compatible with the solvent used and the analyses to be performed and does not come apart during use.
- 2.3. Sample size is determined by the detection limit desired and the amount of sample requested by the laboratory.
- 2.4. Since surface situations vary widely, the method and implements used must be tailored to suit a specific sampling site. In all instances, the ultimate procedures employed must be documented.
- 2.5. These methods have few potential problems; the main concern is obtaining representative samples from irregular, porous surfaces.

### 3. EQUIPMENT AND SUPPLIES

- 3.1. Select sampling equipment based on the analytes of interest, the specific equipment use and the available equipment. Construction materials of the sampling equipment must conform to FS 1000, Tables FS 1000-1 and FS 1000-2.
- 3.2. Clean all sampling equipment and obtain clean sample containers using the appropriate protocols specified in FC 1000.
- 3.3. After appropriate decontamination wrap the equipment in new aluminum foil. Use each sampling device for only one sample, where practical.

## **FS 8110. SAMPLING TECHNIQUES**

Typical sample area is one square foot. However, based upon sampling location, the sample size may need modification due to area configuration.

1. **WIPE SAMPLING:** Wipe sampling is accomplished by using a sterile gauze pad (cotton balls when collecting samples for PCBs), saturating the gauze or cotton balls with a solvent in which the contaminant is most soluble and that does not interfere with the analysis, and then wiping a premeasured sample area. Package gauze pad in an amber sample jar to avoid photodegradation.

- 1.1. Choose appropriate sampling points and measure the designated sampling area.
- 1.2. Record surface area to be wiped.
- 1.3. Wearing a new pair of disposable surgical gloves, open a new sterile package of gauze pad or other appropriate sterilized material and soak the material with the appropriate solvent.
- 1.4. Wipe the sample vertically, and then horizontally, using firm strokes ensuring that the entire surface area is covered.
- 1.5. Place the gauze pad in a precleaned sample container with a Teflon-lined cap.
- 1.6. Place the cap on the sample container, secure the label and custody seal, if applicable, and place the container in a plastic bag.
- 1.7. Store the samples out of direct sunlight and cool to 4°C.

2. **CHIP SAMPLING:** Employed for sampling porous surfaces.

- 2.1. Choose appropriate sampling points and measure the designated sampling area.
- 2.2. Record surface area to be chipped.
- 2.3. Wearing a new pair of disposable surgical gloves, remove a laboratory-cleaned chisel or equivalent sampling device from its wrapping.
- 2.4. Using a precleaned hammer, chip the sample area horizontally and then vertically to an even depth of approximately 1/8 inch.
- 2.5. Place the sample in a precleaned sample container with a Teflon-lined cap.
- 2.6. Place the cap on the sample container, secure the label and custody seal, if applicable, and place the container in a plastic bag.
- 2.7. Store the samples out of direct sunlight and cool to 4°C.

3. **SWEEP SAMPLING:** This technique is appropriate for bulk contamination. A dedicated, hand held sweeper brush is used to collect a sample from a premeasured area.

- 3.1. Choose appropriate sampling points and measure the designated sampling area.
- 3.2. Record surface area to be swept.
- 3.3. Wearing a new pair of disposable surgical gloves, sweep the measured area using a dedicated brush and collect the sample in a dedicated dustpan.
- 3.4. Transfer the sample from the dustpan to the sample container.
- 3.5. Place the cap on the sample container, secure the label and custody seal, if applicable, and place the container in a plastic bag.

- 3.6. Store the samples out of direct sunlight and cool to 4°C.

**FS 8120. DOCUMENTATION**

1. Immediately following sample collection, identify each sample container with a unique field identification code.
2. Record the size and shape of the area sampled.
3. Record site-specific sampling information while still at the site and meet all of the requirements specified in FD 1000.

**FS 8130. SAMPLE TRANSPORT AND HANDLING**

Store the samples out of direct sunlight and cool to 4°C.

**FS 8140. QUALITY ASSURANCE**

1. WIPE SAMPLES
  - 1.1. Collect a blank for each sampling event. Saturate a sterile gauze pad with the project solvent and place it in a prepared sample container. Handle the blank in the exact same manner as the samples.
  - 1.2. Optionally spiked wipe samples can be collected. Prepare these by spiking a measured piece of foil. Allow the solvent containing the standard to evaporate, and collect the sample from the foil surface as described in FS 8110, section 1.
2. See FQ 1000 for quality control protocols for chip and sweep samples.

## **FS 8200. Clean Sampling for Ultratrace Metals in Surface Waters**

Use in conjunction with:

- FA 1000 Regulatory Scope and Administrative Procedures for Use of DEP SOPs
- FD 1000 Documentation Procedures
- FM 1000 Field Planning and Mobilization
- FQ 1000 Field Quality Control Requirements
- FS 1000 General Sampling Procedures
- FS 2000 General Aqueous Sampling
- FS 2100 Surface Water Sampling

### 1. INTRODUCTION AND SCOPE

This procedure is designed for the collection of ambient water samples for the determination of total and dissolved metals at concentrations listed in Table FS 8200-1 and for the collection of other metals and metal species amenable to determination at ultratrace levels. Use these protocols only when the “clean hands, dirty hands” sampling procedures are specifically stipulated in the permit, consent order or as part of the project data quality objectives. This method is not intended for determination of metals normally found in treated and untreated discharges from industrial facilities. Actual concentration ranges to which this guidance is applicable will depend on the sample matrix, dilution levels and other laboratory operating conditions.

- 1.1. Filter samples for dissolved metal determinations through a 0.45 µm capsule filter at the field site.
- 1.2. The ease of contamination of ambient waters with metals cannot be over emphasized. Follow this method closely to avoid contamination. It is based on EPA Method 1669.
- 1.3. This procedure is “performance-based”, and emphasizes that the modification of procedure or technique is allowed as long as neither samples nor blanks are artificially contaminated when using the modified procedures. Thoroughly evaluate any modifications by demonstrating effective collection of field samples.
  - 1.3.1. Modify the procedures below as applicable to the level of effort required for the analytical objectives of the project. Ensure that the modified procedures have been approved by all parties to the project, including DEP permitting or other regulatory authorities.
  - 1.3.2. Document the collection of uncontaminated samples, equipment blanks and other applicable quality control samples using the modified procedures.
- 1.4. The procedures in this SOP are for use only by personnel thoroughly trained in the collection of samples for determination of metals at ambient water quality levels. Documentation of training must be kept on file and readily available for review.

### 2. CONTAMINATION AND INTERFERENCES

- 2.1. Contamination Problems in Ultratrace Metals Analysis

2.1.1. Take extreme care to avoid contamination when collecting water samples for ultratrace metals.

2.1.2. Potential sources of contamination during field activities include metallic or metal-containing equipment or containers (e.g., talc gloves that contain high levels of zinc), decontamination reagents including analyte-free water, improperly cleaned and stored equipment, and atmospheric inputs such as dirt, dust, automobile exhaust, cigarette smoke and nearby structures (roads, bridges, wires, poles).

## 2.2. Avoiding Contamination

Avoid exposing the sample and sampling apparatus to contamination by being acutely aware of potential sources of contamination and paying strict attention to work being performed.

2.2.1. To minimize atmospheric input open or expose all equipment that will contact samples or blanks in a clean room, clean bench, glove box or clean plastic bag. Keep the amount of time between cleaning and use as short as possible. When not in use, cover equipment with clean plastic wrap, store in the clean bench or in a plastic box or glove box, or bag in clean, colorless zip-type bags.

2.2.2. Field personnel must wear clean non-talc gloves during all activities involving handling of sampling equipment. Change gloves that are contaminated by touching an unclean object or substance. Consider wearing multiple pairs of gloves to allow stripping of the outer pair to facilitate the sampling operation.

### 2.2.3. Approved Construction Materials of Sampling Equipment

2.2.3.1. Use only materials and equipment of approved construction (see FS 8210).

2.2.3.2. Do not allow the following materials to come in contact with the sample or be used to hold liquids that come in contact with the sample: Pyrex, Kimax, methacrylate, polyvinylchloride, nylon or Vycor. Do not use highly colored plastics, paper cap liners, pigments used to mark increments on plastics, and rubber, all contain trace levels of metals.

### 2.2.4. Sources of Contamination

2.2.4.1. Collect samples from expected lowest concentrations to the highest concentrations where this information is known.

2.2.4.2. Do not collect, process or ship samples containing high levels of metals at the same time as samples being collected for ultratrace metals determinations.

2.2.4.3. Collect sample as far as possible from airborne contamination. Avoid if possible or take precautions in areas of bare soil subject to wind erosion, airborne dust or dirt, particulate matter, or vapors from automobile, small engines or cigarette smoke as well as nearby bridges, pipes, poles or wires.

2.2.5. Sample Interferences: If a sample is suspected of containing substances that interfere with the analyses of trace metals at these levels, collect sufficient sample to allow the laboratory to identify and overcome the interference problems.

2.2.6. Decontaminate sampling equipment according to procedures detailed in FS 8220.

## **FS 8210. EQUIPMENT AND SUPPLIES**

All equipment (sample containers, dippers, tubing, etc.) coming in direct contact with the sample must be free of the metal(s) of interest. Use materials constructed of fluoropolymers such as fluorinated ethylene propylene (FEP) and polytetrafluoroethylene (PTFE), conventional or linear polyethylene, polycarbonate, polypropylene or ultrapure quartz.

Package and arrange the equipment to minimize field preparations. Any preparations or cleaning done in the field must be done in a way that minimizes the possibility of contamination. See FS 8200, section 2.2.

### 1. SAMPLE CONTAINERS

1.1. Fluoropolymer (FEP, PTFE), conventional or linear polyethylene, polycarbonate, or polypropylene construction material. Use fluoropolymer or glass containers if mercury is a target analyte.

1.2. Decontaminated sample containers must be filled with 0.1% hydrochloric acid (volume/volume, v/v). Prior to shipping to the field site the acid may be emptied and the containers filled with reagent water.

### 2. SUPPORT EQUIPMENT

- Gloves: Clean, non-talc polyethylene, latex, vinyl or polyvinylchloride (PVC).
- Shoulder-length gloves: Clean, non-talc polyethylene, latex, vinyl or PVC.
- Plastic wrap: Clean, colorless polyethylene.
- Storage bags: Plastic, colorless, reclosable.
- Cooler: Non-metallic.
- Ice to keep samples chilled during storage.
- Carboy for collection and storage of dilute waste acids, if necessary.
- Boom: A PVC or plastic rod, pole or other extension used to support or guide the sampling apparatus to the sampling location.
- Field portable glove bag or a field glove box constructed of a non-metallic frame and a cover for the frame of inexpensive, disposable, non-metallic material.

### 3. SAMPLING EQUIPMENT

3.1. Filtration apparatus: Required when collecting samples for dissolved metals. In line 0.45 micron, 15 mm diameter or larger, tortuous path capsule filters.

#### 3.2. Pump and Pump Apparatus

3.2.1. Required for use with the jar sampling system or the continuous flow system. Use a peristaltic or equivalent pump. Equivalent pumps include rotary vacuum, submersible, or other pumps free from metals and suitable to meet the site-specific depth sampling needs.

#### 3.2.2. Tubing

3.2.2.1. Tubing for use with peristaltic pump: Styrene/ethylene/butylene/silicone (SEBS) resin.

3.2.2.2. Tubing for connection to peristaltic pump tubing – fluoropolymer in lengths required to reach the sampling point, taking into consideration the distance required if a boom is used.

3.2.2.3. Tubing connectors: Appropriately sized PVC, clear polyethylene, or fluoropolymer barbed straight connectors used to connect multiple lengths of tubing.

3.3. Grab sampler: Used where depth profiling is not a concern.

3.3.1. Polyethylene pole with a fluoropolymer collar to hold the sample container. A fluoropolymer closing mechanism threaded on to the sample container triggered by a Teflon string that allows opening and closing the container underwater avoiding surface contamination. Components must be made of other acceptable construction materials as detailed in the opening paragraph of this section.

3.3.2. A grab sampler that allows the collection of a discrete water sample and is constructed so that a capped clean sample container can be submerged, the cap removed, and the bottle recapped at a selected depth. This device eliminates contact with conventional sampling devices and eliminates carry over from previous samples.

3.4. Subsurface sampling devices: Appropriate for use in lakes and low flow river systems where depth profiling is necessary.

3.4.1. Jar Sampler

3.4.1.1. Consists of a heavy fluoropolymer 1 liter jar with a fluoropolymer lid equipped with two fluoropolymer fittings. Sample enters the jar by pumping on fluoropolymer tubing attached to one fitting causing the sample to be drawn through the other fitting. A thick fluoropolymer plate supports the jar and allows for attachment of a fluoropolymer torpedo weight.

3.4.1.2. Advantages to the jar sampler:

- The suction device is located in an area remote from the sampling jar.
- The sampling jar can be rinsed with sample.
- There is not a long length of tubing, eliminating the need for decontamination.
- Eliminates atmospheric contact with the sample.

3.4.2. Continuous Flow Sampler

3.4.2.1. Consists of a peristaltic or submersible pump and associated fluoropolymer tubing. A boom may be used to separate the sampling personnel from the equipment and sampling location. A filter is added to the sampling train when collecting dissolved metals.

3.4.2.2. Advantages to the continuous flow sampler:

- Surfaces are easily decontaminated.
- Pump is isolated from the sample bottle.
- In-line filtration is possible.

## **FS 8220. EQUIPMENT DECONTAMINATION PROCEDURES**

### 1. INTRODUCTION AND SCOPE

- 1.1. Strictly follow the procedures outlined in this SOP to ensure that the equipment, reagents, and sample containers brought and used in the field for the purpose of collecting samples for ultratrace metals analyses have been properly decontaminated.
- 1.2. Take care with the storage of the decontaminated equipment. If you notice any indications that the equipment is not clean and an assessment indicates that there has been the possibility the apparatus is contaminated, immediately stop sampling and return the affected equipment for decontamination.
- 1.3. If equipment and field blanks produced from a less rigorous protocol than those detailed in this SOP show no levels of analytes above the method detection limit (MDL) or other source of interference, then these alternative protocols may be used. Maintain complete documentation of the procedure and demonstration of its effectiveness.

### 2. GENERAL REQUIREMENTS

- 2.1. Clean all sampling equipment and sample containers in a designated cleaning area that has been demonstrated to be free of trace element contaminants. This area may be a class 100 clean room, clean benches or a designated equipment cleaning area.
- 2.2. Use new gloves, storage bags and plastic wrap without additional cleaning unless evidence from the blanks indicates they are a source of contamination. In such a case, find an alternative supplier or decontaminate the materials.
- 2.3. After decontamination store each piece of sampling equipment in a clean, single polyethylene zip-type polyethylene bag. Use a second polyethylene bag if shipment is required.
- 2.4. Periodically monitor all cleaning solutions and acid baths for accumulation of metals. When the levels become too high change the solutions and baths and neutralize and discard in compliance with local, state and federal regulations.

## **FS 8221. *Decontamination Equipment and Supplies***

### 1. EQUIPMENT

- 1.1. Buckets or Basins: 5 to 50 L capacity for acid soaking of equipment.
- 1.2. Gloves: Non-talc polyethylene, latex or vinyl. Wear heavy gloves should be worn when working in the acid baths since baths will contain hot, strong acids.
- 1.3. Tongs: For removal of sampling equipment from acid baths. Do not use coated metal tongs.
- 1.4. Brushes: Non-metallic for scrubbing equipment.
- 1.5. Wash bottles: FEP (fluorinated ethylene propylene) or equivalent with screw closure.
- 1.6. Storage bags: Zip-type, non-vented, colorless polyethylene.
- 1.7. Plastic wrap: Clean, colorless polyethylene.

2. REAGENTS: Use only trace metal grade acids for cleaning equipment and supplies. If the purity of a reagent is in question, it must be analyzed and the concentration determined to be below the method detection limit.

- 2.1. Nitric acid: Concentrated (specific gravity 1.41).
- 2.2. Diluted nitric acid: Used for field decontamination.
- 2.3. Nitric acid (1+1): Add 500 mL concentrated nitric acid to 400 mL of reagent grade water and dilute to 1 L with reagent grade water.
- 2.4. Hydrochloric acid: 1N and 4N.
- 2.5. Hydrochloric acid: 0.1% (v/v) ultrapure grade.
- 2.6. Hydrochloric acid: 1% and 0.4% (v/v).
- 2.7. Hydrochloric acid: 10% by weight, trace metal grade.
- 2.8. Alkaline detergent: Liquinox, Alconox or equivalent.

**FS 8222.** *Decontamination Protocols for Sampling Equipment and Sample Containers*

1. DECONTAMINATION IN DESIGNATED CLEANING AREAS

1.1. Sampling Equipment

- 1.1.1. Fill a precleaned bucket or basin with a sufficient quantity of 0.5% solution of liquid detergent. Completely immerse each piece of equipment. Soak for 30 minutes.
- 1.1.2. Thoroughly scrub down all materials with the detergent using a pair of clean gloves and a clean non-metallic brush.
- 1.1.3. Change gloves and place the scrubbed equipment in another precleaned bucket or basin. Rinse all equipment (inside and out) with reagent grade water until there is no sign of detergent residue.
- 1.1.4. Change gloves and place the equipment in a hot bath (50-60°C) of concentrated nitric acid. Allow to soak for 2 hours.
- 1.1.5. Use clean gloves and tongs to remove the equipment and thoroughly rinse with reagent grade water.
- 1.1.6. Change gloves and immerse the equipment in a hot (50-60°C) bath of 1N trace metal grade hydrochloric acid. Soak for 48 hours.
- 1.1.7. Thoroughly rinse all equipment with analyte-free water.
- 1.1.8. Air dry in a class 100 clean bench or other designated clean area.
- 1.1.9. Wrap each piece of equipment in two layers of polyethylene film.

1.2. Sample Containers (all metals except mercury)

- 1.2.1. After cleaning (steps 1.1.1-1.1.8 of this section), fill each bottle with 0.1% (v/v) ultrapure hydrochloric acid and cap tightly.
- 1.2.2. Double bag each bottle in a zip-type polyethylene bag and store at room temperature.

1.3. Procedures for Mercury Sample Containers

- 1.3.1. Clean new bottles by heating at 65-75°C in 4N hydrochloric acid for at least 48 hours.

1.3.2. Cool and rinse bottles three times with analyte-free water and fill with 1% hydrochloric acid solution.

1.3.3. Cap the bottles, place in an oven at 60-70°C and leave overnight.

1.3.4. Cool the bottles, rinse three more times in analyte-free water and fill the bottles with 0.4% (v/v) hydrochloric acid. Place the bottles in a mercury-free class 100 clean bench or other designated clean area until dry.

1.3.5. Tightly cap the bottles, double bag in new polyethylene zip-type bags and store in wooden or plastic boxes.

1.3.6. Bottles may be reused only if it is known that they have not contained mercury at high levels. The procedure in 1.3.1-1.3.5 of this section must be used for cleaning except that the bottles have to remain in the hot 4N hydrochloric acid for only 6-12 hours.

1.4. Polyethylene bags (cleaning is required only if blank contamination is associated with the bags)

1.4.1. Partially fill with cold, 1+1 nitric acid.

1.4.2. Rinse with analyte-free water.

1.4.3. Dry by hanging upside down from a plastic line using a plastic clip.

1.5. Tubing: Rinse with 10% hydrochloric acid by weight and thoroughly flush with water from the site. Soak tubing used for the analysis of mercury samples for at least 8 hours in the 10% Hydrochloric acid solution and dry with metal-free air or nitrogen in a designated clean area.

1.6. Extension Pole: Use a non-metallic brush to scrub the pole with analyte-free water. Wipe down the pole with 0.1% (V/V) ultrapure hydrochloric acid and wrap the pole in polyethylene film.

## 2. RECLEANING THE APPARATUS BETWEEN SAMPLES

If possible, bring enough precleaned equipment to the field for the entire sampling event. If this is not possible follow the following field cleaning protocols:

2.1. In the glove bag using the clean hands/dirty hands procedure rinse the sampling apparatus with diluted nitric acid. See FS 8221, section 2.2.

2.2. Dump the spent diluted acid in the waste carboy.

2.3. Rinse the sampling equipment with analyte-free water and discard the spent water.

2.4. Rinse the sampling apparatus with ambient water.

## FS 8230. SAMPLING PROCEDURES

### 1. GENERAL PROTOCOLS

1.1. Designate one member of the sampling team as clean hands and the other as dirty hands. Clean hands is responsible for all operations involving contact with the sample and/or sample bottle. Dirty hands is responsible for all other activities that do not involve direct contact with the sample or sample bottle. The proper collection of a sample requires a great deal of coordination between clean hands and dirty hands. Each sampler must know and understand his role and if possible the team has experience together.

- 1.2. Begin sample collection at sites of lower concentrations and continue to sites of higher concentrations. This procedure minimizes carryover between sites. To prevent carryover when the relative concentrations of metals are not known for each site, use new equipment (tubing, dippers, etc.) for each site.
  - 1.3. Approach the sampling site from downstream and downwind, when possible. If samples are being collected from a boat, samplers must approach from down current and sample from the bow of the boat. When sampling from shore, it is best to approach the site from downwind.
  - 1.4. The sampling team puts on a clean pair of gloves with clean hands donning shoulder length gloves. All sampling personnel must wear clean, powder-free gloves at all times. Furthermore, when personnel come in contact with equipment that has not been precleaned, they must stop and put on a clean pair of gloves. Dirty hands personnel must help clean hands personnel to put on a clean pair of gloves whenever needed.
2. SAMPLE COLLECTION DIRECTLY INTO THE SAMPLE BOTTLE
    - 2.1. Dirty hands removes the double-bagged sample bottle from storage and unzips the outer bag.
    - 2.2. Clean hands opens the inside bag containing the sample bottle, removes the sample bottle and reseals the inner bag. Dirty hands then reseals the outer bag.
    - 2.3. Clean hands removes the cap, while holding the cap upside down, discards the acid into a waste container or the reagent water into the water body.
    - 2.4. Clean hands submerges the sample bottle allowing it to partially fill, then screws the cap on the bottle, shakes the bottle several times, and empties the rinsewater away from the site. Clean hands repeats the rinses of the sample container two more times following the same procedure. Clean hands then completely fills the sample bottle with sample and, with the bottle still inverted underwater, replaces the bottle cap. The sample has never contacted the air.
    - 2.5. Dirty hands reopens the outer plastic bag and clean hands opens the inside bag, places the bottle inside and zips the bag, dirty hands places the inside bag containing the sample container inside the outer bag and zips the outer bag.
3. SAMPLE COLLECTION WITH GRAB SAMPLING DEVICE
    - 3.1. If necessary, clean hands attaches a bottle to the sampling device inside the field portable glove bag. Ideally this was already accomplished in a clean area before arriving on site.
    - 3.2. Dirty hands removes the sampling device and opens the outer polyethylene bag.
    - 3.3. Clean hands opens the inside polyethylene bag and removes the sampling device and then changes gloves.
    - 3.4. Dirty hands submerges the sampling device and proceeds to fill the sample container.
    - 3.5. When the bottle is full (when no more bubbles appear), dirty hands seals off the sample container and removes the sampling device from the water.
    - 3.6. Dirty hands returns the sampling device to the inner plastic bag and clean hands removes and caps the bottle.

- 3.7. Dirty hands reopens the outer plastic bag, and clean hands opens the inside bag, places the bottle inside it, and zips the inner bag. Dirty hands zips the outer bag.
4. SAMPLE COLLECTION USING A JAR SAMPLING DEVICE
  - 4.1. The sample team puts on gloves and handles bottles as with manual collection.
  - 4.2. Dirty hands removes the jar sampling device from its storage container and opens the outer polyethylene bag. Clean hands opens the inside polyethylene bag and removes the jar sampling apparatus. Ideally the apparatus was assembled inside a clean area at the laboratory. However, if assembly is required in the field, clean hands must perform this operation inside the field portable glove bag.
  - 4.3. While dirty hands is holding the jar sampling apparatus, clean hands connects the pump to the flush line and dirty hands lowers the sampler to the sampling depth.
  - 4.4. Dirty hands turns on the pump allowing > 2 L of water to pass through the system. Dirty hands stops the pump, pulls up the sampling device and places it into a larger clean plastic bag. Both clean hands and dirty hands change gloves.
  - 4.5. Following the procedures in sections 2.2 – 2.3 above, the sampling team gets a sample container and clean hands places the bottle into a glove bag.
  - 4.6. Clean hands tips the sampling jar and dispenses the sample through the short length of tubing into the sample container.
  - 4.7. Clean hands replaces the bottle cap, places the bottle in the inside polyethylene bag and closes the bag. Clean hands places the inside bag in the outside polyethylene bag held by dirty hands and dirty hands closes the bag.
5. CONTINUOUS FLOW SAMPLING: The continuous flow sampling system uses a peristaltic pump and tubing to obtain the sample.
  - 5.1. The sampling team removes the sampling equipment and puts on gloves.
  - 5.2. Dirty hands removes the pump from its storage bag and opens the bag containing the tubing.
  - 5.3. Clean hands installs the tubing while dirty hands holds the pump. Clean hands places the tubing in the sample stream. Both parties change gloves.
  - 5.4. Dirty hands turns the pump on and allows the pump to run for 5-10 minutes to purge the pump and tubing.
  - 5.5. If dissolved metals are to be collected, clean hands places the filter at the end of the tubing.
  - 5.6. After rinsing the sample container three times, clean hands fills the bottle.
6. OTHER TYPES OF SURFACE WATER SAMPLING EQUIPMENT
  - 6.1. Sampling equipment types not included in this SOP but discussed in the Surface Water SOP, FS 2100, may be used for collecting samples for ultratrace metal analyses if they are constructed of acceptable materials as described in FS 8210 and as long as an acceptable equipment blank can be obtained with the subject equipment.
  - 6.2. The clean hands/dirty hands procedures as described in number 3 of this section (Sample Collection with a Grab Sampling Device) must be used when these sample collection devices are used.

## **FS 8240. DOCUMENTATION**

1. Immediately following sample collection, identify each sample container with a unique field identification code.
2. Record sampling information specific to the site while still at the site and meet all of the requirements specified in FD 1000.

## **FS 8250. SAMPLE PRESERVATION**

Preserve all samples in a designated clean area or in the glove bag. Personnel must wear gloves and conduct the process as quickly as possible to eliminate particulate contamination.

### **1. Preservation of Samples for Metals other than Trivalent Chromium, Hexavalent Chromium and Mercury**

1.1. Reagents: nitric acid, ultrapure – 10% (v/v) solution.

1.2. Preservation Protocol: Maintained at 0–4°C from the time of collection until preservation.

1.2.1. If the samples are not preserved immediately upon collection, they must be acid-preserved within 48 hours after sampling.

1.2.2. Using a precleaned, disposable, plastic pipet add 5 mL of the nitric acid solution per liter of sample. Preserve the sample to a pH of <2.

### **2. PRESERVATION OF SAMPLES FOR THE ANALYSIS OF TRIVALENT CHROMIUM: the clean area for the preservation of trivalent chromium must be large enough to hold the vacuum filtration apparatus and an area established for the setup of the wrist-action shaker.**

#### **2.1. Reagents**

2.1.1. Nitric acid, ultrapure

2.1.2. Chromium (III) extraction solution: Prepare this solution by adding 100 mL of ammonium iron (II) sulfate solution to a 125 mL polyethylene bottle. Adjust the pH to 8 with approximately 2 mL of ammonium hydroxide solution. Cap and shake on a wrist-action shaker for 24 hours. This solution is stable for 30 days.

2.1.3. Ammonium Iron (II) sulfate solution (0.01M): Used to prepare the chromium (III) extraction solution. Prepare by adding 3.92 g ammonium iron (II) sulfate solution to a 125 mL polyethylene bottle. Adjust the pH to 8 with approximately 2 mL of ammonium hydroxide solution. Cap and shake on a wrist-action shaker for 24 hours. This iron (III) hydroxide solution is stable for 30 days.

2.1.4. 10% (v/v) high purity hydrochloric acid solution: Shipped in fluoropolymer wash bottles for cleaning preservation equipment between samples.

2.1.5. Stock chromium standard solution (1000 µg/mL): Prepare by adding 3.1 g anhydrous chromium chloride to a 1 L flask and diluting to volume with 1% hydrochloric acid or using a commercially prepared solution. Store in a polyethylene bottle.

2.1.6. Chromium spike solution (1000 µg/L): Prepare by adding 1 mL of the chromium stock standard solution to a 1 L flask and dilute to volume with 1% hydrochloric acid. Store in a polyethylene bottle.

2.1.7. On-going precision and recovery standard (OPR): Prepare by spiking 2.5 mL of the chromium spike solution into a 100 mL flask and bringing to volume with 1% hydrochloric acid.

## 2.2. Preservation Protocol

2.2.1. Decant 100 mL of the sample into a clean polyethylene bottle.

2.2.2. Clean an Eppendorf pipet by pipeting 1 mL of 10% hydrochloric acid followed by 1 mL of reagent water. Use the rinsed pipet to add 1 mL of chromium (III) extraction solution to each sample and blank.

2.2.3. Place each sample into a clean polyethylene bag and shake on a wrist-action shaker for 1 hour.

2.2.4. Remove the sample from the shaker and vacuum filter through a 0.4  $\mu\text{m}$ , pretreated membrane filter using fluoropolymer forceps to handle the membrane. Rinse the filtration apparatus with 15 mL of reagent water.

2.2.5. Fold the membrane into quarters using the forceps, taking precautions not to touch the filter to any surfaces. Transfer the filter to a 30 mL fluoropolymer vial containing 1 mL of ultrapure nitric acid. If the acid was not previously added to the vial, add it with a pipet that has been rinsed with 1 mL of 10% hydrochloric acid and 1 mL of reagent water.

2.2.6. Cap the vial and double bag it for shipment to the laboratory.

## 3. PRESERVATION OF SAMPLES FOR HEXAVALENT CHROMIUM

### 3.1. Reagents

3.1.1. 10% (v/v) ultrapure hydrochloric acid solution: Shipped in fluoropolymer wash bottles for cleaning preservation equipment between samples.

3.1.2. Sodium hydroxide: Concentrated, 50% solution for field-preserving samples for hexavalent chromium analyses.

### 3.2. Preservation Protocol

3.2.1. Decant 125 mL of sample into a clean polyethylene bottle.

3.2.2. Clean an Eppendorf pipet by pipeting 1 mL of 10% hydrochloric acid followed by 1 mL of reagent water. Use the rinsed pipet to add 1 mL of sodium hydroxide to each 125 mL aliquot.

## 4. PRESERVATION OF SAMPLES FOR MERCURY

### 4.1. Reagents

4.1.1. Hydrochloric Acid: Trace-metal purified reagent-grade hydrochloric acid containing less than 5 pg/mL mercury. The hydrochloric acid should be preanalyzed for Hg before use.

4.1.2. Bromine Monochloride (BrCl): In a fume hood dissolve 27 g of reagent grade potassium bromide (KBr) in 2.5 L of low-mercury HCl. Stir for approximately 1 hour in a fume hood. Slowly add 38 g reagent-grade potassium bromate ( $\text{KBrO}_3$ ) to the acid while stirring. When all the potassium bromate has been added, the solution color should change from yellow to red to orange. **(Warning: This process generates copious quantities of free halogens. Add the potassium chromate slowly in a fume hood.)** Loosely cap the bottle and continue to stir for 1 hour before tightening the lid.

#### 4.2. Preservation Protocol

4.2.1. Samples are preserved by either adding 5 mL/L of hydrochloric acid or 5 mL/L bromine monochloride.

4.2.2. Samples may be shipped to the laboratory unpreserved if they are:

- Collected in fluoropolymer bottles.
- Filled to the top with no headspace.
- Capped tightly.
- Maintained at 0–4°C from the time of collection until preservation.

4.2.3. If the samples are not preserved immediately upon collection, they must be acid-preserved within 48 hours after sampling.

4.2.4. Samples that are acid-preserved may lose mercury to coagulated organic materials in the water or condensed on the walls. The best approach is to add bromine monochloride directly to the sample bottle at least 24 hours before analysis. If Bromine monochloride cannot be added directly to the sample bottle, the bottle must be shaken vigorously prior to sub-sampling.

### **FS 8260.           QUALITY CONTROL**

1. Equipment blanks must be collected as required in FQ 1000. Follow the clean hands/dirty hands protocol when preparing blanks.

2. Training programs must require sampling personnel to collect a clean equipment blank before performing field activities.

3. The equipment must be demonstrated to be free from the metals of interest before use in the field.

4. Collect the equipment blanks by:

4.1. Filling a large carboy with reagent water in the laboratory and transporting the filled container to the sample site.

4.2. Processing the reagent water through each of the sampling processing steps and equipment (including any filtration equipment if applicable) that will be used in the field.

4.3. Collecting and preserving a blank in one of the project sample containers and transporting it to the laboratory in the same fashion as the other samples.

5. ADDITIONAL QC FOR COLLECTION OF TRIVALENT CHROMIUM ALIQUOTS

5.1. Prepare one method blank on a 100 mL aliquot of analyte-free water for every 10 or fewer samples preserving the sample of analyte-free water using the steps in FS 8250, section 2.2. For dissolved metals do not filter the blank.

5.2. On-going Precision and Recovery (OPR) Sample

5.2.1. Reagents

5.2.1.1. Stock Chromium Standard Solution (1000 µg/mL): Prepare by adding 3.1 g anhydrous chromium chloride to a 1 L flask and diluting to volume with 1% hydrochloric acid or using a commercially prepared solution. Store in a polyethylene bottle.

5.2.1.2. Chromium Spike Solution (1000 µg/L): Prepare by adding 1 mL of the chromium stock standard solution to a 1L flask and diluting to volume with 1% hydrochloric acid. Store in a polyethylene bottle.

5.2.1.3. On-going Precision and Recovery Standard: Prepare by spiking 2.5 mL of the standard chromium spike solution into a 100 mL flask and bringing to volume with 1% hydrochloric acid.

5.2.2. The sampling team must prepare one on-going precision and recovery standard for every ten or fewer samples. Preserve the OPR standard following the steps in FS 8250, section 2.2.

5.3. Matrix Spike (MS)/Matrix Spike Duplicate (MSD)

5.3.1. Reagents

5.3.1.1. Stock Chromium Standard Solution (1000 µg/mL): Prepare by adding 3.1 g anhydrous chromium chloride to a 1 L flask and diluting to volume with 1% hydrochloric acid or using a commercially prepared solution. Store in a polyethylene bottle.

5.3.1.2. Chromium Spike Solution (1000 µg/L): Prepare by adding 1 mL of the chromium stock standard solution to a 1 L flask and diluting to volume with 1% hydrochloric acid. Store in a polyethylene bottle.

5.3.2. If the background of the sample is known through historical data, spike the MS and MSD at a level of 1 to 5 times the background concentration.

5.3.3. If the background concentration is unknown, spike the MS and MSD at 25 µg/L.

5.3.4. Prepare the MS/MSD by spiking a 100 mL aliquot of the sample with 2.5 mL of the standard chromium spike solution and preserve the MS/MSD by following the steps in FS 8250, section 2.2.

5.3.5. The sampling team must prepare one MS and one MSD for every ten or fewer samples.

**APPENDIX FS 8200**  
**Tables, Figures and Forms**

Table FS 8200-1 Analytical Methods, Metals, and Concentration Levels Applicable to Clean Sampling

Table FS 8200-1

Analytical Methods, Metals, and Concentration Levels Applicable to Clean Sampling

Method	Technique	Metal	MDL (µg/L)
1631	Oxidation/Purge & Trap/CVAFS	Mercury	0.0002
1632	Hydride AA	Arsenic	0.003
1636	Ion Chromatography	Chromium VI	0.23
1637	CC/STGFAA	Cadmium	0.0075
		Lead	0.036
1638	ICP/MS	Antimony	0.0097
		Cadmium	0.013
		Copper	0.087
		Lead	0.015
		Nickel	0.33
		Selenium	0.45
		Silver	0.029
		Thallium	0.0079
		Zinc	0.14
1639	STGFAA	Antimony	1.9
		Cadmium	0.023
		Chromium III	0.1
		Nickel	0.65
		Selenium	0.83
		Zinc	0.14
1640	CC/ICP/MS	Cadmium	0.0024
		Copper	0.024
		Lead	0.0081
		Nickel	0.029

## **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.

<b>Table FT 1000-1: Field Testing Acceptance Criteria</b>	
<b>Parameter</b>	<b>Acceptance Criteria</b>
pH (FT 1100)	$\pm 0.2$ Standard pH Units of buffer or more stringent program criteria
Specific Conductance (FT 1200)	$\pm 5\%$ of standard value
Temperature (FT 1400)	$\pm 0.2^\circ\text{C}$ of NIST-traceable value (with correction factors) Verification over range of applicable values
Dissolved Oxygen (FT 1500)	$\pm 0.3$ mg/L of theoretical value (see Table FT 1500-1)
Turbidity (FT 1600)	0.1-10 NTU: $\pm 10\%$ of standard value 11-40 NTU: $\pm 8\%$ of standard value 41-100 NTU: $\pm 6.5\%$ of standard value > 100 NTU: $\pm 5\%$ of standard value
Total Residual Chlorine (FT 2000)	0.995 calibration curve correlation coefficient $\pm 10\%$ of primary standard value $\pm 10\%$ of secondary standard value Color comparator acceptance criterion: $\pm 10\%$ 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. 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 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

<b>Table FT 1000-1: Field Testing Acceptance Criteria</b>	
<b>Parameter</b>	<b>Acceptance Criteria</b>
pH (FT 1100)	$\pm 0.2$ Standard pH Units of buffer or more stringent program criteria
Specific Conductance (FT 1200)	$\pm 5\%$ of standard value
Temperature (FT 1400)	$\pm 0.2^{\circ}\text{C}$ of NIST-traceable value (with correction factors) Verification over range of applicable values
Dissolved Oxygen (FT 1500)	$\pm 0.3$ mg/L of theoretical value (see Table FT 1500-1)
Turbidity (FT 1600)	0.1-10 NTU: $\pm 10\%$ of standard value 11-40 NTU: $\pm 8\%$ of standard value 41-100 NTU: $\pm 6.5\%$ of standard value > 100 NTU: $\pm 5\%$ of standard value
Total Residual Chlorine (FT 2000)	0.995 calibration curve correlation coefficient $\pm 10\%$ of primary standard value $\pm 10\%$ of secondary standard value Color comparator acceptance criterion: $\pm 10\%$ 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<sup>+</sup>-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.

DEP-SOP-001/01  
FT 1100 Field Measurement of Hydrogen Ion Activity (pH)

- 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 ( $< 200 \mu\text{mhos/cm}$ ) 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  $\pm 0.2$  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

DEP-SOP-001/01  
FT 1100 Field Measurement of Hydrogen Ion Activity (pH)

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.

DEP-SOP-001/01  
FT 1100 Field Measurement of Hydrogen Ion Activity (pH)

- 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  $\mu\text{mhos/cm}$  or greater, use two standard potassium chloride solutions that bracket the range of expected sample conductivities. A single standard at 100  $\mu\text{mhos/cm}$  standard potassium chloride solution is acceptable for situations in which all sample measurements are expected to be less than 100  $\mu\text{mhos/cm}$ .

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  $\mu\text{mhos/cm}$ , only one standard at 100  $\mu\text{mhos/cm}$  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  $\mu\text{mhos/cm}$  standard is 95 to 105  $\mu\text{mhos/cm}$ . 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  $\mu\text{mhos/cm}$  at 25°C

$K_m$  = measured conductivity in  $\mu\text{mhos/cm}$  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, 20<sup>th</sup> 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.

DEP-SOP-001/01  
FT 1200 Field Measurement of Specific Conductance

- 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  $\mu$ mhos/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 ‰.

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 conductivity or density 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. Field Instrument: 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  $\mu\text{mho/cm}$  (whichever is greater), and equipped with temperature-compensation adjustment; or

2.1.2. A precision “vibrating flow densimeter” (see Millero & Poisson, 1981) and a field thermometer.

2.2. Standards:

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, Standard Methods for the Examination of Water and Wastewater).

DEP-SOP-001/01  
FT 1300 Field Measurement of Salinity

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

DEP-SOP-001/01  
FT 1300 Field Measurement of Salinity

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<sub>0</sub>) is given by:

$$D - D_0 = b (T^2 - T_0^2)$$

Where T and T<sub>0</sub> 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<sub>0</sub>) 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.

DEP-SOP-001/01  
FT 1300 Field Measurement of Salinity

- 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 ‰)
    - 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)

DEP-SOP-001/01  
FT 1300 Field Measurement of Salinity

- 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°C increments.

1.2. Standard Thermometer: NIST-traceable Celsius certified thermometer with scale marks for every 0.1°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°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°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°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.

DEP-SOP-001/01  
FT 1400 Field Measurement of Temperature

- 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°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<sub>2</sub>S) 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. Initial Calibration and Initial Calibration Verification

2.3.1. Air Calibration and Initial Calibration Verification (ICV): 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 °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 °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

<b>Table FT 1500-1: Solubility of Oxygen in Water</b>			
<b>at Atmospheric Pressure<sup>1,2</sup></b>			
<b>Temperature</b>	<b>Oxygen Solubility</b>	<b>Temperature</b>	<b>Oxygen Solubility</b>
<b>°C</b>	<b>mg/L</b>	<b>°C</b>	<b>mg/L</b>
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  $\pm 30^\circ$  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  $\%R = 100 \pm 10\%$  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.

DEP-SOP-001/01  
FT 1600 Field Measurement of Turbidity

- 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)

## **FT 1700. Field Measurement of Light Penetration (SECCHI Depth and Transparency)**

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. Boat and Supplies: a boat may be required, and the following supplies must be available:

- Fuel supply (primary and auxiliary)
- Spare parts kit
- Life preservers (USCG approved)
- First aid kit (including emergency phone numbers of local hospitals and family contacts for each member of the sampling team)
- Spare oars
- Nautical charts with sampling/testing site locations

1.2. Field Instruments:

- Secchi disk attached to chain or rope marked at 0.1-meter or 1.0-foot intervals
- LI-COR Photometer (quantum radiometer spherical sensor and meter) or equivalent instrument (underwater sensor)
- Lowering frame for photometer sensor
- Pyranometer sensor or equivalent instrument (terrestrial sensor)
- Mounting and leveling fixture for the pyranometer sensor
- Sensor selector

1.3. Recordkeeping and Documentation Supplies:

- Field notebook (w/ waterproof paper is recommended) or forms
- Indelible pens

## **FT 1710. PHOTOMETERS/RADIOMETERS**

1. CALIBRATION AND USE: This SOP addresses certain instruments. If using other equivalent instrumentation, follow the manufacturer's instructions on the use and calibration of such equipment.

1.1. Assembly

1.1.1. LI-COR Photometer: the LI-COR Quantum/Radiometer/Photometer is used to measure light over two different wavelength ranges: photosynthetically active radiation

(400-700 nm), and solar irradiance (400-1100 nm). The instrument measures light in units of microeinsteins per meter squared per second ( $\mu\text{E}/\text{m}^2/\text{s}$ ). The unit consists of a battery-powered transistorized meter, a pyranometer sensor, an underwater quantum sensor, a sensor selector, cables, and a lowering frame for the underwater sensor.

#### 1.1.2. Lowering Frame Assembly

- 1.1.2.1. Attach a 5-10 pound weight to the base of the lowering frame.
- 1.1.2.2. Attach the secchi disk to the threaded bolt.
- 1.1.2.3. Follow the manufacturer's instructions and attach the sensor to the base.
- 1.1.2.4. Place a small amount of stopcock grease on the O-ring built into the base of the sensor.
- 1.1.2.5. If using the LI-COR, align the yellow dot on the cable with the yellow mark on the sensor and lightly push the cable connector onto the sensor. Then attach the cable screw-on connector.
- 1.1.2.6. Adjust the secchi disk so that the top of the disk corresponds to the top of the sensor bulb.

#### 1.1.3. Meter Assembly

- 1.1.3.1. Attach the patch cable to the meter input and output connectors as specified in the manufacturer's manual.
- 1.1.3.2. Assemble the pyranometer sensor by attaching the sensor to the leveling base using the attachment screw.
- 1.1.3.3. Assemble and attach the pyranometer calconnector (small black bar jack labeled pyranometer sensor) per manufacturer's instructions. If using a LI-COR, the serial number on the calconnector (5608) must match the serial number of the pyranometer serial numbers.
- 1.1.3.4. Attach the quantum sensor calconnector to the BNC cable (cable extending from the underwater sensor) and plug into the instrument sensor port (follow manufacturer's instructions for connection and assembly). The serial number on the calconnector (373) must match the serial number of the quantum sensor.

1.1.4. Battery Check: check the condition of the battery before taking measurements and replace it, if necessary.

### 1.2. Calibration

#### 1.2.1. Meter Zero Adjustment

- 1.2.1.1. After the unit is assembled place the meter face up on a level surface and turn the FUNCTION switch to the OFF position.
- 1.2.1.2. Allow the instrument to remain in the off position for at least one minute, and then determine if the needle on the meter scale is on zero.
- 1.2.1.3. Adjust the needle to zero by turning the mechanical ZERO screw on the front of the meter.

1.2.2. The manufacturer calibrates both the quantum and pyranometer sensor. The accuracy of this calibration is +/- 5%. Further calibration is not possible.

### 1.3. Measuring Light Penetration in Samples

- 1.3.1. Once assembled, carefully lower the unit without putting the weight of the frame assembly on the cable.
  - 1.3.2. If the measurement is taken from an anchored boat, deploy the sensor on the side of the boat with the least shade.
  - 1.3.3. Take readings just above the surface (AIR on record sheet), just below the surface (SURFACE on record sheet), and at one-foot depth increments.
  - 1.3.4. Read both the underwater quantum sensor and the on-deck pyranometer at each depth (including SURFACE and AIR). Pyranometer readings are used to determine if there are any changes in the incident light due to changes in cloud cover. Any such changes must be factored out when light extinction coefficients are calculated.
  - 1.3.5. Use the range setting function to properly scale the readings.
  - 1.3.6. Begin raising the sensor when the light intensity measured by the quantum sensor drops to less than 1% of the incident light (or once the meter reaches the bottom), and repeat each measurement at the previous depth locations.
  - 1.3.7. Once the surface light measurements have been repeated, lower the unit to determine the secchi depth. Alternatively, follow FT 1720 for secchi depth measurement.
2. PREVENTIVE MAINTENANCE: Refer to FT 1000, section 3.
  3. DOCUMENTATION
    - 3.1. Field Instrument Calibration Documentation: Document acceptable calibration (meter zero adjustment) for each instrument unit and field test or analysis, linking this record with affected sample measurements.
      - 3.1.1. Retain vendor certifications of all factory-calibrated instrumentation.
      - 3.1.2. Designate the identity of specific instrumentation in the documentation with a unique description or code for each instrument unit used.
        - 3.1.2.1. Record manufacturer name, model number and identifying number such as a serial number for each instrument unit.
      - 3.1.3. Record the time and date of all initial calibrations.
      - 3.1.4. Record the instrument reading (value in appropriate measurement units) of all calibrations.
      - 3.1.5. Record the name of the analyst(s) performing the calibration.
      - 3.1.6. Retain manufacturers' instrument specifications.
      - 3.1.7. Document whether successful initial calibration occurred.
      - 3.1.8. Document any corrective actions taken to correct instrument performance according to records requirements of FD 3000.
        - 3.1.8.1. Document date and time of any corrective action.
        - 3.1.8.2. Note any incidence of discontinuation of use of the instrument due to calibration failure.
      - 3.1.9. Describe or cite the specific calibration or verification procedure performed (DEP SOP or internal SOP).

- 3.2. 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)
  - Estimated percent cloud cover
  - Secchi Depth
  - Total Depth

#### **FT 1720. MEASUREMENT OF SECCHI DEPTH**

1. INTRODUCTION: This SOP applies when the Secchi depth is the only parameter being measured; i.e., the other light penetration measurements are not included in the scope of the project. In such occasions, the only equipment from this SOP that is needed in the field is the secchi disk (see FT 1700, section 1.2).
2. PROCEDURE
  - 2.1. Remove sunglasses. If using a boat, conduct the measurements over the shaded side of the boat or with the sun to the observers back.
  - 2.2. Clip the calibrated chain or rope to the Secchi disk. Make sure the chain is attached so that depth is determined from the upper surface of the disk.
  - 2.3. Slowly lower the secchi disk in the water, visually observe the disk sectors, and record the depth at which the disk disappears. If it is visible to the lake or stream bottom, check the appropriate box in the field sheet.
  - 2.4. Lower the disk beyond the point recorded in section 2.3 above. Slowly raise the disk and record the depth at which it reappears. The Secchi depth is the average of the two readings.
  - 2.5. Note any conditions that might affect the accuracy of the measurement in the field sheet. If the disappearance depth is < 1.0 m, determine the depth to the nearest 0.05 m by marking the chain at the nearest depth marker and measuring the remaining length with a tape measurer.
3. DOCUMENTATION: See FT 1000, section 4 for additional details
  - 3.1. 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

## FT 1800. Field Measurement of Water Flow and Velocity

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

This SOP describes the procedures used during intensive surveys of water bodies (rivers and streams) where the discharge measurement (Q) is an important parameter in the calculation of wasteload allocations by DEP. These procedures are applicable to shallow rivers and streams (depth less than 4 feet) where the measurements are conducted by wading with assistance from other personnel.

1.1. Site Selection: Survey the study area before taking flow measurements, and carefully select flow sites that will allow the most accurate flow measurements.

1.1.1. Constricted areas are usually the most convenient and allow greater accuracy because the constriction reduces the width of each subsection and increases the current velocity.

1.1.2. Flow sites should have a uniform flow and should be free of eddies, slack water, and excessive turbulence.

1.1.3. In addition, the streambed should be free of boulders or aquatic vegetation. Obstructions in the stream may need to be removed both at the measurement site and upstream of the flow site. Obstruction removal allows for more accurate flow measurements and should not affect the actual stream flow.

1.1.4. These site selection criteria introduce a bias that tends to overestimate the stream velocity. In general, velocities taken for flow measurements are not representative of the average stream velocity. Time-of-travel dye studies should be used to determine average stream velocities.

1.2. Current Meter Selection: After the flow sites have been determined, select the appropriate current meter for each site.

1.2.1. DEP recommends electronic current meters such as the Marsh-McBirney or SonTek ADV because these meters are more sensitive than mechanical meters and are easier (quicker) to use. In order to have the most flexibility when using a meter, consider using meters that measure flow at a variety of depths and can be attached to a wading rod, a long staff, or even to the sounding unit of the bridgeboard.

1.2.2. Do not change or substitute current meters during a transect. If a meter malfunctions mid-way through a cross-section, then repeat the entire transect with a new meter.

1.2.3. DEP recommends that the same type of current meter be used during subsequent intensive surveys at the same site.

### 2. EQUIPMENT AND SUPPLIES

2.1. Field instruments: DEP personnel use the Marsh-McBirney Model 201D or Flo-Mate Model 2000 Flow Meter. Both measure water velocity by creating a magnetic field and measuring the voltage produced when water (a conductor) flows through the field. Other flow meters with the sensitivity and accuracy required for the study are acceptable.

2.2. Recordkeeping and Documentation Supplies:

- Field notebook (w/ waterproof paper is recommended) or forms Indelible pens

3. CALIBRATION AND USE: The following are instructions for the Marsh-McBirney Flow Meters, however, other flow meter types are acceptable. Follow the manufacturer's instructions for calibration and use.

3.1. Marsh-McBirney 201D

3.1.1. Assembly: Assemble the 201D per manufacturer's instructions.

3.1.2. Calibration

3.1.2.1. After the unit has been assembled, perform a calibration to determine if the internal circuitry is functioning properly:

- Turn the selector switch to the CAL position and the time constant switch to 2.
- The reading must be in the range of 9.8 and 10.2 after a 10-second warm-up.
- If the reading is not within the above-mentioned range, turn the meter off and check the batteries, then repeat the above two steps.
- If the unit fails the CAL test after the battery charge, send the unit to the manufacturer for maintenance.

3.1.3. Measurements with the Marsh-McBirney 201D- once this meter has been properly mounted onto the wading rod and calibrated, current measurements can be obtained:

3.1.3.1. Position the submersible sensor perpendicular to the current at the depth determined for the appropriate velocity method, and allow several seconds for the meter to adjust to the current.

3.1.3.2. Follow the manufacturer's instructions for operation.

3.1.3.3. Record the measurement on the Discharge Measurement Notes (form FD 9000-11).

3.1.3.4. Turn the SCALE switch to the off position and move to the next sampling location.

3.2. Marsh-McBirney Flo-Mate 2000

3.2.1. Calibration: Following assembly per manufacturer's instructions, perform a zero calibration check to determine if the internal circuitry is functioning properly:

3.2.1.1. Clean the sensor to remove oil that can cause noisy readings.

3.2.1.2. Place the sensor in a five-gallon bucket of water keeping it at least three inches away from the sides and bottom of the bucket.

3.2.1.3. To make sure the water is not moving, wait 10 or 15 minutes after you have positioned the sensor before taking any zero readings.

3.2.1.4. For the Flo-Mate 2000, use a filter value of 5 seconds. Zero stability is +/- 0.05 ft/sec.

- To initiate the 'zero start sequence' press the STO and RCL keys at the same time. You will see the number 3 on the display.
- Decrement to zero with the down arrow key.
- The number 32 will be displayed.
- The unit will decrement itself to zero and turn off. The unit is now zeroed.

3.2.2. Measurements with the Marsh-McBirney Flo-Mate 2000: Current measurements can be made after the meter has been properly mounted onto the wading rod and calibrated:

3.2.2.1. Position the submersible sensor perpendicular to the current at the depth determined for the appropriate velocity method, and allow several seconds for the meter to adjust to the current.

3.2.2.2. Depress the ON/C button on the display unit.

3.2.2.3. Set the FPA (fixed point average) to five seconds by depressing either the up or down arrows.

3.2.2.4. Select the FT/SEC position by toggling between the ON/C and OFF buttons.

3.2.2.5. Record the measurement on the Discharge Measurement Notes (form FD 9000-11).

3.2.2.6. Depress the OFF button and move to the next sampling location.

#### 4. FLOW MEASUREMENTS

##### 4.1. Estimating Discharge

4.1.1. The instruments identified in section 3 above are designed to take individual velocity measurements. These measurements are sometimes used as point velocities to calibrate model velocities, but are more frequently used to determine the volume rate of flow (discharge) of a water body.

4.1.2. To determine discharge, divide the cross-section of the water body into subsections.

4.1.2.1. Measure and record the velocity, width, and depth of each subsection.

4.1.2.2. The sum of the products of the individual subsection observations provides an estimate of discharge using the following basic formula:

$$Q = \sum_{i=1}^n (A_i \times V_i)$$

Where:

Q = discharge in cfs

A<sub>i</sub> = cross-sectional area of subsection i (ft<sup>2</sup>)

V<sub>i</sub> = velocity of subsection i (ft/s)

4.2. The Mid Section Method: This method determines the discharge using the subsection velocity measurements.

4.2.1. Secure the end of a tag line (tape measure) to the right bank of the stream (facing downstream).

4.2.2. Extend the line across the stream and secure the other end of the line to the left bank.

4.2.3. Make sure that the tape is tight and the numbers are visible.

4.2.4. Read and record the tape measurements corresponding to both the left and right edges of the water and calculate the total width of the stream.

4.2.5. Then divide the stream into approximately 15-20 subsections. While it is generally easier if subsections are of equal width, it may be necessary to vary the subsection widths if the flow varies significantly along the cross section.

4.2.5.1. Subsections must be narrower where the depth and velocity is highest.

4.2.6. Starting at the right edge of the water and standing on the downstream side of the tape, move along the tape to the first subsection.

4.2.6.1. Measure and record the depth (from the water surface) and the tape measure length.

4.2.6.2. If the depth is greater than 2.5 feet, measure the velocity at two points in each vertical at depths corresponding to two-tenths and eight-tenths the total depth.

4.2.6.3. If the depth is less than 2.5 feet, then measure velocity at a depth of six-tenths the total depth.

4.2.6.4. Do not stand in a position that interferes with the current. The USGS recommends placing the current meter at least three inches downstream from the tape measure and that the hydrologist stand at least 1.5 feet from the meter.

4.2.7. Repeat steps 4.2.6.1 through 4.2.6.4 above at each position corresponding to the distance of successive subsections. Continue the procedure until reaching the left edge of the water.

4.3. Sample Depths for Velocity Measurements:

4.3.1. An accurate estimate of the mean velocity in the vertical is made by averaging the velocity at two depths (see 4.2.6.2 above).

4.3.2. In shallow water (depth less than 2.5 feet), use top-setting wading rods that are designed to easily adjust to the six-tenths depth. To set the rod, first measure the depth of the water (to the nearest tenth of a foot) on the fixed support rod. Then adjust the sliding support rod so that the top scale reads the depth of the water. This automatically adjusts the meter to the six-tenths depth. Note that the sample depth terminology can be confusing when using the wading rod because the sample depths are referenced to the water surface and the natural tendency is to adjust the wading rod from the bottom up. For example, if the total depth is four feet, then the six-tenths depth is 2.4 feet ( $4 \times .6 = 2.4$ ) from the surface. This means that the current meter should be positioned 1.6 feet off the bottom (the remaining four-tenths of the depth).

5. PREVENTIVE MAINTENANCE: Refer to FT 1000, section 3.

6. DOCUMENTATION

6.1. 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.

6.1.1. Retain vendor certifications of all factory-calibrated instrumentation.

6.2. Designate the identity of specific instrumentation in the documentation with a unique description or code for each instrument unit used.

6.2.1.1. Record manufacturer name, model number and identifying number such as a serial number for each instrument unit.

6.2.2. Record the time and date of all initial calibrations and all calibration verifications.

6.2.3. Record the instrument reading (value in appropriate measurement units) of all calibration verifications.

6.2.4. Record the name of the analyst(s) performing the calibration.

6.2.5. If applicable, document the specific standards used to calibrate or verify the instrument or field test with the following information:

- Type of standard or standard name
- Value of standard, including correct units

6.2.6. Retain manufacturers' instrument specifications.

6.2.7. Document whether successful initial calibration occurred.

6.2.8. Document whether each calibration verification passed or failed.

6.2.9. Document any corrective actions taken to correct instrument performance according to records requirements of FD 3000.

6.2.9.1. Document date and time of any corrective action.

6.2.9.2. Note any incidence of discontinuation of use of the instrument due to calibration failure.

6.2.10. Describe or cite the specific calibration or verification procedure performed (DEP SOP or internal SOP).

6.3. Field-Testing Measurement Data:

6.3.1. Record all flow readings and supporting information. See United States Geological Survey Guidance (USGS) on flow measurement for examples of standard documentation (<http://pubs.usgs.gov/tm/>).

6.3.2. Also record each of the following, if not addressed in 6.3.1 above

- 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 1900. Continuous Monitoring with Installed Meters

Use in conjunction with:

- FT 1000 General Field Testing and Measurement
- FT-series Field Testing SOPs for applicable parameters
- FS 1000 General Sampling Procedures
- FD 1000 Documentation Procedures

1. INTRODUCTION: Many facilities rely on in-line continuous measurement devices to monitor parameters such as dissolved oxygen, conductivity, pH, temperature, residual chlorine and turbidity. In order to ensure the stability and reliability of such measurements, the calibration of these instruments must be checked regularly. In cases where it is impractical to take these instruments off-line on a daily basis, use the calibration procedures described below.

### 2. CALIBRATION AND VERIFICATION

2.1. Calibrate the continuous monitoring instrument **before installation** according to the manufacturer's specifications for initial calibration. Ensure that the instrument has been calibrated and the calibration verified according to the requirements in the applicable DEP SOPs.

2.2. **On a daily basis**, measure a grab sample taken at or as near as possible to the same location as the in-line meter. The grab-sample test measurements must be taken with an instrument that has been properly calibrated and verified per the applicable DEP SOPs for individual parameter tests.

2.3. Compare the results of the daily verification with the continuous meter reading taken at the same time as the grab sample was collected. The continuous meter calibration is acceptable for the applicable parameters if the differences with the grab-sample results meet the following criteria:

- 2.3.1. Dissolved Oxygen: no greater than 0.2 mg/L difference (or historically established criteria not to exceed 0.5 mg/L difference);
- 2.3.2. Specific Conductance: no greater than 10% of the calibrated instrument reading;
- 2.3.3. pH: no greater than 0.2 pH units difference (or historically established criteria not to exceed 0.5 pH units difference);
- 2.3.4. Temperature: no greater than 0.5°C difference;
- 2.3.5. Residual Chlorine: no greater than 20% of the calibrated instrument reading; and
- 2.3.6. Turbidity: no greater than 20% of the calibrated instrument reading.

2.4. When the comparisons performed in section 2.3 above indicate a changing trend in the difference between the grab sample measurement and the continuous meter measurement for any parameter, determine the cause of the problem and perform appropriate corrective actions, such as maintenance, repair, calibration or other activities needed for the proper operation of the continuous meter under calibrated conditions.

2.5. Perform the initial calibration (per section 2.1 above) each time the instrument is taken off-line, after every preventative maintenance activity, and **immediately** after determining that any of the criteria verifications in 2.3.1 through 2.3.6 above are not met.

DEP-SOP-001/01  
FT 1900 Continuous Monitoring With Installed Meters

- 2.6. All acceptable field data must be bracketed by acceptable calibration verifications (see section 2.3 above). Qualify data that are not bracketed by acceptable calibration verifications.
3. EXTENDED VERIFICATION INTERVALS
- 3.1. If historically generated data demonstrate that a specific instrument remains stable for longer periods of time, the time interval between initial calibration and calibration verifications may be increased.
- 3.2. The maximum time interval is one month or at the conclusion of a sampling event, whichever is less.
- 3.3. Base the selected time interval on the shortest interval that the instrument maintains stability.
- 3.4. If an extended time interval is used, and the instrument consistently fails to meet the final calibration verification:
- 3.4.1. The instrument may need maintenance to correct the problem; or
  - 3.4.2. The time period is too long and must be decreased.
- 3.5. Retain all data associated with studies that support a decreased frequency of calibration verifications for at least five years after the procedure was last used.
4. PREVENTIVE MAINTENANCE: Refer to FT 1000, section 3.
5. DOCUMENTATION
- 5.1. Record all information specified in the individual field-testing SOPs.
- 5.2. Document the daily verifications of the continuous meter by recording:
- Project name (if applicable)
  - Date and time (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)
  - Analyte or parameter measured
  - Reading from the continuous meter, including reporting units
  - Reading from the second instrument used for the grab-sample measurement, including reporting units
  - The name of the person conducting the verification
  - Unique identification of the specific instrument unit(s) used for the test(s)
- 5.3. Where applicable, record the differences for the results of meter comparisons as specified in section 2.3 above.
- 5.3.1. Calculate the differences in the results between the meter measurements of the grab sample with the corresponding measurements from the continuous meter for the applicable parameters
- 5.4. Indicate the acceptability of the verifications per the criteria in section 2.3

## FT 2000. Field Measurement of Residual Chlorine

Use in conjunction with:

- FA 1000 Regulatory Scope and Administrative Procedures for Use of DEP SOPs
- FT 1000 General Field Testing and Measurement
- FS 1000 General Sampling Procedures
- FS 2000 General Aqueous Sampling
- FD 1000 Documentation Procedures
- FC 1000 Cleaning / Decontamination Procedures
- FM 1000 Field Planning and Mobilization

Chlorinating water supplies and polluted waters at treatment facilities is a common practice to destroy or deactivate disease-producing microorganisms. This SOP describes the most commonly used field procedures for measuring the residual chlorine that remains after chlorination.

For reporting limits below 0.2 mg Cl/L, use the titrimetric methods in FT 2020. The methods in FT 2010 or FT 2030 may be used if a lower detection limit and range of calibration can be demonstrated in the sample matrix of interest.

**See the applicable referenced methods in FT 2050 if measurements other than total residual chlorine are required. Use this SOP when analyzing drinking water compliance samples for free or total chlorine (section 2.1.2).**

### FT 2010. DPD COLORIMETRIC METHOD

1. SCOPE AND APPLICABILITY: DEP recommends this method if the testing levels that must be met are between 0.2 to 4.0 mg/L residual chlorine. This method is least affected by the presence of organic matter.

#### 2. EQUIPMENT AND SUPPLIES

##### 2.1. Field Instruments:

2.1.1. Use any of the following photometric instruments for residual chlorine measurements. The instrument must allow calibration using **at least** two standards and a blank, except as noted in 3.2.2 below.

- Spectrophotometer, for use at a wavelength of 515 nm and a light path of 1 cm or longer;
- Filter Photometer, equipped with a filter having maximum transmission in the wavelength range of 490 to 530 nm and providing a light path of 1 cm or longer or
- Colorimeters designed for residual chlorine measurement

2.1.2. Color Comparator: use only for the analysis of free and total chlorine in drinking water samples for compliance monitoring

2.2. Appropriate laboratory glassware such as volumetric flasks and volumetric pipets.

2.3. Sample Cells (cuvettes): Use sample cells or tubes of clear, colorless glass or plastic specifically designed for the test instrument.

2.3.1. Keep cells clean, both inside and out, and discard if scratched or etched.

2.3.2. Never handle cells where the light beam strikes the sample.

## FT 2000 Field Measurement of Residual Chlorine

2.3.3. Clean sample cells by thorough washing with laboratory detergent solution (inside and out) followed by multiple rinses with distilled or de-ionized water. Air dry sample cells prior to use or rinse thoroughly with sample before color development and measurement.

2.3.3.1. Sample cells may be rinsed in the field with the detergent step omitted if it is determined that no interference with accurate measurement will occur and that the sample has not left insoluble residue on the surfaces of the cell.

2.3.4. Mask minor imperfections or scratches in the cells with a very thin layer of silicone oil on the outside surfaces. 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.

2.3.5. Because small differences between cells significantly impact measurement, use optically matched cells or use the same cell for calibration and sample measurement.

2.4. Reagents and Standards:

- DPD reagent powder pillows (from commercial supplier) or
- Phosphate buffer solution and DPD indicator solution (prepared according to SM 4500-CI-G).
- Chlorine-demand-free water

2.4.1. Primary Standards: Use standard potassium permanganate solutions or chlorine standards prepared in the appropriate concentration range of interest according to method SM 4500-CI-G. The primary standards should only be prepared by persons or organizations proficient in preparing analytical standards. Do not reuse primary standards.

2.4.2. Secondary Standards: Use secondary standards certified by the manufacturer for a specific instrument model. Use secondary standards only for continuing calibration verifications according to the procedures in section 3.2.6. Verify the values of secondary standards according to the procedure and frequency outlined in section 3.2.5.

2.4.2.1. Care of Secondary Standards: Protect standards from direct sunlight, heat and scratches.

- Store the standards in the upright position. The most convenient way is to keep the standards in the original storage box provided by the manufacturer.
- During transport to and from the field, keep the standards in an air-conditioned vehicle away from the sun. Do not store on the dashboard or in the trunk if a vehicle.
- If the vehicle is not air conditioned, the standards may be placed in a watertight plastic bag and kept cooled in an ice chest.
- When not in use, store the standards in air conditioning or in ambient air not to exceed 90°F.
- Avoid getting fingerprints on the glass vial. Handle the standards only by the cap.
- Before daily use, inspect the secondary standard vials and, if necessary, clean the outside of the standard vials with a dilute solution of detergent, followed by a deionized or distilled water rinse. Wipe dry with lint-free paper or cloth.

2.4.2.2. Discard the standards set when:

- the standard value can no longer be verified (3.2.5);

## FT 2000 Field Measurement of Residual Chlorine

- obvious discoloration or fading has occurred,
- residue on the surfaces of the vials cannot be removed,
- scratches are visible on the glass vials; or
- a secondary gel standard has melted or resolidified in a position different from the original.

2.5. Recordkeeping and Documentation Supplies:

- Field notebook or forms (waterproof paper is recommended) )
- Indelible pens

## 3. CALIBRATION AND USE

3.1. Interferences: Sample color and turbidity may interfere in all colorimetric procedures applied to natural and treated waters. Other possible interferences are from: bromine, chlorine dioxide, iodine, permanganate, hydrogen peroxide, and ozone. If interferences are suspected, consult the applicable method for guidance (see FT 2050).

3.2. Calibration

3.2.1. Follow the calibration activities in FT 1000.

3.2.2. Initial Calibration: Use the primary standards (see 2.4.1 above) for initial calibration. An initial calibration must be performed if verification attempts are not successful (see 3.2.4 and 3.2.6 below).

3.2.2.1. Use a minimum of a blank and two standards that bracket the range of the sample measurements.

3.2.2.2. If the instrument cannot be calibrated with a blank and two standards, calibrate with a blank and one standard that bracket the range of the sample measurements.

3.2.2.3. Verify instruments with pre-set or factory calibrations against primary standards per 3.2.3 below.

3.2.2.4. The correlation coefficient of the standard calibration curve must be greater than or equal to 0.995 for all calibrations.

3.2.3. Instruments with Pre-Set or Factory Calibration

3.2.3.1. Instruments with a pre-set calibration do not require an initial calibration if the instrument calibration is verified with primary standards over the range of use (see 3.2.4 and 3.2.6 below for verification procedures).

3.2.3.2. Verify with primary standards before first use and at least annually.

3.2.3.3. Perform an initial calibration (3.2.2 above) when verification attempts are not successful.

3.2.4. Initial Calibration Verification: Immediately after calibrating an instrument, perform an initial calibration verification by reading at least one primary standard as a sample. The value of this standard must be within quantitative calibration bracket established in 3.2.2 above. The instrument reading from this standard must be within 10% of its standard value.

3.2.4.1. Perform initial verifications of color comparators per 3.2.6.4 below.

3.2.5. Determining or Verifying the Values of Secondary Standards:

3.2.5.1. Use only those certified by the manufacturer for a specific instrument. The values of secondary standards may be dependent on the make and model of the

instrument. **Perform all steps of the verification process on the same instrument model that will be used with the secondary standards.**

3.2.5.2. At a minimum, verify the values of secondary standards annually or when

- The standards appear to have been damaged;
- The standards were stored in direct sunlight;
- The meter failed to meet verification requirements with the secondary standards
- **More frequent calibration verifications are required for discharge permit compliance measurements or other regulatory requirements.**

3.2.5.3. Determine or verify the values of secondary standards using the following procedure

- Perform an initial calibration or calibration verification with primary standards.
- Select the primary standard concentrations so that the secondary standard concentrations are bracketed with acceptable primary standards.
- Immediately after verifying the acceptability of the calibration, 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, but the result is within the manufacturer's stated tolerance range, assign the reading as the value of the standard.
- If the reading is outside the +/- 10% criterion **and** the manufacturer's stated tolerance range, discard the secondary standard.

3.2.6. Continuing Calibration Verification:

3.2.6.1. Perform a continuing calibration verification using at least one primary or secondary standard. The concentration of the CCV standard should be within the initial calibration bracket established in 3.2.2 above and cannot be a zero or blank standard.

- If sample concentrations are outside the range established by the initial calibration, the range may be extended by selecting a continuing calibration verification standard that will bracket the sample concentrations.
- If sample concentrations exceed the range setting of the instrument (e.g., high or low range), verify at least two standards that bracket the sample in the alternate range setting.

3.2.6.2. Each CCV measurement must be within 10% of the known standard value. For secondary standards, use the known value(s) determined in 3.2.5 above. If any CCV attempt fails to meet the 10% acceptance criterion, establish the cause of the failure and reattempt the CCV before analyzing samples. The instrument must be recalibrated with an initial calibration (see 3.2.2 above) if the CCV acceptance criterion cannot be achieved. Qualify as estimated all sample measurement data obtained since the last acceptable verification.

3.2.6.3. Perform a CCV after the last sample measurement has been taken, but no longer than 24 hours after the previous verification. 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 (see FT 1000 section 2.2.5).

DEP-SOP-001/01  
FT 2000 Field Measurement of Residual Chlorine

3.2.6.4. For color comparators, verify comparator accuracy every six months by evaluating the comparator against primary standards with concentration values bracketing sample measurements. If the comparator readings differ from the standard values by more than 10%, qualify all sample measurements made since the last verification as estimated. Plot the comparator readings against the primary standard values. Use the plotted graph as a correction curve to be applied to future analyses of samples with the comparator. Replace comparators if color scales appear faded or discolored.

3.3. Sample Analysis (spectrophotometer or photometer):

3.3.1. Rinse the cuvette with a small amount of sample.

3.3.2. Discard the rinsate, and fill the cuvette with sample.

3.3.2.1. If samples are colored or turbid, compensate for these interferences by "zeroing" the meter with the sample before adding the chemicals for color development.

3.3.3. Add the reagents (DPD, buffer, etc.) to the sample according to the manufacturer's instructions.

3.3.4. Invert the container to mix.

3.3.5. Wait the required time for color development as specified in the referenced method or manufacturer's instructions. Do not exceed the maximum allowable time for color development before reading the sample.

3.3.6. Gently wipe the sides with a lint-free tissue and insert the cuvette into the instrument.

3.3.7. Follow the instrument's instructions for obtaining the sample value (either by direct read-out or by using a plot of the calibration curve).

3.3.8. After recording the sample reading, remove the cuvette, discard the sample and rinse the cuvette 3 – 5 times with de-ionized or distilled water.

3.3.9. Repeat steps 3.3.1 through 3.3.8 until all samples have been tested.

3.3.10. If the concentration of the samples exceeds the range setting of the instrument (e.g., high or low), change the range setting, and read the samples again. See 3.2.6.1 concerning calibration verification in a different range from the original initial calibration.

3.4. Color Wheel Comparator: Follow the manufacturer's instructions for obtaining the sample value from a color wheel when used for drinking water sample analysis.

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.

6.1.1. 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.

DEP-SOP-001/01  
FT 2000 Field Measurement of Residual Chlorine

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., potassium permanganate)
- Value of standard, including correct units (e.g.,  $\text{KMnO}_4 = 1 \text{ mg/L}$ )
- 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 2020. TITRIMETRIC METHODS

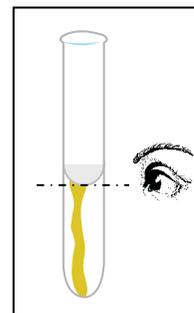
Residual chlorine can be measured using several different titrimetric methods. These methods take more time, require some skill in making chemical measurements, require several different reagents, and must be performed within 15 minutes of sample collection. Unless the expected concentration levels are below the analytical sensitivity of colorimeters, DEP recommends using the DPD colorimetric method (FT 2010).

If a titrimetric method must be used, select one of the following methods: SM 4500-Cl B, SM 4500-Cl C, SM 4500-Cl D, SM 4500-Cl E or SM 4500-Cl F. The following general discussions deal with using the titrimetric equipment only.

Quantitative and chronological brackets are not required for these methods.

Titrant solutions must be standardized at the frequencies specified in the above reference methods.

1. The volumetric glassware that is used to transfer and to titrate must be thoroughly clean.
  - 1.1. Use class A pipets for transferring samples and reagents; use a class A buret for titration.
  - 1.2. The volumetric pipets and the buret must be free flowing. This means that there cannot be any droplets remaining on the sides of the glassware when the liquid is dispensed.
  - 1.3. Check the glassware before use by filling with de-ionized or distilled water and allowing to drain. Do not use the glassware if droplets appear.
  - 1.4. Clean by using a buret brush or soaking. Use hot water and laboratory detergent.
  - 1.5. Rinse with tap water to remove the detergent.
  - 1.6. Rinse with de-ionized water and check for water droplets.
  - 1.7. Additional cleaning with chromic acid, or alcoholic potassium hydroxide may be needed to remove stubborn oil or films.
2. Rinse all glassware with a small amount of the solution to be dispensed or titrated, and discard the rinse.
  - 2.1. Carefully fill (or pipet) with the solution.
  - 2.2. Read the volume from the **bottom** of the meniscus [see figure⇒].
  - 2.3. After filling the buret, record the initial volume.
3. When performing the titration, add the titrant slowly.
  - 3.1. Swirl the flask gently while adding the titrant.
  - 3.2. As the solution comes closer the endpoint, the color change will last for a longer period of time. When this occurs, add the titrant dropwise and mix thoroughly between drops.
  - 3.3. The reaction is complete when the color change is permanent. Take the reading on the buret at the completion of the titration and record the reading.
4. Titrate at least two aliquots of each sample.



DEP-SOP-001/01  
FT 2000 Field Measurement of Residual Chlorine

5. Titrate at least one blank.
6. DOCUMENTATION:
  - 6.1. Standard and Reagent Documentation: Document information about standards and reagents used for calibrations, verifications, and sample measurements.
    - 6.1.1. Note the date of receipt, the expiration date and the date of first use for all standards and reagents.
      - 6.1.1.1. Document acceptable verification of any standard used after its expiration date.
    - 6.1.2. Record the concentration or other value for the standard in the appropriate measurement units.
      - 6.1.2.1. Note vendor catalog number and description for preformulated solutions as well as for neat liquids and powdered standards.
      - 6.1.2.2. Retain vendor assay specifications for standards as part of the calibration record.
    - 6.1.3. Record the grade of standard or reagent used.
    - 6.1.4. When formulated in-house, document all calculations used to formulate calibration standards.
      - 6.1.4.1. Record the date of preparation for all in-house formulations.
    - 6.1.5. Describe or cite the procedure(s) used to prepare any standards in-house (DEP SOP or internal SOP).
    - 6.1.6. Record the preparation of all reagents in the field notebook or in a form specifically designed for this purpose.
      - 6.1.6.1. Document all titrant standardizations.
7. For each sample and blank, record the volume of each sample, and the beginning and ending readings on the buret.

## **FT 2030. ION-SELECTIVE ELECTRODE METHODS**

1. INTRODUCTION AND SCOPE: Adapted from the "Orion Research Instruction Manual", Residual Chlorine Electrode Model 97-70, 1997. This method may be used if a method detection limit study verifies that the method can achieve the desired permit limits. This is not recommended for on-site use.
2. EQUIPMENT AND SUPPLIES
  - 2.1. Instrument
    - 2.1.1. pH-millivolt meter capable of an expanded 0.1 mV reading.
    - 2.1.2. Platinum-iodide combination electrode (recommended) or
    - 2.1.3. A platinum and an iodide ion selective electrodes.
    - 2.1.4. Magnetic Stirrer
  - 2.2. Reagents and Standards

DEP-SOP-001/01  
FT 2000 Field Measurement of Residual Chlorine

- pH 4.0 Buffer
- Acetic acid
- Potassium Iodide Solution: Dissolve 42 g potassium iodide and 0.2 g sodium carbonate in 500 mL chlorine demand-free deionized/distilled water.
- Potassium iodate (Primary Standard – 0.00281 N): Dissolve 0.1005 g potassium iodate ( $\text{KIO}_3$ ) in chlorine demand-free deionized/distilled water. Dilute to 1000 mL.

2.3. Recordkeeping and Documentation Supplies:

- Field notebook forms (waterproof paper is recommended) or
- Indelible pens

3. CALIBRATION AND USE

3.1. Standard Preparation: Prepare standards by volumetrically pipetting 0.2, 1.0, and 5.0 mL of the potassium iodate into 100 mL volumetric flasks.

3.1.1. Add 1 mL of the buffer and 1 mL potassium iodide solution to each.

3.1.2. Swirl and let stand for 2 minutes.

3.1.3. Bring to 100 mL, stopper and invert several times to mix.

3.1.4. Prepare a blank by adding all reagents except the potassium iodate to a 100 mL volumetric and bring the volume to 100 mL.

3.2. Initial Calibration: Follow manufacturer's instructions on the use of the instrument. Use the three standards and the blank to calibrate. Plot the curve on semilogarithmic graph paper or enter values into a direct-reading ion meter.

3.3. Verify the initial calibration before proceeding with sample analysis. Read at least one calibration standard as a sample. The measured value must be within 10% of the known value of the standard.

3.4. Continuing Calibration Verification: Use at least one of the standards to check the stability of the standard curve at the end of the analytical run or batch as in 3.3 above.

3.5. Follow the calibration and verification requirements in FT 1000, section 2.2.

3.6. Sample Analysis:

3.6.1. Adjust the pH of the sample with acetic acid to 4 – 5 pH units.

3.6.2. Pipet 1 mL buffer and 1 mL potassium iodide into a 100 mL volumetric flask. Swirl to mix and let stand for at least 2 minutes.

3.6.3. Bring to the volume to 100 mL with the pH-adjusted sample, stopper, and invert several times to mix.

3.6.4. Follow manufacturer's instructions for the use of the instrument.

3.7. Calculations:

3.7.1. Read the residual chlorine value in mg/L (R) from the calibration curve: mg/L residual chlorine =  $R \times 100/\text{mL sample used}$

3.7.2. Record all calculations.

4. PREVENTIVE MAINTENANCE: Refer to FT 1000, section 3.

5. DOCUMENTATION:

DEP-SOP-001/01  
FT 2000 Field Measurement of Residual Chlorine

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., potassium permanganate)
- Value of standard, including correct units (e.g.,  $\text{KMnO}_4 = 1 \text{ mg/L}$ )
- 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.

## FT 2000 Field Measurement of Residual Chlorine

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 2040. SCREENING METHOD TO DETERMINE THE ABSENCE OF RESIDUAL CHLORINE**

1. INTRODUCTION AND SCOPE: In some cases, wastewater treatment plants may need to determine the complete absence of residual chlorine after dechlorination. Some metered instruments may not have sufficient sensitivity to measure below 0.2-mg/L. This procedure was developed by Region 4 of the Environmental Protection Agency to be used to **determine, but not report** the absence of residual chlorine.

2. METHOD: Use any residual chlorine method. If a colorimetric method (FT 2010) is used, the spectrophotometer or colorimeter must be able to distinguish between 0.02 and 0.05 mg/L chlorine. To document the sensitivity, perform a method detection limit study to verify that the method detection limit is at least 0.02 mg/L.

3. PROCEDURE:

See Figure FT 2000-1

3.1. If used, calibrate the meter following FT 2010. Otherwise, use a titrimetric method (FT 2020).

3.2. Perform all tests within 15 minutes of collecting the samples.

3.3. Collect a grab sample at a point just before dechlorination or the effluent of the chlorine contact basin. This is sample **A**.

3.4. Collect a second grab sample after dechlorination. This should correspond to the final effluent monitoring point (sample **B**).

3.4.1. Sample **A** and Sample **B** must differ only by the dechlorination treatment. **There cannot be any waste streams that enter the system between the two collection points.**

3.5. Measure and pour equal volumes of Sample **A** and Sample **B** into a clean container that can be sealed. Use a container that leaves little or no headspace when filled. This is sample **C**.

3.5.1. Cap and gently invert the container (sample **C**) several times to mix the contents. **Do not shake vigorously.**

3.6. Measure the total residual chlorine in samples **A** and **C**.

DEP-SOP-001/01  
FT 2000 Field Measurement of Residual Chlorine

3.7. Calculate the concentration in sample **B**:

$$\text{Residual Chlorine in B (mg/L)} = [\mathbf{C}^2] - \mathbf{A}$$

3.8. The absence of residual chlorine is verified if the residual chlorine in **B** is less than or equal to  $\frac{1}{2} \mathbf{A} \times 1.10$ . Refer to figure FT 2000-1 for illustrative examples.

3.9. If the value results in a negative number and a sulfite salt (e.g., sodium bisulfite, sodium metabisulfite) was used to dechlorinate the effluent, less dechlorination agent can be added.

4. DOCUMENTATION: Document the following items as applicable.

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., potassium permanganate)
- Value of standard, including correct units (e.g.,  $\text{KMnO}_4 = 1 \text{ mg/L}$ )
- Link to information recorded according to section 5.1 above

DEP-SOP-001/01  
FT 2000 Field Measurement of Residual Chlorine

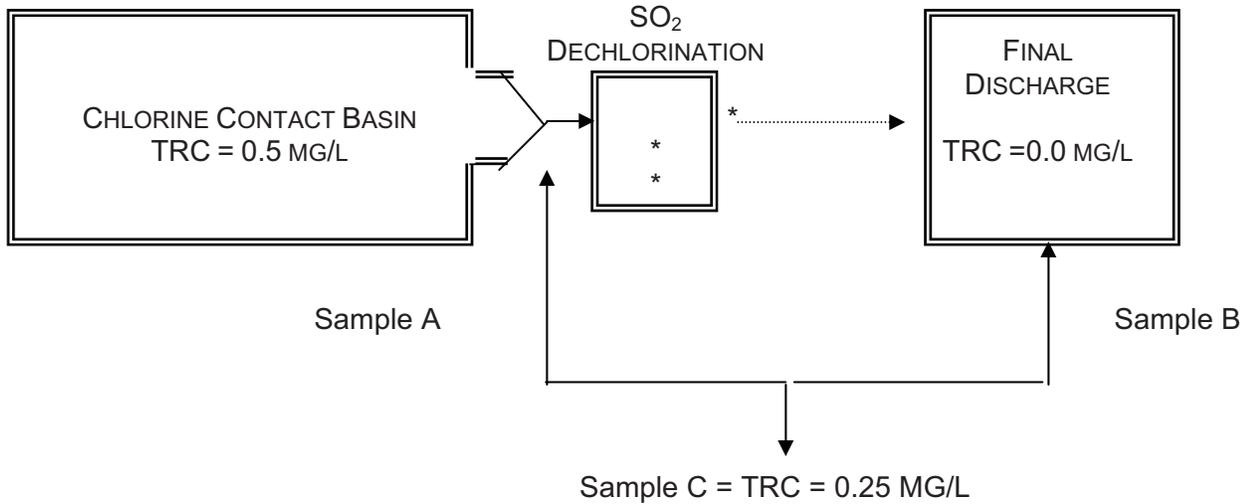
- 4.2.7. Retain manufacturers' instrument specifications.
  - 4.2.8. Document whether successful initial calibration occurred.
  - 4.2.9. Document whether each calibration verification passed or failed.
  - 4.2.10. Document any corrective actions taken to correct instrument performance according to records 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)

**Appendix FT 2000**  
**Tables, Figures and Forms**

Figure FT 2000-1 Screening Method for Determining Absence of Residual Chlorine

Figure FT 2000-1

**SCREENING METHOD FOR DETERMINING ABSENCE OF RESIDUAL CHLORINE**



A = Grab sample collected just prior to dechlorination.

B = Grab sample collected downstream of dechlorination at final discharge point.

C = Equal volumes of A & B mixed without aeration and the expectant

$$\text{TRC concentration mg/L} = \frac{A + B}{2} = \frac{0.5 + 0.0}{2} = 0.25$$

If  $1/2 A = C$ , then the TRC at Sample B =  $<0.01$  or the MDL value determined on the instrument whichever was greater.

If  $1/2 A > C$ , then excess SO<sub>2</sub> was added. The TRC concentration would be  $<0.25$  mg/L at Sample C and the TRC for Sample B = 0.0 mg/L and would be reported as a < value.

If  $C > 1/2 A$ , then Sample B would have TRC present in final effluent. To calculate the Sample B value:  $[C * 2] - A = \text{TRC concentration}$ . Example: If the TRC concentration of C = 0.27 and A = 0.5, then 0.

## ***FT 3000. AQUATIC HABITAT CHARACTERIZATION***

See also the following sections:

- FA 1000 Administrative Procedures
- FC 1000 Cleaning/Decontamination Procedures
- FD 1000 Documentation Procedures
- FM 1000 Field Planning and Mobilization
- FQ 1000 Field Quality Control Requirements
- FS 1000 General Sampling Procedures
- FT 1000 General Field Testing and Measurement
- LD 7000 Documentation of Biological Laboratory Procedures
- LQ 7000 Quality Control for Biological Community Analysis
- LT 7000 Determination of Biological Indices

1. INTRODUCTION AND SCOPE: The purpose behind habitat assessment is to collect key physical data components that can assist in interpreting biological community results. For example, if biological community health is impaired in a water body, is habitat disturbance or water quality degradation responsible?

### ***FT 3001. Physical/Chemical Characterization***

This sampling procedure requires specific training and demonstration of competency due to the expert judgment exercised during field sampling. It is recommended that individuals conducting this procedure train with DEP staff (via workshops and/or participating in field sampling) and pass a field performance test.

#### 1. EQUIPMENT AND SUPPLIES

- Physical/Chemical Characterization Field Sheet (FD 9000-3)
- Stream/River Habitat Sketch Sheet (FD 9000-4) or site map
- Pencil and pen
- Watch or stopwatch
- Flow Meter (optional)
- D-frame dip net with U.S. No. 30 mesh and handle marked in 0.1-m increments
- Secchi disk with at least three meters of 0.2 m sections marked on its rope
- Tape measure (100 m)
- Flagging tape
- Camera (optional)
- GPS tool (optional)

- Multi-probe meter or separate pH, dissolved oxygen, temperature and conductivity meters

## 2. METHODS

2.1. Fill in the information requested at the top of the Physical/Chemical Characterization Field Sheet (FD 9000-3), including the STORET station number, sampling date, sampling location, field identification and receiving body of water. (Much of this information can be recorded prior to field sampling.) Record the time when the water quality samples are first taken or when the assessment begins. If available, use a GPS tool to identify the latitude and longitude of the sampling location and record them on FD 9000-3.

2.2. Measure and record values for standard water quality parameters, including temperature, pH, dissolved oxygen, specific conductance or salinity and Secchi depth (see FT 1000).

2.3. In streams or rivers, measure the 100 m length of the sampling area and mark the beginning, end and sections of appropriate length (usually 10 or 25 meters) with flagging tape.

2.4. For streams and rivers, start at the downstream end of the reach and draw a sketch of the site on the Stream/River Habitat Sketch Sheet (FD 9000-4). In your sketch, show the observable (by sight or touch) location and amount of each productive substrate type in the 100 m reach. Using the grid on the map form, count the number of grid spaces for each substrate type. Divide each of these substrate numbers by the total number of grid spaces contained within the site sketch. If you cannot observe portions of the system (e.g., due to dark color and depth), include only the number of grids where observations were possible as the denominator in this calculation. Record this percent coverage value for each substrate type. For lakes, divide the site map into twelve equal sections and note visual markers that may assist in distinguishing those sections. You can use a pencil to draw the sketch of the site. GPS coordinates and photographs of the sampling area are also useful tools for documenting habitat conditions and identifying station locations.

2.5. Observe and estimate the percentage of land-use types in the watershed that drain to the site, including all that potentially affect water quality. Examination of maps prior to field sampling is a necessary component of this determination. Record this information on FD 9000-3.

2.6. Rate the potential for erosion within the portion of the watershed that affects your site. Record this information on FD 9000-3.

2.7. "Local non-point-source pollution" refers to contamination introduced by stormwater runoff. Estimate this input and record this information on FD 9000-3.

2.8. When sampling a 100 m section of a river or stream, measure or estimate the width of the system, from shore to shore, at a "typical" transect representative of the site. A "typical" transect is where the width/depth profile is most representative of the stream. In most cases, this will not be in deep pools or bends. When sampling a lake, wetland or estuary, estimate the size of the system or the size of the sample area within the system. Record this information on FD 9000-3.

2.9. Take three measurements of water depth across this transect using the ruled dip net handle or ruled rope of the Secchi disk and record this information on FD 9000-3.

2.10. Take three measurements of water velocity (one at each of the locations where water depth was measured) using either a flow meter or the ruled dip net handle,

watch/stopwatch, and a floating leaf or other object. For example, measure the length of time in seconds it takes for a submerged leaf or other detritus to travel 1 meter. Then, divide 1 by the number of seconds it took the leaf to travel the meter. Record this information on the data sheet. This procedure is relatively straightforward in streams and rivers. In lakes and wetlands, there is often no water velocity to measure, so note that on the form. However, if there is velocity (as in certain riverine wetlands or flow-through lakes), measure the velocity at three points across the system. In estuaries, the velocity will depend upon tidal cycle. Note the velocity during sampling and relate that to where it occurs in the tidal cycle.

2.11. Measure the vegetated riparian buffer zone width on each side of the stream or river or at the least buffered point of the lake, wetland, or estuary; this is the distance from the edge of the water to where clearing or other human activities begin. Record the distance for the least buffered side or point of the system on FD 9000-3. If the vegetated buffer zone width for the least buffered side or point is greater than 18 m, record ">18 m."

2.12. In a stream or river, indicate whether or not the area in the vicinity of the sampling station has been artificially channelized and to what extent the system has recovered.

2.13. Indicate the presence or absence of impoundments in the area of the sampling station that alter the natural flow regime or the movement of biota.

2.14. Where applicable, estimate and record the vertical distance from the current water level to the peak overflow level. Peak overflow level is indicated by debris hanging in bank, floodplain vegetation, or deposition of silt or soil. (When bank overflow is rare, a high water mark may not be apparent.) Add this distance to the current water depth (see section 2.9 above) to determine the distance of the high water mark above the streambed and record this value.

2.15. Check the box for the percentage range that best describes the degree of shading in the sampling area. This percentage should be an integration over the entire 100 m reach.

2.16. Note any odors associated with the bottom sediments and check the appropriate box. Note the presence or absence of oils in the sediment; for this step, and observe the extent of sheen on the water after the substrate has been disturbed. Finally, note any deposits in the area, including the degree of smothering by sand or silt.

2.17. Indicate the type of aquatic system being sampled. If the station is in a stream or river, indicate stream order.

2.18. Note the presence and types of any noticeable water odors and check the appropriate box. Note the term that best describes the relative coverage of any oil on the water surface.

2.19. Based on visual observation, check the term that best describes the amount of turbidity in the water before it was disturbed by sampling.

2.20. Check box for the term that best describes the color of the water, indicating whether the water is tannic, green, clear or other. (If "other" is checked, indicate what the color is.)

2.21. Describe the weather conditions during the time of sampling, particularly the relative amount of sunshine/cloud cover, temperature, and wind speed and direction. Record any other conditions/observations that are helpful in characterizing the site.

2.22. Estimate and record the relative abundances of the following: periphyton, fish, aquatic macrophytes and iron/sulfur bacteria.

2.23. Sign and date the form (FD 9000-3).

## FT 3100. Stream and River Habitat Assessment

This sampling procedure requires specific training and a demonstration of competency due to the expert judgment exercised during field sampling. It is recommended that individuals conducting this procedure train with DEP staff (via workshops and/or participating in field sampling) AND complete the training requirements listed in FA 5720.

### 1. EQUIPMENT AND SUPPLIES

- Completed Physical/Chemical Characterization Field Sheet (FD 9000-3); see FT 3001, section 2
- Completed Stream/River Habitat Sketch Sheet (FD 9000-4); see FT 3001, section 2.4
- Stream/River Habitat Assessment Field Sheet (FD 9000-5)
- Pen
- D-frame dip net with U.S. No. 30 mesh and handle marked in 0.1-m increments

### 2. METHODS

2.1. Fill in the information requested at the top of the Stream/River Habitat Assessment Field Sheet (FD 9000-5), including the STORET station number, sampling date, sampling location, field identification and receiving body of water. Record the time of sampling as described in FT 3001, section 2.1.

2.2. Follow the criteria given on the data sheet within each category to determine the appropriate score for that category.

2.3. Score the **Substrate Diversity** by evaluating the number of different kinds of productive substrates present. Refer to the Stream/River Habitat Sketch Sheet (FD 9000-4) and the Physical/Chemical Characterization Field Sheet (FD 9000-3). The following substrates are considered productive: snags (woody debris or logs larger than thumb diameter); roots (less than thumb diameter, with finer roots usually being more productive); aquatic vegetation (in contact with the water); leaf packs/mats in association with flow (leaves must be partially decomposed to be better habitat; leaf mats at the bottom may be productive if sufficient oxygen is present, but anaerobic leaf mats are not considered productive habitat); rocky substrate (usually limestone outcrops with rock diameters greater than 5 cm). Once the number of substrates has been determined, assign a score for substrate diversity in the appropriate spot on the sheet. (Higher values indicate a better condition than lower values.) The quality of the substrates present should then be given consideration in the scoring process. For example, partially decomposed leaf packs and "old" snags are better than fresh substrates and should be given higher scores within the same category. A minimum occurrence of two square meters of a particular substrate in the reach is necessary to count that substrate as being "present."

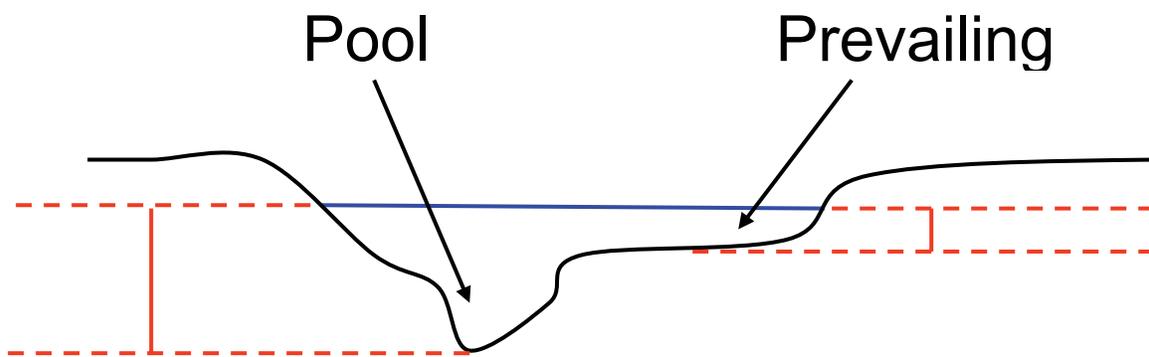
2.4. **Substrate Availability** is the relative spatial abundance of productive habitats present. Refer to the entry on FD 9000-3, as determined from FD 9000-4. A minimum occurrence of two square meters of a particular substrate in the reach is necessary to count that substrate as being "present." Include only productive habitats in the mapping and scoring process. Score substrate availability on the data sheet based on the sum of the percentages of productive habitats in the stream reach.

2.5. Using the ranges given on the data sheet, assign a **Water Velocity** score based on the maximum velocity observed at the typical cross-section of stream or river as determined on the physical/chemical form (FT 3001 section 2.10). Avoid areas immediately before or

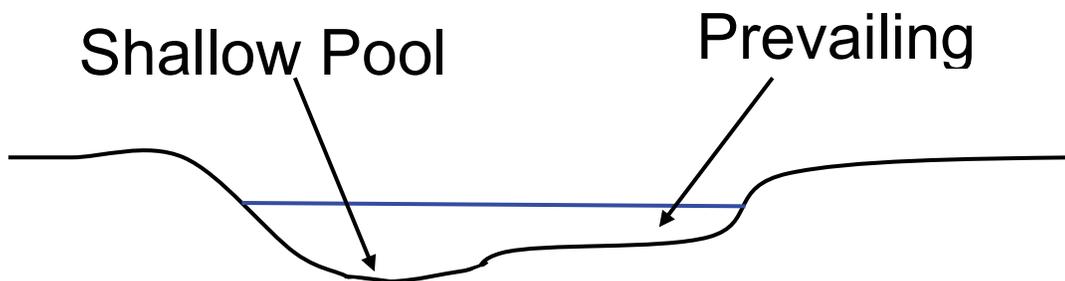
after snags or other material that restrict or enhance the velocity unless this is typical of the majority of the run. Note that in the majority of Florida streams, velocities over 1 m/s are considered unusually high, and should be included in the “poor” category. An exception to this policy would be in narrow or shallow areas of streams with natural limestone bottoms, where velocities approaching 1 m/s may be normal and, thus, would be scored in the “optimal” category.

2.6. The **Habitat Smothering** parameter is an assessment of sand and silt deposition onto what would otherwise be productive habitats. Scoring is a two-step process. Assign a habitat smothering score as determined by the following two steps:

2.6.1. First, determine (by referring to FD 9000-4) if adequate pools are present. For large, wide rivers it may be more appropriate to base the estimate on the actual amount of smothering on the habitats rather than the number of pools. A pool is defined as an area where the depth is at least 2 times the prevailing depth.



A natural system should have 1 to 2 pools every 12 times the width of the stream. For example, a 3 meter wide stream should have at least 1 pool every 36 meters or a total of 3-6 pools per 100 meter reach ( $100\text{m}/36\text{m} = 2.8$  segments). If there are no pools; i.e., the stream depth is nearly the same throughout the 100m reach, assign a score in the “poor” category. If there are minimal (less than 1 pool every 12 times the width) or shallow pools (a shallow pool is any pool where the depth is much less than 2 times the prevailing depth), score the stream in the “marginal” category.



Pools should occur on the outside of curves in the stream and on the downstream side of large, woody debris. A score in the “suboptimal” or “optimal” categories should be assigned to a stream with adequate pools based on the percent smothering as described in 2.6.2 below.

2.6.2. Second, check for deposition of sand or silt on visible habitats. While a light dusting of sand or silt is normal, excessively thick coatings will reduce habitability of the substrate. Sand or silt smothering on visible habitats is indicated if either is present on a substrate in an amount greater than a light dusting (3-5 mm). Determine a percentage value for visible habitats that are not habitable due to sand and/or silt smothering.

2.7. Add the scores for the primary habitat components (see sections 2.3-2.6 above) and record this primary score on the form. The primary habitat components refer to in-stream features.

2.8. Observe whether or not the reach of stream or river in the sampling area is artificially channelized. Assign a score for **Artificial Channelization** using the following guide:

2.8.1. Poor- A highly altered system with ALL of the following; straightened stream channel, box-cut banks and a monotypic depth. Spoil banks or other indications of dredging may be visible.

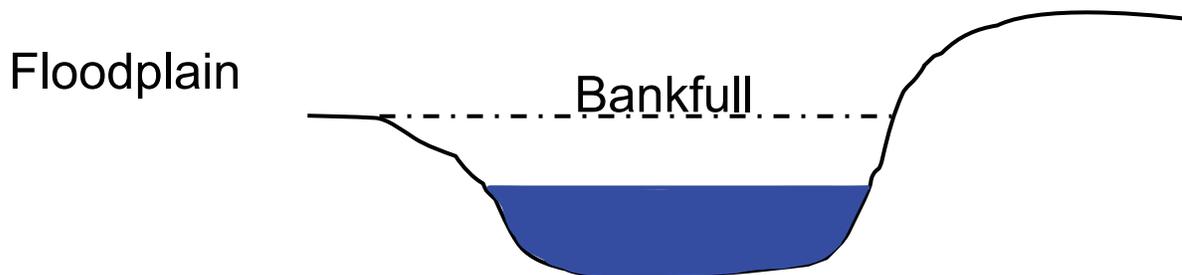
2.8.2. Marginal- An altered system with some sinuosity in stream channel, often developed within the old dredged area, OR some diversity in depth but no pools as defined in 2.6 above. Spoil banks may be visible.

2.8.3. Suboptimal- Good sinuosity has developed within and outside of the old channelized area AND the bottom has a diversity of depths approaching what's expected of a non-dredged system (1 to 2 pools every 12 times the width of the stream). Spoil banks may be visible, but have established vegetation growing on them.

2.8.4. Optimal- A system with good stream channel sinuosity AND a diversity of depths as defined in 2.6 above. No evidence of dredging or straightening.

2.9. Refer to FD 9000-4 for areas along the bank that have eroded or have the potential for bank sloughing. Score artificially stable banks such as concrete according to bank stability, not according to natural vs. artificial stability. Determine the extent of erosion potential for the site and assign a **Bank Stability** score for each bank (The "left bank" is on your left when you are looking upstream).

2.9.1. First, determine where "bankfull" is in relation to the height of each bank. Bankfull is defined as the stage at which channel maintenance is most effective and occurs on average every 1-2 years. For most natural Florida streams, bankfull is the height of the lowest bank, where the stream is connected to the floodplain.



Other indicators of bankfull (especially in larger systems) are the tops of point bars, staining and vegetation lines. If the substrate at bankfull is limestone, pipe clay or concrete, then automatically score the bank in the "optimal" category and skip 2.9.2 and 2.9.3 below. Ideally, bankfull should be greater than 60% of the bank height or above the woody root zone. If this is the case, the bank gets a "plus" for this subcomponent. Otherwise, bankfull is less than 60% of bank height and below the woody root zone and it should receive a "minus".

2.9.2. Second, determine the slope of the bank. The more gentle the slope the more stable the bank. Score a bank with a slope less than 60° with a plus for this subcomponent. A bank with a slope of greater than 60° warrants a minus.

2.9.3. Third, determine if bankfull is above or below the root zone. If bankfull is above the root zone and there are few raw or eroded areas, score this subcomponent a plus. Otherwise, score it a minus. Woody vegetation/roots are more stable than herbaceous and should be scored accordingly.

2.9.4. Lastly, count up the number of pluses from each subcomponent (a total of 3 possible) and score within each category as described below:

2.9.4.1. Poor- 0 pluses

2.9.4.2. Marginal- 1 plus

2.9.4.3. Suboptimal- 2 pluses

2.9.4.4. Optimal- 3 pluses

2.10. Assign a score for the **Riparian Buffer Zone Width** that best characterizes the width of vegetation on each side of the channel. This zone is measured from the edge of the stream bank to where clearing or other adverse human activity begins. Take into account the intensity of the disturbance and score accordingly. For example, a footpath that runs along one bank for 20 meters is much less intense than a paved road that runs along the same 20 meter stretch. A native vegetated buffer zone of greater than 18 m (approximately 60 feet) is currently considered optimal.

2.11. Identify the plants in the riparian zone, determining the extent of coverage and whether the vegetation is native or exotic. Look for these classes of plants: bottomland or mesic hardwoods, understory shrubs and non-woody macrophytes. Assign a **Riparian Zone Vegetation Quality** score based on the classes of plants present, the degree of bank vegetative cover, and how closely the plant community at the site approaches that expected of an undisturbed community in the region.

2.12. Add the scores for the secondary habitat components (see sections 2.8-2.11) and record this secondary score on the form. The secondary habitat components refer to morphological and riparian zone features.

2.13. Add the primary score (see section 2.7) and the secondary score (see section 2.12) to get the habitat assessment total score. Record the habitat assessment total score on the form.

2.14. Sign and date the form (FD 9000-5).

## **FT 3200. Lake Habitat Assessment**

This sampling procedure requires specific training and a demonstration of competency due to the expert judgment exercised during field sampling. It is recommended that individuals conducting this procedure should train with DEP staff (via workshops and/or participating in field sampling) and pass a field performance test.

1. EQUIPMENT AND SUPPLIES

- Completed Physical/Chemical Characterization Field Sheet (FD 9000-3); see FT 3001, section 2
- Lake Habitat Assessment Field Sheet (FD 9000-6)
- Pen
- Identification keys for aquatic plants
- Lake map
- Frotus
- Petite Ponar or Ekman dredge
- Plastic bucket
- Water color standard (20 PCU) in a clear plastic or Teflon bottle
- Clear plastic or Teflon sample bottles (for water color comparisons)

2. METHODS

2.1. Before going into the field, obtain a map of the sampling lake, and divide the sampling area into 12 equal sections on the map. For lakes less than 1,000 acres, logically divide the lake into 12 sampling units. For lakes larger than 1,000 acres, also divide the lake into two to four major sampling divisions.

2.2. Before going into the field, fill in the information requested at the top of the Lake Habitat Assessment Field Sheet (FD 9000-6), including the STORET station number, sampling date, sampling location, field identification, county and lake size.

2.3. At the site, make a preliminary survey of the lake to become familiar with features of the shoreline and lake sections corresponding to the lake map. Mark features observed.

2.4. Check the box that most adequately describes the **Hydrology** (water residence time) of the system. Lakes characterized by long water residence times and no surface water inflow or outflow are isolated systems dominated by rain events and groundwater seepage. Lakes with some flow or moderate to long water residence times have some surface water inputs but rarely have surface water discharges. Flow-through lakes are characterized by short water residence times.

2.5. Mark the box that accurately describes the **Color** of the lake. Very clear and moderately colored lakes should be sampled for benthic macroinvertebrates (see FS 7460). Dark and extremely dark lakes require the visual vegetative survey method, not invertebrate sampling. Dark lakes are defined as having a color greater than 20 PCU; make a visual comparison using a 20 PCU standard and a sample of lake water.

2.6. Score the Secchi depth based on the depth at which the Secchi disk can first no longer be seen. Disk visible on bottom (VOB) gets a score of 20.

2.7. To score the **Vegetation Quality**, survey each section of the lake and identify the major submerged and emergent vegetation. Note the dominant species. Lakes with less than 5% aerial coverage of nuisance vegetation score in the optimal category. Lakes with 6%-20% nuisance vegetation or more than 50% of the surface covered with native, emergent macrophytes score in the suboptimal range. If the maximum depth of the "lake" is two meters or less and the macrophyte coverage is >50%, evaluate the site using wetland methods. The marginal category for this parameter is characterized by lakes with large

masses (21%-40%) of nuisance macrophytes (*Hydrilla*, hyacinth, cattail, duckweed, etc.) or algal mats. Lakes rating in the poor category for this parameter have either >40% nuisance vegetation (macrophytes and/or algal mats) or few plants present indicating plant removal.

2.8. For the **Stormwater Inputs** category, assign an appropriate score based on how stormwater enters the lake. Sheet flow over an uncultivated vegetated buffer zone is considered optimal. Ditches, discharge pipes and streams are other sources for stormwater input. When scoring this parameter, consider best management practices (BMPs). For example, ditching with good BMPs (swales, retention areas, etc.) should score higher than ditching directly into the lake.

2.9. To determine **Bottom Substrate Quality**, use a Petite Ponar or Ekman dredge to collect bottom samples from at least four separate locations on the lake. Score the lake based on the predominant substrate. A substrate dominated by sand with small amounts of detritus and coarse particulate organic matter (CPOM) is considered optimal. Submerged aquatic vegetation (SAV) may be present as well. Higher percentages of CPOM, hard-packed sand, algae or nuisance macrophytes covering the bottom are lower quality substrates. Thick deposits of fine detritus or anaerobic mud/muck are considered to be in the poor category.

2.10. To determine **Lakeside Adverse Human Alterations**, visually observe the entire perimeter of the lake for human-made structures such as houses and roads. Less than 10% development of the shoreline is considered to be in the optimal category. The greater the percentage of development, the lower the score for this category.

2.11. Identify plants in the **Upland Buffer Zone**, determining the width of the vegetated zone, percentage of vegetated shoreline, and whether the vegetation is native or exotic. A buffer zone of >18 m is considered optimal.

2.12. To determine **Adverse Watershed Land Use**, score the potential effects from adverse human land uses based on a continuum of amounts, density and type as listed on the form.

2.13. Add the scores from each assessment parameter and record the sum. This value is the site's habitat assessment total score.

2.14. Sign and date the form (FD 9000-6).

**FT 3300. Wetland Habitat Assessment, (Reserved)**

**FT 3400. Estuary Habitat Assessment, (Reserved)**

**Appendix FT 3000**  
**Tables, Figures and Forms**

Form FD 9000-3 Physical/Chemical Characterization Field Sheet

Form FD 9000-4 Stream/River Habitat Sketch Sheet

Form FD 9000-5 Stream/River Habitat Assessment Field Sheet

Form FD 9000-6 Lake Habitat Assessment Field Sheet

**PHYSICAL/CHEMICAL CHARACTERIZATION FIELD SHEET**

SUBMITTING AGENCY CODE: _____ SUBMITTING AGENCY NAME: _____		STORET STATION NUMBER: _____	DATE (M/D/Y): _____	TIME _____	RECEIVING BODY OF WATER: _____
REMARKS: _____	COUNTY: _____	LOCATION: _____		FIELD ID/NAME: _____	

**RIPARIAN ZONE/STREAM FEATURES**

PREDOMINANT LAND-USE IN WATERSHED (specify relative percent in each category):

FOREST/NATURAL <input type="text"/>	SILVICULTURE <input type="text"/>	FIELD/PASTURE <input type="text"/>	AGRICULTURAL <input type="text"/>	RESIDENTIAL <input type="text"/>	COMMERCIAL <input type="text"/>	INDUSTRIAL <input type="text"/>	OTHER (SPECIFY) <input type="text"/>
--	--------------------------------------	---------------------------------------	--------------------------------------	-------------------------------------	------------------------------------	------------------------------------	---

LOCAL WATERSHED EROSION (check box): None  Slight  Moderate  Heavy

LOCAL WATERSHED NPS POLLUTION (check box): No evidence  Slight  Moderate potential  Obvious sources

WIDTH OF RIPARIAN VEGETATION (m) On least buffered side:	LIST & MAP DOMINANT VEGETATION ON BANK	TYPICAL WIDTH, DEPTH & VELOCITY <input type="text"/> m wide	TYPICAL VELOCITIES
ARTIFICIALLY CHANNELIZED <input type="checkbox"/> no <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> recent, severe some recovery mostly recovered		----- <input type="text"/> m/s <input type="text"/> m/s <input type="text"/> m/s	7 secs = 0.14 m/s
ARTIFICIALLY IMPOUNDED <input type="checkbox"/> yes <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> more sinuous		<input type="text"/> m deep <input type="text"/> m deep <input type="text"/> m deep	6 secs = 0.17 m/s
HIGH WATER MARK <input type="text"/> + <input type="text"/> = <input type="text"/> (m above present water level)    (present depth in m)    (m above bed)			5 secs = 0.20 m/s
			4 secs = 0.25 m/s
			3 secs = 0.33 m/s
			2 secs = 0.50 m/s
			1 sec = 1.0 m/s

CANOPY COVER %: OPEN:  LIGHTLY SHADED (11-45%):  MODERATELY SHADED (46-80%):  HEAVILY SHADED:

**SEDIMENT/SUBSTRATE**

SEDIMENT ODORS: NORMAL:  SEWAGE:  PETROLEUM:  CHEMICAL:  ANAEROBIC:  OTHER:  \_\_\_\_\_

SEDIMENT OILS: ABSENT:  SLIGHT:  MODERATE:  PROFUSE:

SEDIMENT DEPOSITION: SLUDGE:  SAND SMOTHERING: NONE MODERATE SLIGHT SEVERE SILT SMOTHERING: NONE MODERATE OTHER: \_\_\_\_\_

SUBSTRATE TYPE	% COVERAGE	# TIMES SAMPLED	METHOD	SUBSTRATE TYPES	% COVERAGE	# TIMES SAMPLED	METHOD
WOODY DEBRIS (SNAGS)				SAND			
LEAF PACKS OF MATS				MUD/MUCK/SILT			
AQUATIC VEGETATION				OTHER:			
ROCK OR SHELL RUBBLE				OTHER:			
ROOTS				<b>DRAW AERIAL VIEW SKETCH OF HABITATS FOUND IN 100 M SECTION</b>			

WATER QUALITY	DEPTH (M):	TEMP. (°C):	PH (SU):	D.O. (MG/L):	COND. (UMHO/CM) OR SALINITY (PPT):	SECCHI (M):
TOP						
MID-DEPTH						
BOTTOM						

SYSTEM TYPE: STREAM: 1<sup>ST</sup>-2<sup>ND</sup> ORDER    5<sup>TH</sup>-6<sup>TH</sup> ORDER  
3<sup>RD</sup>-4<sup>TH</sup> ORDER    7<sup>TH</sup> ORDER OR GREATER    LAKE:  WETLAND:  ESTUARY:  OTHER:  \_\_\_\_\_

WATER ODORS (CHECK BOX): NORMAL:  SEWAGE:  PETROLEUM:  CHEMICAL:  OTHER:  \_\_\_\_\_

WATER SURFACE OILS (CHECK BOX): NONE:  SHEEN:  GLOBS:  SLICK:

CLARITY (CHECK BOX): CLEAR:  SLIGHTLY TURBID:  TURBID:  OPAQUE:

COLOR (CHECK BOX): TANNIC:  GREEN (ALGAE):  CLEAR:  OTHER:  \_\_\_\_\_

WEATHER CONDITIONS/NOTES:	ABUNDANCE:	ABSENT	RARE	COMMON	ABUNDANT
	PERIPHYTON	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	FISH	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	AQUATIC MACROPHYTES	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	IRON/SULFUR BACTERIA	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

SAMPLING TEAM: _____	SIGNATURE: _____	DATE: _____
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**Stream/River Habitat Sketch Sheet**

Length of grid represents 100 m of stream (not linear meters).  
 (Horizontal scale is double vertical scale, draw proportionately).

Substrates: Code key, draw proportionate habitat abundance.

- Snags
- Roots
- Leaf Packs (or mats)
- Macrophytes
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_

**Velocity:**  
 Note where velocity measures were taken.

**Habitat Smothering:**  
 Note areas (on map) where sand or silt is smothering substrates, limiting habitability.

**Bank Stability:**  
 Note areas (on map) with unstable, eroding banks.

**Riparian Buffer Width:**  
 Note areas (on map) where natural vegetation is altered or eliminated.

Plants observed/other notes:

Downstream

STATE OF FLORIDA, DEPARTMENT OF ENVIRONMENTAL PROTECTION  
**STREAM/RIVER HABITAT ASSESSMENT FIELD SHEET**

SUBMITTING AGENCY CODE: _____		STORET STATION NUMBER: _____	DATE (MM/DD/YY): _____	RECEIVING BODY OF WATER: _____
SUBMITTING AGENCY NAME: _____				
REMARKS: _____	COUNTY: _____	LOCATION: _____	FIELD ID/NAME: _____	

Habitat Parameter	Optimal	Suboptimal	Marginal	Poor
<b>Primary Habitat Components</b>  <b>Substrate Diversity</b> _____ 20 19 18 17 16	Four or more productive habitats present [snags, tree roots, aquatic vegetation, leaf packs (partially decayed), rock] 20 19 18 17 16	Three productive habitats present. Adequate habitat. Some substrates may be new fall (fresh leaves or snags) 15 14 13 12 11	Two productive habitats present. Less than desirable habitat, frequently disturbed or removed 10 9 8 7 6	One or less productive habitat. Lack of habitat is obvious, substrates unstable or smothered 5 4 3 2 1
<b>Substrate Availability</b> _____ 20 19 18 17 16	Greater than 30% productive habitat present at site 20 19 18 17 16	16% to 30% productive habitat, by aerial extent 15 14 13 12 11	6% to 15% productive habitat 10 9 8 7 6	Less than 5% productive habitat 5 4 3 2 1
<b>Water Velocity</b> _____ 20 19 18 17 16	Max. observed at typical transect: > 0.25 m/sec. But < 1 m/sec 20 19 18 17 16	Max. observed at typical transect: >0.1 to 0.25 m/sec 15 14 13 12 11	Max. observed at typical transect: 0.05 to 0.1 m/sec 10 9 8 7 6	Max. observed at typical transect: <0.05 m/sec; or spate occurring: > 1 m/sec 5 4 3 2 1
<b>Habitat Smothering</b> _____ ----- Primary Score _____ 20 19 18 17 16	Adequate number of pools (1-2 per 12 times width) and <25% of habitats affected by sand or silt accumulation. 20 19 18 17 16	Adequate number of pools (1-2 per 12 times width) and >25% of habitats affected by sand or silt accumulation. 15 14 13 12 11	Does not have required number of pools (1-2 per 12 times width) and/or has shallow pools (<2 times prevailing depth). 10 9 8 7 6	Pools are absent. Most habitats affected by sand or silt accumulation. 5 4 3 2 1
<b>Secondary Habitat Components</b>  <b>Artificial Channelization</b> _____ 20 19 18 17 16	Good sinuosity. No evidence of dredging or artificial straightening. No spoil banks. Diversity of depths. 20 19 18 17 16	Good sinuosity within old channelized area and a diversity of depths. Evidence of dredging in the past (>10 yrs) but mostly recovered. 15 14 13 12 11	Some sinuosity developed within channelized area. Some diversity of depth, but no pools (>2 times prevailing depth) present. 10 9 8 7 6	Straightened with spoil banks. Box-cut, monotypic depth with no pools. 5 4 3 2 1
<b>Bank Stability</b>  Right Bank _____ Left Bank _____ 10 9	Bankfull > 60% of bank height. Slope of bank ≤ 60°. Bankfull is within or above the root zone with few raw, eroded areas. 10 9	Only meets 2 of the 3 requirements for optimal bank stability. 8 7 6	Only meets 1 of the 3 requirements for optimal bank stability. 5 4	Bankfull < 60% of bank height. Slope of bank > 60°. Bankfull is below the root zone with raw, eroded areas. 3 2 1
<b>Riparian Buffer Zone Width</b>  Right Bank _____ Left Bank _____ 10 9	Width of vegetation greater than 18 m 10 9	Width of vegetation >12 to 18 m 8 7 6	Width of vegetation 6 to 12 m. human activities still close to system 5 4	Less than 6 m of buffer zone due to intensive human activities 3 2 1
<b>Riparian Zone Vegetation Quality</b>  Right Bank _____ Left Bank _____ ----- Secondary Score _____ 10 9	Over 80% of riparian surfaces consist of normal, expected plant community for given sunlight & habitat conditions (e.g., native plants, trees, understory shrubs, or non-woody macrophytes). Minimal disturbance. 10 9	>50% to 80% of riparian zone is undisturbed (normal, expected plant community for given sunlight & habitat conditions). Some disruption in community observed. 8 7 6	25% to 50% of riparian is undisturbed (normal, expected plant community for given sunlight & habitat conditions). Disruption obvious. 5 4	Less than 25% of riparian is undisturbed (normal, expected plant community for given sunlight & habitat conditions). 3 2 1

**TOTAL SCORE**

Date: _____	Analyst: _____	Signature: _____
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STATE OF FLORIDA, DEPARTMENT OF ENVIRONMENTAL PROTECTION  
**Lake Habitat Assessment Field Sheet**

STORET STATION NUMBER:	DATE (M/D/Y)	LAKE NAME										FIELD ID / NAME:									
ECO-REGION:	COUNTY:	SAMPLING LOCATION/DESCRIPTION:										LAKE SIZE:									
<b>PARAMETER</b>	No surface inflow or outflow present, very long water residence time, groundwater seepage dominates					Surface water inflow present, but flow is rare, moderate to long water residence time					Surface water inflow and outflow present (or outflow only), sometimes with visible flow, short water residence time					Impounded, hydrology of system artificially controlled					
<b>HYDROLOGY</b>	<input type="checkbox"/>					<input type="checkbox"/>					<input type="checkbox"/>					<input type="checkbox"/>					
<b>Color</b>	Very clear, uncolored water (benthic sampling appropriate) <input type="checkbox"/>					Water somewhat tannin stained (benthic sampling appropriate) <input type="checkbox"/>					Dark, discolored water (water color 20 PCU or higher) <input type="checkbox"/>					Visibility extremely reduced due to high color <input type="checkbox"/>					
	<b>Optimal</b>					<b>Suboptimal</b>					<b>Marginal</b>					<b>Poor</b>					
<b>Secchi</b> <input type="checkbox"/>	Secchi >3 m      Secchi(m)					3	2.6	2.2	1.8	1.4	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	
	Or	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
<b>Vegetation Quality</b> <input type="checkbox"/>	Diverse, expected native vegetation (emergent or submersed), less than 5% nuisance taxa					Mostly expected native plants, but moderate growths (6%-20% of lake) of nuisance macrophytes, or more than 50% of lake covered with plants					Large masses (21%- 40%) of nuisance macrophytes (e.g., Hydrilla, hyacinth, cattail, etc.) or algal mats					Lake choked (>40%) with nuisance macrophytes (duckweed, hyacinth, etc.) or algal mats, or few plants present at all (e.g., plants removed)					
	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
<b>Stormwater Inputs</b> <input type="checkbox"/>	Stormwater enters system via sheet flow over non-cultivated and/or natural vegetation					Some direct stormwater inputs (ditches, pipes, cultivated vegetation < 10%) but good BMPs in place					Moderate direct inputs of stormwater (ditches, pipes, cultivated vegetation 11%-50%) but few BMPs in place					Much direct input of stormwater (ditches, pipes, cultivated vegetation > 51%) and no or ineffective BMPs in place					
	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
<b>Bottom Substrate Quality</b> <input type="checkbox"/>	Diverse mixture of sand, detritus, with small amounts of CPOM/mud/muck. SAV may be present					Mixture of sand or clay and detritus with higher % CPOM/mud/muck content. SAV may be present					Moderate layer of CPOM/mud/muck, or hardpacked sand only, or moderate algal growth (mats or Chara) on bottom					Thick deposits of CPOM, or fine detritus and anaerobic muck/mud/silt, or algal growth or nuisance plants (Hydrilla) cover bottom					
	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
<b>Lakeside Adverse Human Alternations</b> <input type="checkbox"/>	Very few man-made structures, roads, or other disturbance adjacent to lake (<10%)					Moderate disturbance visible (structures, roads or other), 10%-49% lakeside affected					Many structures, roads or other human disturbance visible (50%-70%) lakeside affected					Highly developed or disturbed (>70% of lakeside affected)					
	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
<b>Upland Buffer Zone</b> <input type="checkbox"/>	Expected native vegetation between uplands and littoral zone, greater than 90% of shore with >18 m buffer					89%-51% of shoreline with >18m buffer or >75% with 10m to 18m buffer					50%-30% of shoreline with >18m buffer or 50%-74% with 10m to 18m buffer					< 29% of shoreline with >18m buffer					
	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
<b>Adverse Watershed Land Use</b> <input type="checkbox"/>	Score the potential effects from adverse human land uses, based on a continuum of amount and type, with least to most adverse as follows: Native vegetation, Silviculture, Pasture or Citrus, Low Density Residential, Row Crops, Commercial, High Density Residential, Urban, Industrial																				
	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	

TOTAL SCORE		COMMENTS:
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ANALYSIS DATE:	ANALYST:	SIGNATURE:
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Series	PDF File	Description
Field Title Page	<a href="#">fieldtitle.pdf (80 kB)</a>	Title Page, Field
FA 1000	<a href="#">fa1000.pdf (400 kB)</a>	Administrative
FC 1000	<a href="#">fc1000.pdf (280 kB)</a>	Field Decontamination
FD 1000	<a href="#">fd1000.pdf (380 kB)</a>	Documentation
FM 1000	<a href="#">fm1000.pdf (240 kB)</a>	Field Mobilization
FQ 1000	<a href="#">fq1000.pdf (90 kB)</a>	Quality Control
FS 1000	<a href="#">fs1000.pdf (612 kB)</a>	General Sampling
FS 2000	<a href="#">fs2000.pdf (297 kB)</a>	General Water Sampling
FS 2100	<a href="#">fs2100.pdf (107 kB)</a>	Surface Water Sampling
FS 2200	<a href="#">fs2200.pdf (486 kB)</a>	Groundwater Sampling
FS 2300	<a href="#">fs2300.pdf (65 kB)</a>	Drinking Water Sampling
FS 2400	<a href="#">fs2400.pdf (217 kB)</a>	Wastewater Sampling
FS 3000	<a href="#">fs3000.pdf (159 kB)</a>	Soil Sampling
FS 4000	<a href="#">fs4000.pdf (89 kB)</a>	Sediment Sampling
FS 5000	<a href="#">fs5000.pdf (241 kB)</a>	Waste Sampling
FS 6000	<a href="#">fs6000.pdf (709 kB)</a>	Tissue Sampling
FS 7000	<a href="#">fs7000.pdf (442 kB)</a>	Biological Communities
FS 8100	<a href="#">fs8100.pdf (50 kB)</a>	Contaminated Surfaces Sampling
FS 8200	<a href="#">fs8200.pdf (258 kB)</a>	Clean Sampling for Trace Metals
FT 1000	<a href="#">ft1000.pdf (98 kB)</a>	Field Testing General
FT 1100	<a href="#">ft1100.pdf (72 kB)</a>	Field pH
FT 1200	<a href="#">ft1200.pdf (149 kB)</a>	Field Specific Conductance
FT 1300	<a href="#">ft1300.pdf (74 kB)</a>	Field Salinity
FT 1400	<a href="#">ft1400.pdf (65 kB)</a>	Field Temperature
FT 1500	<a href="#">ft1500.pdf (109 kB)</a>	Field Dissolved Oxygen
FT 1600	<a href="#">ft1600.pdf (88 kB)</a>	Field Turbidity
FT 1700	<a href="#">ft1700.pdf (76 kB)</a>	Field Light Penetration
FT 1800	<a href="#">ft1800.pdf (89 kB)</a>	Field Flowmeters
FT 1900	<a href="#">ft1900.pdf (46 kB)</a>	Field Continuous Monitoring
FT 2000	<a href="#">ft2000.pdf (232 kB)</a>	Field Residual Chlorine
FT 3000	<a href="#">ft3000.pdf (559 kB)</a>	Habitat Assessment
Lab Title Page	<a href="#">labtitle.pdf (81 kB)</a>	Title Page, Laboratory

**Attachment F**  
**Field Data Sheets**

## ECT FIELD TRIP INFORMATION SHEET

### PROJECT INFORMATION

### FIELD TEAM MEMBERS ON SITE

Project & Task #:

Client & Project Name:

### FIELD TRIP STARTING AND ENDING DATE AND TIME

Start Date: \_\_\_\_\_

End Date: \_\_\_\_\_

Start Time: \_\_\_\_\_

End Time: \_\_\_\_\_

### LOCATION (Complete Prior to Field Trip)

Site Name: \_\_\_\_\_

Petroleum Site: Yes  No

Street Address (if applicable): \_\_\_\_\_

City or Town (if applicable): \_\_\_\_\_

County (optional) & State: \_\_\_\_\_

FDEP Facility ID Number: \_\_\_\_\_

ECT Project Manager: \_\_\_\_\_

### SCOPE OF WORK -- OVERVIEW

(ALL FIELD TEAM MEMBERS SIGN THE CHAIN OF CUSTODY and SAMPLING LOGS)

### SAMPLING PARAMETERS

 PH

 TEMP

 COND

 DO

 TURB

 ORP

### SUBCONTRACTORS

Company

Task

Telephone Number

### COMMENTS

 HASP

 FIELD FORMS

 APPROPRIATE TABLES (soil analyticals, gw analyticals, gw elevations, etc.)

 SITE MAP

 WORK ORDER

 APPROPRIATE FIGURES

### SIGNATURES (Sign PRIOR to Field Trip)

Recorded by: \_\_\_\_\_

Date: \_\_\_\_\_

Reviewed by: \_\_\_\_\_

Date: \_\_\_\_\_



# BORING LOG

Boring/Well Number:		Permit Number:		FDEP Facility Identification Number:	
Site Name:		Borehole Start Date:		Borehole Start Time: _____ AM _____ PM	
		Borehole End Date:		End Time: _____ AM _____ PM	
Environmental Contractor:		Geologist's Name:		Environmental Technician's Name:	
Drilling Company:		Pavement Thickness (inches):	Borehole Diameter (inches):		Borehole Depth (feet):
Drilling Method(s):		Apparent DTW (in feet from soil moisture content):	Measured DTW (in feet after water recharges in well):	OVA (list model and check type): _____ FID _____ PID	
Deposition of Drill Cuttings [check method(s)]: _____ Drum _____ Spread _____ Backfill _____ Stockpile _____ Other (describe if other or multiple items are checked):					
Borehole Completion (check one): _____ Well _____ Grout _____ Bentonite _____ Backfill _____ Other (describe)					

Sample Type	Sample Depth Interval (feet)	Sample Recovery (inches)	Unfiltered OVA	Filtered OVA	Net OVA	Depth (feet)	Sample Description (include grain size based on USCS, odors, staining and other remarks)	USCS Symbol	Moisture Content	Lab Soil and Ground Water Samples (list sample number and depth or temporary screen interval)
						----				
						----- 1				
						-----				
						----- 2				
						-----				
						----- 3				
						-----				
						----- 4				
						-----				
						----- 5				
						-----				
						----- 6				
						-----				
						----- 7				
						-----				
						----- 8				
						-----				
						----- 9				
						-----				
						----- 10				

1.) SPT -std penetration test      HSA -hollow stem auger      HA - hand auger      SSA -solid stem auger      SS - split spoon      PH - post hole
MR -mud rotary      DPT -direct push technology
2.) Soil description to include: USCS (symbol & written), grain size, color, secondary components (in %), moisture content (dry, moist, very moist, wet, saturated), density/consistency, contacts (gradational or sharp).
3.) Moisture Content Codes: D = Dry; M = Moist; W = Wet; S = Saturated
4.) General observation notes to include (at a minimum) depth to ground water, presence of odors (distinguish between natural organics versus petroleum organics), soil discoloration or staining, free product, percent recovery of cored sample intervals.

Instrument (Make/Model #) **YSI 63**

Instrument # **01G0198**

Parameter: [check all that apply]

TEMPERATURE     CONDUCTIVITY     SALINITY     Ph     ORP  
 TURBIDITY     RESIDUAL CL     DO     OTHER \_\_\_\_\_

**STANDARDS Ph:** [Specify the type(s) of standards used for calibration, the origin of the standards, the standard values, and the date the standards were prepared or purchased.]

Standard A 7.00                      **LOT #** \_\_\_\_\_                      **EXP.** \_\_\_\_\_  
 Standard B 4.00                      **LOT #** \_\_\_\_\_                      **EXP.** \_\_\_\_\_  
 Standard C \_\_\_\_\_

DATE (yy/mm/dd)	TIME (hr:min)	STD (A, B, C)	STD VALUE	INSTRUMENT RESPONSE	% DEV	CALIBRATED (YES, NO)	TYPE (INIT, CONT)	SAMPLER INITIALS
		A	7					
		B	4					
		A	7					
		B	4					

**STANDARDS Conductivity:** [Specify the type(s) of standards used for calibration, the origin if the standards, the standard values, and the date the standards were prepared or purchased.]

Standard A 100                      **LOT #** \_\_\_\_\_                      **EXP.** \_\_\_\_\_  
 Standard B 500                      **LOT #** \_\_\_\_\_                      **EXP.** \_\_\_\_\_  
 Standard C 1000                      **LOT #** \_\_\_\_\_                      **EXP.** \_\_\_\_\_

DATE (yy/mm/dd)	TIME (hr:min)	STD (A, B, C)	STD VALUE	INSTRUMENT RESPONSE	% DEV	CALIBRATED (YES, NO)	TYPE (INIT, CONT)	SAMPLER INITIALS
		A	100					
		B	500					
		C	1000					
		A	100					
		B	500					
		C	1000					

Field Instrument Calibration Records

Instrument (Make/Model #) **YSI 55**

Instrument # 0817-50290

Parameter: *[check all that apply]*

TEMPERATURE     CONDUCTIVITY     SALINITY     Ph     ORP  
 TURBIDITY     RESIDUAL CL     DO     OTHER \_\_\_\_\_

**STANDARDS Dissolved Oxygen:** *[Specify the type(s) of standards used for calibration, the origin of the standards, the standard values, and the date the standards were prepared or purchased.]*

Standard A **AIR 100% HUMIDITY** \_\_\_\_\_

Standard B \_\_\_\_\_

Standard C \_\_\_\_\_

DATE (yy/mm/dd)	TIME (hr:min)	STD (A, B, C)	STD VALUE	INSTRUMENT RESPONSE	% DEV	CALIBRATED (YES, NO)	TYPE (INIT, CONT)	SAMPLER INITIALS

Field Instrument Calibration Records

Instrument (Make/Model #) **LaMotte 2020E**

Instrument # 26858

Parameter: *[check all that apply]*

TEMPERATURE     CONDUCTIVITY     SALINITY     Ph     ORP  
 TURBIDITY     RESIDUAL CL     DO     OTHER \_\_\_\_\_

**STANDARDS Turbidity:** *[Specify the type(s) of standards used for calibration, the origin of the standards, the standard values, and the date the standards were prepared or purchased.]*

Standard A **1.0 NTU**    1.0 NTU    **LOT #** \_\_\_\_\_    **EXP.** \_\_\_\_\_

Standard B **10.0 NTU**    10 NTU    **LOT #** \_\_\_\_\_    **EXP.** \_\_\_\_\_

Standard C \_\_\_\_\_

DATE (yy/mm/dd)	TIME (hr:min)	STD (A, B, C)	STD VALUE	INSTRUMENT RESPONSE	% DEV	CALIBRATED (YES, NO)	TYPE (INIT, CONT)	SAMPLER INITIALS



Field Instrument Calibration Records

Instrument (Make/Model #) **YSI 556**

Instrument # 04G11899

Parameter: *[check all that apply]*

TEMPERATURE     CONDUCTIVITY     SALINITY     Ph     ORP  
 TURBIDITY     RESIDUAL CL     DO     OTHER \_\_\_\_\_

**STANDARDS Dissolved Oxygen:** *[Specify the type(s) of standards used for calibration, the origin of the standards, the standard values, and the date the standards were prepared or purchased.]*

Standard A AIR 100% HUMIDITY

Standard B \_\_\_\_\_

Standard C \_\_\_\_\_

DATE (yy/mm/dd)	TIME (hr:min)	STD (A, B, C)	STD VALUE	INSTRUMENT RESPONSE	% DEV	CALIBRATED (YES, NO)	TYPE (INIT, CONT)	SAMPLER INITIALS

Field Instrument Calibration Records

Instrument (Make/Model #) **LaMotte 2020E**

Instrument # 26858

Parameter: *[check all that apply]*

TEMPERATURE     CONDUCTIVITY     SALINITY     Ph     ORP  
 TURBIDITY     RESIDUAL CL     DO     OTHER \_\_\_\_\_

**STANDARDS Turbidity:** *[Specify the type(s) of standards used for calibration, the origin of the standards, the standard values, and the date the standards were prepared or purchased.]*

Standard A 1.0 NTU    1.0 NTU    **LOT #** \_\_\_\_\_    **EXP.** \_\_\_\_\_

Standard B 10.0 NTU    10 NTU    **LOT #** \_\_\_\_\_    **EXP.** \_\_\_\_\_

Standard C \_\_\_\_\_

DATE (yy/mm/dd)	TIME (hr:min)	STD (A, B, C)	STD VALUE	INSTRUMENT RESPONSE	% DEV	CALIBRATED (YES, NO)	TYPE (INIT, CONT)	SAMPLER INITIALS



## WELL CONSTRUCTION AND DEVELOPMENT LOG

WELL CONSTRUCTION DATA				
Well Number:	Site Name:	FDEP Facility I.D. Number:	Well Install Date(s):	
Well Location and Type (check appropriate boxes): <input type="checkbox"/> On-Site <input type="checkbox"/> Right-of-Way <input type="checkbox"/> Off-Site Private Property <input type="checkbox"/> Above Grade (AG) <input type="checkbox"/> Flush-to-Grade		Well Purpose: <input type="checkbox"/> Perched Monitoring <input type="checkbox"/> Shallow (Water-Table ) Monitoring <input type="checkbox"/> Intermediate or Deep Monitoring <input type="checkbox"/> Remediation or Other (describe)		Well Install Method:  Surface Casing Install Method:
If AG, list feet of riser above land surface:				
Borehole Depth (feet):	Well Depth (feet):	Borehole Diameter (inches):	Manhole Diameter (inches):	Well Pad Size: _____ feet by _____ feet
Riser Diameter and Material:		Riser/Screen Connections: <input type="checkbox"/> Flush-Threaded <input type="checkbox"/> Other (describe)	Riser Length: _____ feet from _____ feet to _____ feet	
Screen Diameter and Material:		Screen Slot Size:	Screen Length: _____ feet from _____ feet to _____ feet	
1 <sup>st</sup> Surface Casing Material: also check: <input type="checkbox"/> Permanent <input type="checkbox"/> Temporary		1 <sup>st</sup> Surface Casing I.D. (inches):	1 <sup>st</sup> Surface Casing Length: _____ feet from <u>  0  </u> feet to _____ feet	
2 <sup>nd</sup> Surface Casing Material: also check: <input type="checkbox"/> Permanent <input type="checkbox"/> Temporary		2 <sup>nd</sup> Surface Casing I.D. (inches):	2 <sup>nd</sup> Surface Casing Length: _____ feet from <u>  0  </u> feet to _____ feet	
3 <sup>rd</sup> Surface Casing Material: also check: <input type="checkbox"/> Permanent <input type="checkbox"/> Temporary		3 <sup>rd</sup> Surface Casing I.D. (inches):	3 <sup>rd</sup> Surface Casing Length: _____ feet from <u>  0  </u> feet to _____ feet	
Filter Pack Material and Size:	Prepacked Filter Around Screen (check one): <input type="checkbox"/> Yes <input type="checkbox"/> No		Filter Pack Length: _____ feet from _____ feet to _____ feet	
Filter Pack Seal Material and Size:			Filter Pack Seal Length: _____ feet from _____ feet to _____ feet	
Surface Seal Material:			Surface Seal Length: _____ feet from _____ feet to _____ feet	

WELL DEVELOPMENT DATA			
Well Development Date:	Well Development Method (check one): <input type="checkbox"/> Surge/Pump <input type="checkbox"/> Pump <input type="checkbox"/> Compressed Air <input type="checkbox"/> Other (describe)		
Development Pump Type (check): <input type="checkbox"/> Submersible <input type="checkbox"/> Other (describe)	<input type="checkbox"/> Centrifugal <input type="checkbox"/> Peristaltic	Depth to Groundwater (before developing in feet):	
Pumping Rate (gallons per minute):	Maximum Drawdown of Groundwater During Development (feet):	Well Purged Dry (check one): <input type="checkbox"/> Yes <input type="checkbox"/> No	
Pumping Condition (check one): <input type="checkbox"/> Continuous <input type="checkbox"/> Intermittent	Total Development Water Removed (gallons):	Development Duration (minutes):	Development Water Drummed (check one): <input type="checkbox"/> Yes <input type="checkbox"/> No
Water Appearance (color and odor) At Start of Development:		Water Appearance (color and odor) At End of Development:	

WELL CONSTRUCTION OR DEVELOPMENT REMARKS









