

SITE-SPECIFIC QUALITY ASSURANCE PROJECT PLAN ADDENDUM NO. 2A

For Phase II Environmental Site Assessment Activities at

**West Main Street Property
102/120 West Main Street
Lake Butler, Florida
ACRES No. 250833**

**Conducted Under EPA Brownfields Cooperative Agreement
BF-02D29322-0**

Prepared for



UNION *County*
LAKE BUTLER • WORTHINGTON SPRINGS • RAIFORD • PALESTINE • PROVIDENCE

**Union County, Florida
15 NE 1st Street
Lake Butler, Florida 32054**

Prepared by:



**30704 Sergeant E. I. "Boots" Thomas Drive
Spanish Fort, Alabama 36527
(251) 990-9000**

PPM Project No. 20165101-Task 18

October 15, 2024

Company Name	PPM Consultants, Inc.
Project #	20165101.TASK 18
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A1. APPROVALS

PPM Consultants, Inc. Program Manager:

Jere "Trey" Hess

Printed Name



10/15/24

Signature/Date

PPM Consultants, Inc. Project Manager:

Jenny Black

Printed Name



10/15/24

Signature/Date

PPM Consultants, Inc. QA Manager:

Annie McIlwain, P.E.

Printed Name



10/15/24

Signature/Date

Union County, FL Brownfields Coordinator:

James Williams

Printed Name



10/16/2024

Signature/Date

**U.S. EPA Project Manager/Officer/
Designated Approving Official:**

Printed Name

AUSTIN GILLY Digitally signed by AUSTIN GILLY
Date: 2025.04.21 14:59:20 -04'00'

Signature/Date

The Environmental Protection Agency (EPA) requires that a Quality Assurance Project Plan (QAPP) be prepared to support all federally funded brownfields environmental projects involving the collection and use of environmental data prior to beginning site work. Many brownfield projects typically involve work at multiple sites with varying site conditions, resulting in the need for multiple QAPPs. In an effort to reduce costs and streamline the preparation and approval of QAPPs, EPA has developed a process whereby a Generic QAPP can be created to address many of the quality control/quality assurance components, systems, and procedures common to most projects, with specific addenda developed for each unique project. Union County prepared, submitted, and obtained approval of the Generic QAPP. The document was prepared in accordance with the Brownfields Quality Assurance Project Plans, Interim Instructions, Generic QAPP, and the Instructions for Preparation of Quality Assurance Project Plans For EPA Brownfields Projects in the Southeast, U.S. EPA, Region 4, July 2020. This QAPP Addendum, and the approved Generic QAPP, describes the Quality Assurance/Quality Control (QA/QC) and other technical activities that are implemented to ensure that the results of the work performed will satisfy the stated performance criteria.

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A3. DISTRIBUTION LIST

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

Union County Distribution List:

- **James Williams, County Coordinator, Union County**, 15 NE 1st Street, Lake Butler, Florida 32054; Phone: (386) 496-0027; countycoord@unioncounty-fl.gov

FDEP Distribution List (If Requested):

- **Darrin McKeehen, P.G., Brownfields Coordinator, Florida Department of Environmental Protection (FDEP) – Northeast District**, 8800 Baymeadows Way West, Suite 100, Jacksonville, Florida 32256; Phone: (904) 256-1545; darrin.mckeehen@floridadep.gov

EPA Distribution List:

- **Alyssa Kuhn, Environmental Protection Agency (EPA) Project Manager/Officer/Designated Approving Official (DAO), EPA Region 4**, Atlanta Federal Building, 61 Forsyth Street Southwest, Atlanta, Georgia 30303; Phone: (404) 562-8197; kuhn.alyssa@epa.gov

PPM Consultants, Inc. (PPM):

- **Jere “Trey” Hess, Program Manager, PPM**, 289 Commerce Park Drive, Suite D, Ridgeland, Mississippi 39157; Phone: (601) 953-2564; trey.hess@ppmco.com
- **Annie C. McIlwain, P.E., Quality Assurance Manager, PPM**, 289 Commerce Park Drive, Suite D, Ridgeland, Mississippi 39157; Phone: (601) 956-3663; annie.mcilwain@ppmco.com
- **Jenny Black, Project Manager, PPM**, 119 W Garden Street, Suite 200, Pensacola, Florida 32502; Phone: (850) 429-1536; jenny.black@ppmco.com

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Laboratory Distribution List:

- **Amy Weinberg, Project Manager, Eurofins Environmental Testing (Eurofins),**
6712 Benjamin Road, Suite 100, Tampa, Florida 33634; Phone: (813) 885-7427;
amy.weinberg@et.eurofinsus.com

All personnel, including all field staff, will receive applicable sections of this Site-Specific QAPP Addendum and subsequent revisions.

A4. PROJECT/TASK ORGANIZATION

Successful completion of brownfield projects requires a diverse mix of professionals operating as a team to accomplish project goals. The general organizational structure, lines of authority, responsibilities of key management, Union County, and regulatory agency individuals to be involved with this project were described in the Generic QAPP, and will not change for this specific project, except for the following.

Personnel changes from the Generic QAPP include:

- **Quality Assurance Manager:** Annie McIlwain will be the Quality Assurance (QA) Manager with the duties outlined in the Generic QAPP Section A4.
- **Project Manager:** Jenny Black will be the Project Manager with the duties outlined in the Generic QAPP Section A4.
- **Ben Clabaugh, P.G., Field Team Leader, PPM,** 119 W Garden Street, Pensacola, Florida 32502; Phone: (850) 898-1407; ben.clabaugh@ppmco.com
- **Jeff Ferretti, Geologist, PPM,** 750 South Northlake Boulevard, Suite 1012, Altamonte Springs, Florida 32701; Phone: (407) 240-1127; jeff.ferretti@ppmco.com
- **Laboratory Director – Eurofins:** Amy Weinberg will be responsible for coordinating the analysis of the samples and laboratory validation of the data.

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The proposed project team is shown in **Figure 1, Project Organization Chart** in **Appendix A**.

A5. PROBLEM DEFINITION/BACKGROUND

PPM conducted a Phase I Environmental Site Assessment (ESA) for the subject property in accordance with American Society for Testing and Materials (ASTM) International Standard Practice E 1527-21 and submitted the Phase I ESA report dated December 12, 2023, to Union County. The Phase I ESA identified surrounding property historical uses that have, or potentially have contributed to soil and groundwater impact, identified potential contaminants in soil and groundwater, and provided information on site geology/hydrogeology; etc. The Phase I ESA Executive Summary is included in **Appendix B, Phase I ESA Executive Summary**.

This Site-Specific QAPP Addendum is in support of a Phase II ESA that has the objective to determine the presence, if any, of soil and groundwater impacts from historical uses of petroleum products identified on the subject property and surrounding properties in the Phase I ESA. Impact is defined as concentrations of chemicals of potential concern (COPC) that exceed FDEP Florida Administrative Code (FAC) Chapter 62-777 Groundwater Cleanup Target Levels (GCTL). This Phase II ESA scope of work is designed to confirm the presence or absence of environmental impacts by collecting soil and groundwater samples in the locations where impacts are considered most likely to exist based on the findings of the Phase I ESA. It is not the purpose of this assessment to delineate impacts or to support the design of a remedial action plan, although the findings may be used to prepare an Analysis of Brownfield Cleanup Alternatives (ABCA) report.

A5.1 SITE DESCRIPTION

The subject property consists of one ±0.241-acre parcel of vacant land. Remnants of asphalt/concrete parking/drive areas and a concrete pad from a former automobile repair facility structure are located on the subject property. The subject property is located at 30° 01' 22" North Latitude, 82° 20' 21" West Longitude as shown in **Figure 2, Site Location Map** in **Appendix A**.

Properties surrounding the subject property consist of commercial properties. The site is bordered to the north by West Main Street, followed by Union County Sheriff's Office; to

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the northeast by West Main Street and NW 1st Avenue, followed by Union County Sheriff's Office and the Union County Courthouse; to the east by NW 1st Avenue, followed by the former Welch Auto & Tire Service; to the southeast by NW 1st Avenue, followed by a residence; to the south by Windstream (internet provider); to the southwest by a retail/office structure; to the west by B Squared Baked Goods and More; and to the northwest by West Main Street, followed by Union County Supervisor of Elections.

Site and area features are shown in **Figure 3, Site / Area Map** and **Figure 4, Monitoring Well Location Map** in **Appendix A**. Site conditions are shown in photographs included in **Appendix C, Site Photographs**.

A5.2 SITE HISTORY

Historical fire insurance maps indicate the subject property was developed with a dilapidated structure in 1913 and a post office in 1920. The post office remained on the subject property until at least 1949. Historical and regulatory records indicate the subject property was occupied by a retail petroleum station from 1957 to 1989 and was occupied by an automobile repair facility until 2022. The subject property has consisted of vacant land since early 2023.

A5.3 PHASE I ESA FINDINGS

The Phase I ESA reported the historical uses of the surrounding properties as a recognized environmental condition (REC). This REC includes:

- **Groundwater contamination area in the surrounding area.** One leaking underground storage tank (LUST) facility (Shell/Welch's) was formerly located on the subject property and four LUST facilities (Shadd's Facility/Shell, Handi-Way Food Store/Union Beverage, Cargo Station/Hungry Howie's, and Biellings Tire) are located between 150 and 310 feet north or northwest of the subject property. Leaked gasoline from these facilities created a comingled plume of petroleum contamination in groundwater in the surrounding area, which includes the subject property. The media of concern is groundwater, soil, and soil vapor. This condition is a REC.

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A5.4 CHEMICALS OF POTENTIAL CONCERN

The COPCs associated with LUST facilities located on the subject property and surrounding properties are volatile organic compounds (VOC), semi-volatile organic compounds (SVOC), total recoverable petroleum hydrocarbons (TRPH), and lead. Petroleum releases to groundwater can occur due to tank or fueling overfills, and leaks of storage tanks, piping and dispensers.

A5.5 CONCEPTUAL SITE MODEL

Previous environmental studies, historical information, topographic maps, and other resources were reviewed to develop a conceptual site model. The subject property consists of one ±0.241-acre parcel of vacant land. Remnants of asphalt/concrete parking/drive areas and a concrete pad from a former automobile repair facility structure are located on the subject property.

PPM reviewed the most recent United States Geological Survey (USGS) 7.5 Minute Topographic Map dated 2021 for the Lake Butler Quadrangle in which the subject property is located. The map is used as the base map for **Figure 2, Appendix A**. According to this map, the elevation at the subject property is approximately 140 feet above mean sea level (AMSL). The area topography is generally flat and the groundwater flow direction in the area of the subject property is interpreted to be to the east-southeast. Notable geographical features in the surrounding area include a tributary of Lake Butler and Lake Butler located approximately 1,000 feet east-northeast and 1,400 feet north of the subject property, respectively. Based on the relative elevation between the subject property (140 feet AMSL) and the nearest perennial body of surface water (130 feet AMSL), the depth to groundwater beneath the subject property is estimated to be 10 feet below ground surface (BGS).

PPM also reviewed area-specific physical setting information that was obtained pursuant to agency file review for Shell/Welch's that was formerly located on the subject property. The last site investigation occurred in 2007 and indicated the groundwater flow direction at the subject property was toward the east-southeast, the hydraulic gradient was 0.0035 feet/foot (ft/ft), and the depth to groundwater in one onsite groundwater monitoring well was 17.43 feet BGS.

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There is one Area of Concern (AOC) for this proposed scope of work. The AOC is depicted in **Figure 4, Appendix A**. The results of this investigation will be used to determine if soil and groundwater are currently impacted above regulatory levels, and if further investigation or cleanup is warranted. The AOC is listed below.

AOC-1 – Former LUST facilities: AOC-1 is associated with potential subsurface impacts from onsite and off-site LUST facilities. As noted above, the COPCs associated with LUST facilities are VOCs, SVOCs, TRPH, and lead.

As noted above, groundwater flow direction underneath the property is likely to be to the east-southeast. The groundwater flow direction at the site will be confirmed during the Phase II ESA investigation. The results of this investigation will be used to determine if soil and groundwater are currently impacted above regulatory levels, and if further investigation or cleanup is warranted.

A6. PROJECT/TASK DESCRIPTION/TIMELINE

A6.1 PROJECT TASKS –GROUNDWATER SAMPLING

The primary environmental media to be sampled during the Phase II ESA will be groundwater. Laboratory analysis will be tailored to the COPCs associated with the nature of the REC. COPCs associated with the property are VOCs, SVOCs, TRPH, and lead. Laboratory test methods are discussed in **Section B2**.

As noted above, based on data from the subject property and other nearby sites the depth to groundwater is expected to be less than 20 feet BGS, the groundwater flow direction is likely to the east-southeast, and subsurface lithology consists of fine sand to approximately 5 feet BGS followed by sand with intermittent clay lenses.

Monitoring well locations are shown in **Figure 4, Appendix A**.

Field measurements to be taken during the Phase II ESA will include the following:

- Groundwater flow direction in shallow groundwater will be determined by surveying the top of casings of the monitoring wells and collecting depth-to-water

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measurements from each well. This data will be used to determine the groundwater elevations and calculations of the groundwater flow direction.

- The latitude and longitude of all sampling locations will be recorded with a hand-held Global Positioning System (GPS) device.

Data considered to be critical in decision-making include the following:

- **Laboratory groundwater results:** The results from the groundwater sampling will be the most critical element that will drive decisions at the subject property. The laboratory results of the groundwater analysis will be compared to the most current FDEP GCTLs. If concentrations exceed FDEP GCTLs, then secondary assessment phase activities may be necessary to delineate the extent of impact.
- **Groundwater flow direction:** Based on data from the Shadd's Facility LUST site, the groundwater flow direction is toward the east-southeast. The groundwater flow direction will be confirmed during the sampling of existing on-site monitoring wells.
- **Spatial mapping of data points.** The latitude and longitude of all sampling locations will be recorded with a hand-held GPS device and will be plotted on a to-scale site map. This data is considered critical to the interpretation of analytical data and the estimation of potential remedial costs.

Data considered to be non-critical in decision-making include the following:

- **Evaluation of off-site sources.** Data collection necessary to assess potential impacts from off-site sources of hazardous substances is non-critical. The primary values of this data are to identify potential health risks posed to future occupants of the property and to differentiate the source(s) of any COPCs that are found on the property. Groundwater samples collected at greater depth below the water table are considered less critical than samples collected at the water table. In the absence of impact from suspected onsite sources, data collected to evaluate suspected off-site sources is considered less critical.
- **Method Detection Limits greater than FDEP GCTLs.** Some COPCs, specifically some polycyclic aromatic hydrocarbon (PAH) compounds, have Cleanup Target Levels (CTL) that are less than standard Method Detection Limits (MDL) and Practical Quantification Limits (PQL). PAH MDLs in water samples

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may be further affected by low sample volumes, which is possible in slow recharge groundwater zones. When all data for a specific COPC is below standard MDLs for all media, the data will be considered as a negative indication of environmental impact even when the MDL exceeds the CTL. Estimated J-values for a COPC detected between the MDL and PQL but exceed the CTL will be considered as a positive indication of environmental impact.

Groundwater analytical results will be compared to the most current FDEP GCTLs. FDEP Chapter 62-777 GCTLs are included in **Appendix D, FDEP Cleanup Target Levels**.

There are no special conditions under which the data should be collected. The scope of work is subject to change based upon conditions encountered in the field; however, no change in scope will be initiated without prior approval from Union County and the FDEP. Seasonal conditions should not be a factor in the scheduling of fieldwork unless conditions are too wet (e.g. tropical storms and/or hurricanes) to allow work to proceed.

The tasks described above will provide the data needed to determine if soil and groundwater have been impacted in the AOC and to determine if further investigation or cleanup is necessary prior to redevelopment. It is not the purpose of this investigation to horizontally or vertically delineate any COPC that may be found in soil and groundwater. A timeline for completion of the work is depicted in **Figure 5, Project Schedule** in **Appendix A**.

A7. QUALITY OBJECTIVES/CRITERIA FOR MEASUREMENT DATA

Data collected from this project will be used to:

- Ascertain if there is a threat to public health or the environment.
- Locate and identify potential sources of contamination. Sampling data will be used to formulate remediation strategies and estimate remediation costs.
- Determine treatment and disposal options. Characterize soil for onsite or off-site treatment.
- Verify attainment of clean-up goals. Ascertain if additional remediation is required.

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When conducting Brownfield investigations, all measurements will be made so that results are reflective of the medium and conditions being measured. Prior to all environmental measurement activities, site-specific Data Quality Objectives (DQO) and measurement performance criteria will be determined. DQOs are qualitative and quantitative statements that specify the quality of the Brownfield environmental monitoring data required to support decisions. DQOs are predicated in accordance with the anticipated end uses of the data which are to be collected. DQOs are applicable to phases and aspects of the data collection process including site investigation, design, construction, and remedy operations. It is important to note that the level of detail and data quality needed will vary with the intended use of the data.

DQOs are qualitative and quantitative statements that specify the purpose, quality, and/or quantity of the environmental data required to support management and remedial decisions at each site. DQOs are predicated in accordance with the anticipated end uses of the data that are to be collected. This DQO process was developed within the framework of the Guidance on Systematic Planning Using the Data Quality Objectives Process EPA Quality Assurance/G-4, and Section 3 of Quality Assurance Guidance for Conducting Brownfields Site Assessment, which is outlined in the following seven steps:

Seven Step Process

1: State the Problem

Real environmental contamination may exist on the site sourced from the subject property. Redevelopment of the site is sought for potential commercial or governmental purposes. Assessment is needed to evaluate the site for impacts to determine if an environmental remedy is needed relative to the proposed redevelopment.

2: Identify the Decision

The principal objective of this investigation is to provide analytical data to evaluate the nature of potentially impacted media at the site. The data and interpretation will answer the question of what media has been impacted at the site, what chemical has impacted the site, and to what extent is the site impacted.

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- Based on quantitative sample data of soil and groundwater, can the site or areas within the site be considered for redevelopment with or without an environmental remedy?

3: Identify Inputs to the Decision

Groundwater samples will be collected to provide analytical data for site characterization. Samples will be collected and analyzed as outlined in **Sections B1** and **B2** of this document. The data will be compared to applicable action levels relevant to the sampled media as related in **Section A6** of this document.

4: Define the Study Boundaries

Spatial Boundaries: The area within the site boundaries will comprise the study area. Three Decisions Units (DU) are defined in the study area:

- DU1: Surface Soil
- DU2: Subsurface Vadose Zone Soil
- DU3: Shallow Groundwater

Temporal Boundaries: The approximate schedule for the Phase II ESA is indicated in **Figure 5, Appendix A** and discussed in **Section A6**.

5: Develop a Decision Rule

The decision rule is predicated on answering the question-related in **Step 2** above. The relative impacts of site media can be gauged by direct evaluation of the analytical data generated. If analytical data reflects impacts above action levels outlined in **Section A6**, further assessment, and/or an ABCA would be recommended to evaluate the impact. A typical ABCA would include an evaluation of remedies such as:

- remediation cleanup options,
- engineering controls and/or easements,
- institutional controls, or
- no further action.

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If any of these available remedies are not deemed feasible other than no further action, then redevelopment of the site may not be practical.

6: Specify Limits of Decision Errors

Groundwater Sampling

Statistical sampling is not included as a part of this assessment. Qualitative data collection is not planned for this assessment, except those visual and odorous observations of groundwater sampling. These field-derived data are considered supplementary to laboratory-derived data and are not critical to the decision, except in the event of a potential vapor encroachment condition. Field meters will be calibrated per the manufacturer's specifications to an appropriate standard; however, any decisions based on qualitative data will be verified using laboratory analysis.

The null hypothesis is that the site has elevated levels of environmental contaminants onsite above background or allowable regulatory levels that pose an impediment to site redevelopment. This hypothesis will be evaluated by laboratory analytical sampling only. The alternative hypothesis is that elevated levels of contaminants are not present at the site at sufficient concentrations or quantities to impede site redevelopment for the intended use. One common problem resulting in decision error when comparing site data with regulatory criteria is overcoming matrix interferences or elevated detection limits, which can often be resolved as discussed in **Section A6**. Furthermore, our contract laboratories will conduct Tier II data verification on the data developed. The quality of the data generated using the specific Laboratory Quality Assurance Management Plan (QAMP) will provide analytical data of known quality and precision for this project. A sufficient volume of each sample will be collected in the field to allow re-analysis if the laboratory data quality objectives are not reached or if additional analysis is required. One equipment blank will be collected to ensure field decontamination procedures meet performance criteria. Sample corrective actions could include resampling, rerunning a sample, or a determination that the data failure would not have a significant impact on the data integrity, or conclusions reached during the project.

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7: Optimize the Design

Design optimization is in essence the selection of the most resource-effective assessment approach to meet project goals within defined study boundaries. While this process is somewhat inherent in Brownfields assessments given budgetary constraints of grant funding, a formalized process is nevertheless warranted. The preceding DQO steps were reviewed for concordance, and the approach described in **Section B1** was selected. Sample techniques and spatial distribution were selected based on “worst-case” locations established through site observations, previous reports, and historical review. Through the systematic limitation of decision error described in **Step 6**, laboratory-derived data will sufficiently test the null hypothesis.

Every effort has been made to ensure that the scope of this assessment is as cost-effective and sufficient in scope as possible to test the null hypothesis within the defined study boundaries. In general, PPM's approach identifies and assesses areas of environmental concern having the highest probability of environmental impairment based on available information. Analytical suites are selected based on valid science and an understanding of processes involved through the development of a comprehensive Conceptual Site Model (CSM).

Lastly, to support the optimization process, this Site-Specific QAPP has been approved by the stakeholders and EPA with regard to project goals and sample design prior to implementation.

Criteria for Measurement Data

Critical data considered for decisions will include analytical results for the groundwater samples that meet quality assurance/quality control (QA/QC) criteria. Specifically, whether COPC concentrations exceed, or do not exceed CTLs. This data will determine the need for additional assessment and/or remediation if any.

Non-critical data that are utilized to support decisions may include groundwater field parameter measurements [pH, temperature, conductivity, dissolved oxygen (DO), oxidation-reduction potential (ORP), turbidity, color, and odor], observations during groundwater purging activities (drawdown at purging rates), and measurement of groundwater flow. The data collection should be performed under routine conditions and in accordance with applicable FDEP and EPA standard operating procedures (SOP) for field

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and laboratory activities. This information will be used to supplement the critical data, it is not needed to make the decision of whether remediation is warranted.

A8. SPECIAL TRAINING REQUIREMENTS/CERTIFICATION

Only personnel with the training and experience to conduct the required tasks will be selected to perform the work. The minimum level of training required for project personnel is included in Section A8 of the Generic QAPP. The individuals assigned to the project are depicted in **Figure 1, Appendix A**.

Certifications required for subcontracted services that were not specified in the Generic QAPP include the following:

Laboratory Services (Eurofins, Tampa, Florida). Current National Environmental Laboratory Accreditation Conference (NELAC) for specified analyses. Eurofins's NELAC certification and Quality Assurance Manual are provided in **Appendix E, Laboratory Quality Manual / COC Reporting Limit Specifications**.

A9. DOCUMENTS AND RECORDS

An organized system for the identification, review, acceptance, control, and maintenance of records, which includes provisions for retention, protection, preservation, revision, traceability, accountability, and retrievability of the records will be maintained (both electronic and hard copy) for field, office and laboratory information. Details on these procedures are included in Section A9 of the Generic QAPP.

Document and records requirements for groundwater sampling (Logbooks) will be maintained per *Florida DEP-SOP-001/01 FD 1000 Documentation Procedures, January 2017*. An internet link to these SOPs is included in Appendix B of the Generic QAPP. 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 **Appendix F, Field Forms**.

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B1. SAMPLING DESIGN PROCESS

The sampling design took into consideration the Phase I ESA findings, the documented locations of the onsite and off-site RECs, the constituents likely to be associated with these types of activities, the media likely to be impacted (groundwater), the site configuration, physical obstructions, and the future use of the property.

One groundwater sample will be collected from each monitoring well; therefore, a total of seven groundwater samples (MW-34S through MW-37S, MW-A, MW-B, and MW-C) will be collected for laboratory analysis for VOCs per EPA Method 8260, SVOCs per EPA Method 8270, TRPH per EPA Method Florida Petroleum Range Organics (FL-PRO), and lead per EPA Method 6010. Monitoring well locations are shown in **Figure 4, Appendix A**.

Specific field activities to be conducted for the Phase II ESA include:

- Preparing a site-specific Health and Safety Plan (HASP).
- A grab sample of groundwater will be collected from the top 2 feet of the water table.
- Determining groundwater flow direction by surveying the top of casings of the monitoring wells and collecting depth to water measurements from each well. This data will be used to determine the groundwater elevations and calculations of the groundwater flow direction.

It is assumed that all areas necessary to complete the scope of work will be accessible. If an area is not accessible, alternate areas will be sought to the extent reasonable. All proposed drilling locations are subject to adjustment due to the presence of buried utilities and other physical obstructions that are encountered in the field. Any limitations that obstruct or alter the scope of work will be described in the Phase II ESA report.

B2. SAMPLING AND ANALYTICAL METHODS REQUIREMENTS

Monitoring wells (MW-34S through MW-37S, MW-A, MW-B, and MW-C) are constructed of 2-inch diameter, scheduled (SCH) 40 polyvinyl chloride (PVC) casing and well screen. Well screens are 10 feet long and have 0.01-inch machine slots. Wells will be developed by pumping the well with a submersible pump until discharge is relatively free

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and clear of suspended sediment. After development, the primary sampling method of “low-flow” will be initiated with a minimum of three sets of groundwater parameters recorded to document parameter stabilization. In accordance with the *FDEP SOP-001/01 FS 2200 Groundwater Sampling SOP (Appendix G)* purging is considered complete when the pH and specific conductance of the groundwater have stabilized, and the turbidity has either stabilized or is below 10 Nephelometric Turbidity Units (NTU). Stabilization occurs when, for at least three consecutive measurements, the pH remains constant within 0.2 Standard Units (SU), temperature remains constant within 0.2 degrees Celsius (°C), specific conductance varies no more than 5 percent, and the percent saturation DO is less than 20 percent. Groundwater samples will be collected using a peristaltic pump or disposable bailers. The final sampling method will be largely dictated by groundwater recovery rates and sample depths of the monitoring wells. Each sample will be transferred from the sampling device into their respective laboratory-prepared containers and immediately placed on ice. Groundwater samples, along with the chain of custody records, will be delivered to an independent testing laboratory for analysis. A total of seven groundwater samples will be collected for analysis. All groundwater samples will be collected in accordance with the *FDEP SOP-001/01 FS 2200 Groundwater Sampling (Appendix G)*.

Disposable nitrile gloves will be worn during sample handling and changed between each sample acquisition. All sampling equipment will be decontaminated between monitoring wells by a wash with Luminol® detergent, followed by a rinse with isopropyl alcohol and then distilled water.

Groundwater samples will be analyzed per the appropriate EPA or Standard Method as shown in the table below:

Parameter	Method
	Groundwater
VOCs	EPA Method 8260
SVOC	EPA Method 8270
TRPH	EPA Method FL PRO
Lead	EPA Method 6010

In no case will the standard MDL exceed the FDEP CTL concentration for a particular compound unless special circumstances in the laboratory dictate a higher detection limit

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(available methodology, sample volume, dilution, matrix interference, etc.) and in those cases, a narrative of the reason for the higher-than-normal detection limits will be given with the analysis and the estimated value flagged in the data report.

QA/QC samples will be collected for groundwater during sampling activities. For groundwater, one duplicate groundwater sample, and one groundwater sampling equipment rinsate blank will be collected for every ten samples, one field blank will be collected per day, and one trip blank will be included with each cooler. QA/QC samples will be analyzed for VOCs per EPA Method 8260.

Sample locations analytical methods, holding time, preservation, and container requirements are shown in **Table 1, Sample Locations, Analytical Methods, Holding Times, Preservation, and Container Requirements, Appendix H, Table.**

B3. HANDLING AND CUSTODY REQUIREMENTS

Strict protocols for maintaining sample integrity from sample collection to receipt by the laboratory will be followed, as described in Section B3 of the Generic QAPP. The Laboratory Quality Manual for Eurofins is provided in **Appendix E.**

B4. ANALYTICAL METHODS AND REQUIREMENTS

Analytical methods for groundwater are provided in **Table 1, Sample Locations, Analytical Methods, Holding Times, Preservation, and Container Requirements (Appendix H).** Turnaround time for soil and groundwater is typically 7 to 10 days. The analytical methods are referenced in **Section B2.** All other analytical information is provided in the Generic QAPP.

B5. FIELD QUALITY CONTROL REQUIREMENTS

Table 1, Appendix H provides a number of samples, container requirements, analytical methods, preservative requirements, and QA/QC sampling specific to this site. In addition, QA/QC acceptance criteria for matrix spikes, equipment blanks, trip blanks, and laboratory control samples, etc. The Eurofins Quality Manual is provided in **Appendix E.**

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B6. LABORATORY QUALITY CONTROL REQUIREMENTS

The Eurofins Laboratory Quality Manual is provided in **Appendix E**.

B7. FIELD EQUIPMENT AND CORRECTIVE ACTION

This information is provided in Section B7 of the Generic QAPP.

B8. LABORATORY EQUIPMENT AND CORRECTIVE ACTION

The Eurofins Laboratory Quality Manual is provided in **Appendix E**.

B9. ANALYTICAL SENSITIVITY AND PROJECT CRITERIA

Eurofins will be responsible for ensuring that the methods used to measure the constituents in potentially impacted media are sensitive enough to enable comparisons to regulatory compliance criteria or other health or risk-based standards. Laboratory MDLs and PQLs associated with COPCs are provided in **Appendix E**.

B10. DATA MANAGEMENT AND DOCUMENTS

Data and documents will be managed in accordance with the protocol described in Section B10 of the Generic QAPP. All documents will be kept in PPM's Spanish Fort, Alabama office.

C1. ASSESSMENT AND RESPONSE ACTIONS

This information was provided in Section C1 of the Generic QAPP.

C2. PROJECT REPORTS

This information was provided in Section C2 of the Generic QAPP.

D1. FIELD DATA EVALUATION

This information was provided in Section D1 of the Generic QAPP.

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D2. LABORATORY DATA EVALUATION

This information was provided in Section D2 of the Generic QAPP.

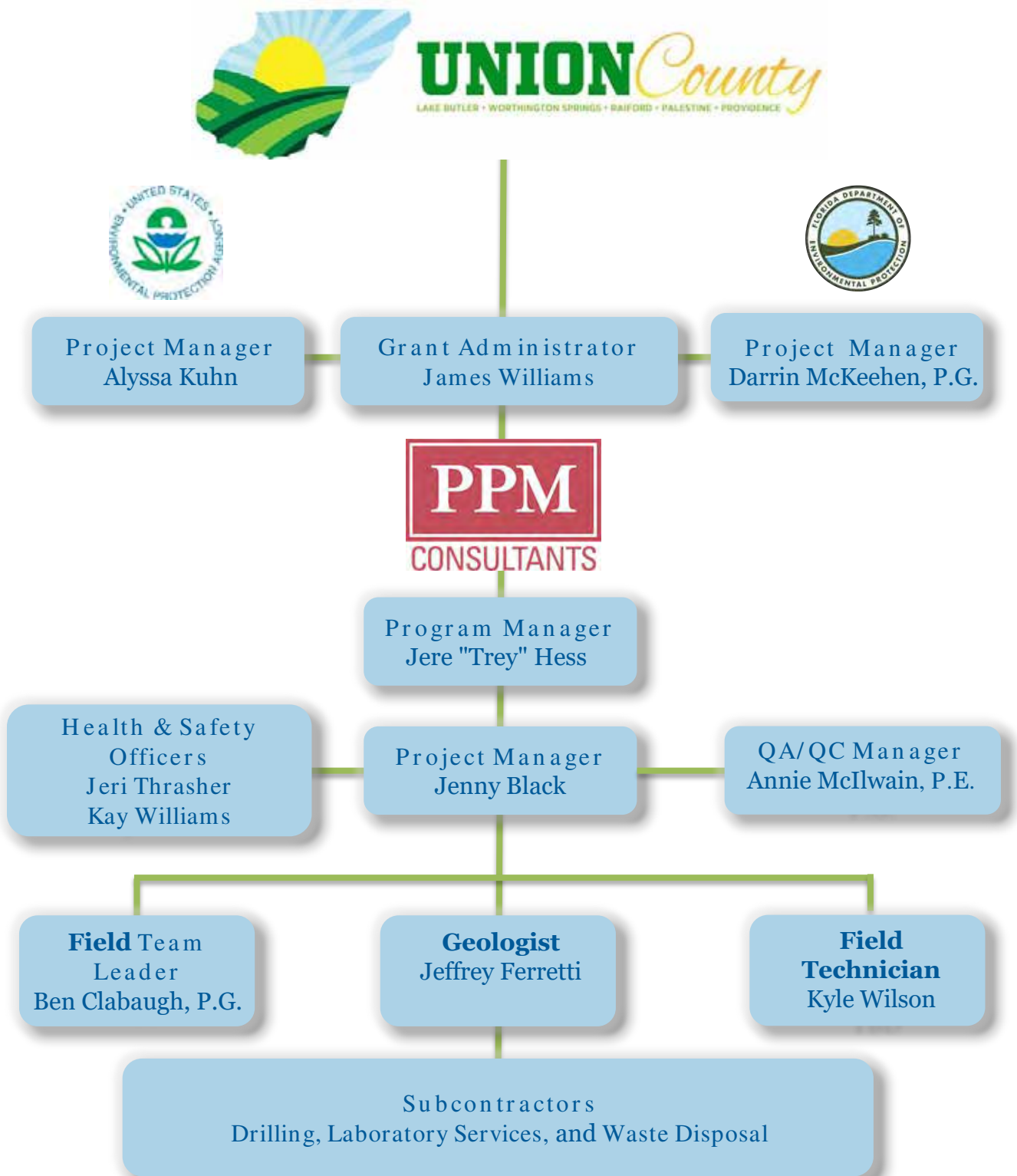
D3. DATA USABILITY AND PROJECT VERIFICATION

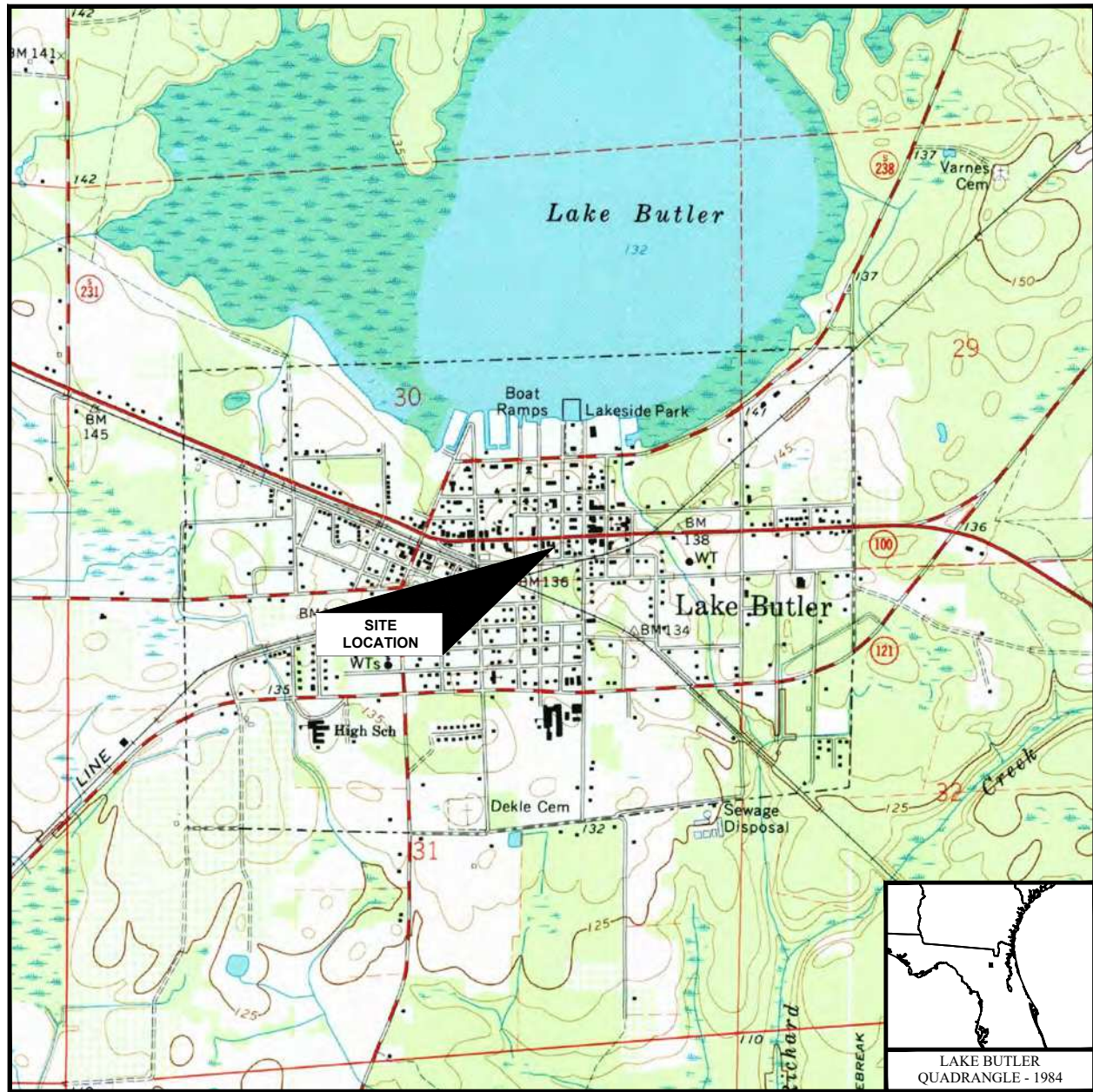
The Eurofins Laboratory Manager will review and verify the laboratory data generated under their corrective action system for accuracy according to Eurofins Laboratory Quality Manual Section 13.0, Corrective Action. Any problems identified during this process will be reported to the PPM Project Manager in the analytical report. The PPM QA Manager and Project Manager will validate laboratory data upon receipt of the analytical results. The Eurofins Laboratory Quality Manual is provided in **Appendix E**.

APPENDICES

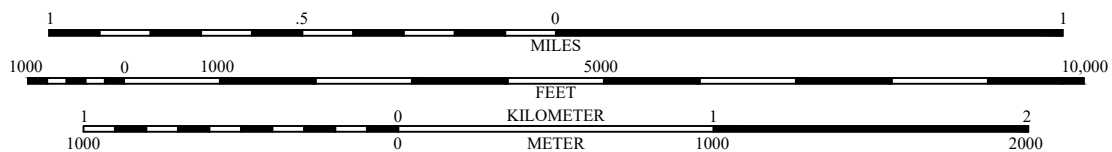
APPENDIX A – FIGURES

FIGURE 1
PROJECT ORGANIZATION CHART





SCALE: 1 : 24,000



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JCP

DRAWN DATE:

11/27/23

PROJECT NUMBER:

20165101

PHASE:

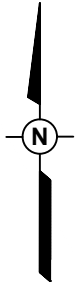
TASK 18

UNION COUNTY, FLORIDA
WEST MAIN STREET PROPERTY
102 / 120 WEST MAIN STREET
LAKE BUTLER, FLORIDA

SITE LOCATION MAP

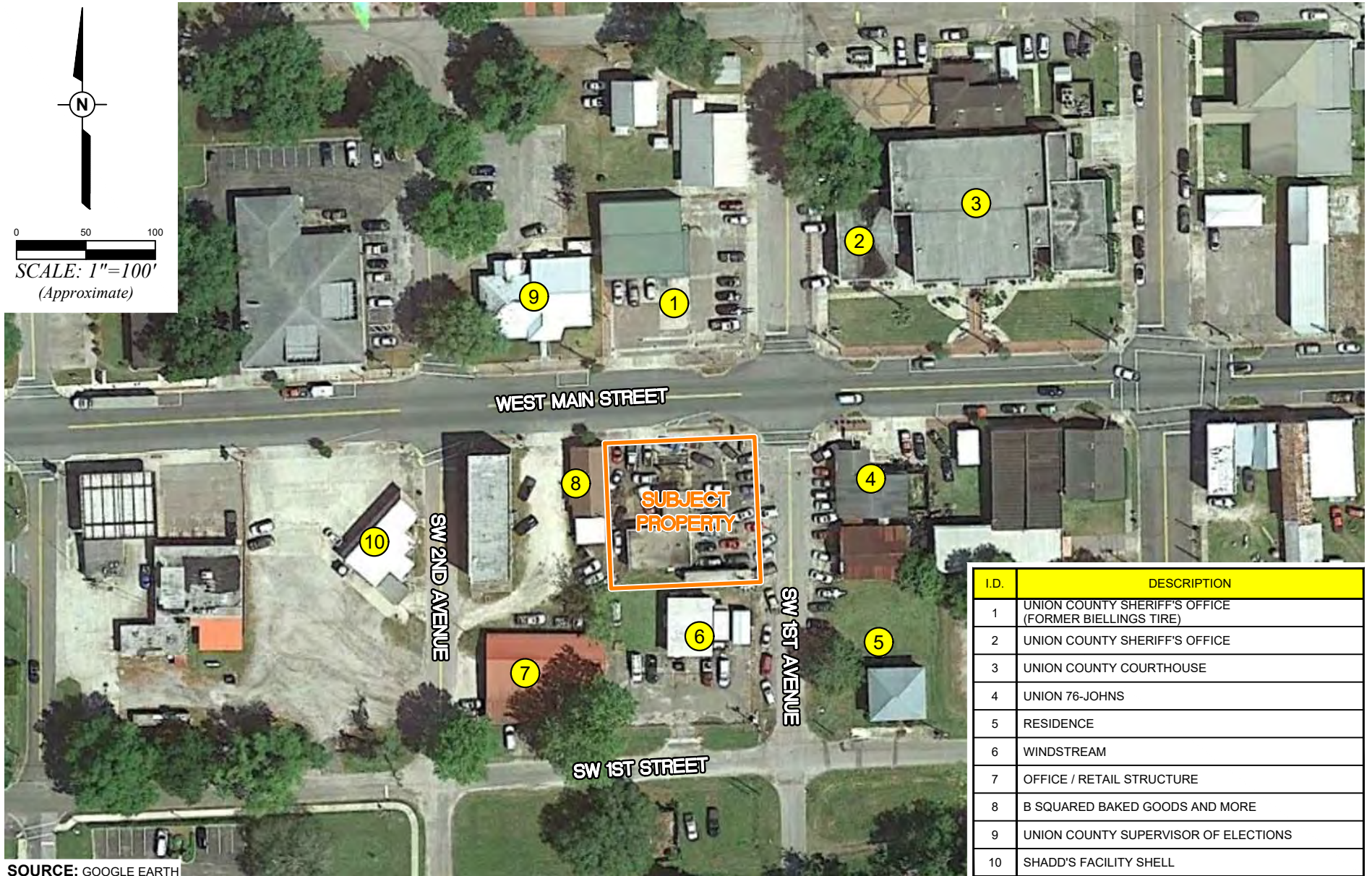
FIGURE
NUMBER

2



0 50 100

SCALE: 1"=100'
(Approximate)



SOURCE: GOOGLE EARTH

I.D.	DESCRIPTION
1	UNION COUNTY SHERIFF'S OFFICE (FORMER BIELLINGS TIRE)
2	UNION COUNTY SHERIFF'S OFFICE
3	UNION COUNTY COURTHOUSE
4	UNION 76-JOHNS
5	RESIDENCE
6	WINDSTREAM
7	OFFICE / RETAIL STRUCTURE
8	B SQUARED BAKED GOODS AND MORE
9	UNION COUNTY SUPERVISOR OF ELECTIONS
10	SHADD'S FACILITY SHELL

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PROJECT NUMBER:

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PHASE:

TASK 18

UNION COUNTY, FLORIDA
WEST MAIN STREET PROPERTY
102 / 120 WEST MAIN STREET
LAKE BUTLER, FLORIDA

SITE / AREA MAP

FIGURE
NUMBER

3

APPENDIX B – PHASE I ESA EXECUTIVE SUMMARY



EXECUTIVE SUMMARY

PPM Consultants, Inc. (PPM) was retained by Union County, Florida to conduct a Phase I Environmental Site Assessment (ESA) of the West Main Street Property (the subject property) located at 102/120 West Main Street in Lake Butler, Florida. The purpose of this assessment was to identify recognized environmental conditions (REC) in connection with the subject property by means of interviews, review of record information, and site reconnaissance. The environmental assessment was conducted in conformance with the scope of ASTM International Standard Practice E1527-21.

PPM conducted the site reconnaissance on October 11, 2023. The subject property consists of one ± 0.241 -acre parcel of vacant land. Remnants of asphalt/concrete parking/drive areas and a concrete pad from a former automobile repair facility structure are located on the subject property. Historical fire insurance maps indicate the subject property was developed with a dilapidated structure in 1913 and a post office in 1920. The post office remained on the subject property until at least 1949. Historical and regulatory records indicate the subject property was occupied by a retail petroleum station from 1957 to 1989 and was occupied by an automobile repair facility until 2022. The subject property has consisted of vacant land since early 2023.

Properties surrounding the subject property consist of commercial properties. The site is bordered to the north by West Main Street, followed by Union County Sheriff's Office; to the northeast by West Main Street and NW 1st Avenue, followed by Union County Sheriff's Office and the Union County Courthouse; to the east by NW 1st Avenue, followed by Welch Auto & Tire Service; to the southeast by NW 1st Avenue, followed by a residence; to the south by Windstream (internet provider); to the southwest by a retail/office structure; to the west by B Squared Baked Goods and More; and to the northwest by West Main Street, followed by Union County Supervisor of Elections. Historical records indicate that the adjoining property to the north was undeveloped land from at least 1913 to 1920, developed with a residence from at least 1939 to at least 1949, and developed with a retail petroleum station from at least 1958 to at least 1981. An automobile repair facility also occupied the adjoining property to the north until at least 2000. The current office building has located on the adjoining property to the south since at least 2002 and has occupied by the Union County Sheriff's Office since at least 2014. The adjoining property to the northeast was a public square in 1913 and a park in 1920. The Union County Courthouse and the office structure currently occupied by the Union county Sheriff's Office have been present on the adjoining property to the northeast since 1936 and the early 1970s, respectively. Historical records indicate that the adjoining property to the east was developed with retail structures



from at least 1913 to at least 1938 and was developed with a retail petroleum station from at least 1949 to 1986. An automobile repair facility occupied the adjoining property to the east until 2022. The structures on the adjoining property to the east have been vacant since early 2023. The adjoining property to the southeast has been residential since at least 1913. Historical records indicate that the structure on the adjoining property to the south was occupied by a telephone company (Alltel) from at least 1958 to 2005 and has been occupied by an internet provider (Windstream) since 2006. The adjoining property to the southwest was developed with a lean-to in 1913, developed with one and/or two warehouses between 1920 and 1987, and has been developed with a retail/office structure since at least 1995. The adjoining property to the west was undeveloped land from at least 1913 to at least 1938 and has been developed with a retail structure since at least 1949

This assessment has revealed the following RECs, controlled recognized environmental conditions (CREC), and/or significant data gaps (SDG) in connection with the subject property.

- **Groundwater contamination area in the surrounding area.** One leaking underground storage tank (LUST) facility (Shell/Welch's) was formerly located on the subject property and four LUST facilities (Shadd's Facility/Shell, Handi-Way Food Store/Union Beverage, Cargo Station/Hungry Howie's, and Biellings Tire) are located between 150 and 310 feet north or northwest of the subject property. Leaked gasoline from these facilities created a comingled plume of petroleum contamination in groundwater in the surrounding area, which includes the subject property. The media of concern is groundwater, soil, and soil vapor. This condition is a REC.

APPENDIX C - SITE PHOTOGRAPHS

Vacant County Property

PPM Project No.: 20165101.Task 15



PHOTOGRAPH 1
View of the subject property, facing south-southwest.



PHOTOGRAPH 2
View of the west portion of the subject property, facing southwest.



PHOTOGRAPH 3
View of the west portion of the subject property, facing south.



PHOTOGRAPH 4
View of the south portion of the subject property, facing east.

Photos Taken October 11, 2023 by K. Grosjean



PHOTOGRAPH 5

View of the west portion of the subject property, facing north-northeast.



PHOTOGRAPH 6

View of one of the groundwater monitoring wells (MW-35) on the subject property.



PHOTOGRAPH 7

View of a former groundwater monitoring well on the subject property.



PHOTOGRAPH 8

View of the Union County Sheriff's Office (former Bielling's Tire) on the adjoining property to the north, across West Main Street, facing north.



PHOTOGRAPH 9

View of the Union County Sheriff's Office and the Union County Courthouse on the adjoining property to the northeast, across West Main Street and SW 1st Avenue, facing northeast.



PHOTOGRAPH 10

View of a vacant automobile repair facility and former retail petroleum station on the adjoining property to the east, across SW 1st Avenue, facing east-southeast.



PHOTOGRAPH 11

View of a residence on the adjoining property to the southeast, across SW 1st Avenue, facing northeast.



PHOTOGRAPH 12

View of Windstream (internet provider) on the adjoining property to the south, facing north-northeast.



PHOTOGRAPH 13

View of a retail/office structure on the adjoining property to the southwest, facing northwest.



PHOTOGRAPH 14

View of the Union County Supervisor of Elections on the adjoining property to the northwest, across West Main Street, facing northwest.

APPENDIX D – FDEP CLEANUP TARGET LEVELS

CHAPTER 62-777 CONTAMINANT CLEANUP TARGET LEVELS

62-777.100 Referenced Guidelines.

62-777.150 Applicability.

62-777.170 Derivation of Cleanup Target Levels.

62-777.100 Referenced Guidelines.

Specific references to the guidelines listed below are made within this chapter. These guidelines are not standards as defined in Section 403.803, F.S. Use of the guidelines is not mandatory; the guidelines are included for informational purposes only.

(1) Approach to the Assessment of Sediment Quality in Florida Coastal Water, Volumes 1-4, dated November 1994.

(2) Technical Report: Development of Cleanup Target Levels (SCTLs) for Chapter 62-777, F.A.C., Final Report, dated February 2005.

(3) Guidance for the Selection of Analytical Methods and for the Evaluation of Practical Quantitation Limits, dated October 12, 2004.

(4) Development and Evaluation of Numerical Sediment Quality Assessment Guidelines for Florida Inland Waters, dated January 2003.

Specific Authority 376.303, 376.30701, 376.3071, 376.3078(4), 376.81, 403.061, 403.704 FS. Law Implemented 376.3071, 376.30701, 376.3078(4), 376.81, 403.707 FS. History—New 8-5-99, Amended 4-17-05.

62-777.150 Applicability.

(1) This chapter provides criteria in tables and figures that apply to site rehabilitation at sites that are governed by the terms of a brownfield site rehabilitation agreement pursuant to Chapter 62-785, F.A.C.; to site rehabilitation pursuant to Chapters 62-730, F.A.C., Hazardous Waste, and 62-780, F.A.C., Contaminated Site Cleanup Criteria; and to the program specific contaminants of concern for site rehabilitation pursuant to Chapter 62-770, F.A.C., Petroleum Contamination Site Cleanup Criteria, and Chapter 62-782, F.A.C., Drycleaning Solvent Cleanup Criteria; and to the treatment of soil at facilities permitted pursuant to Chapter 62-713, F.A.C., Soil Treatment Facilities. Those rule chapters identify the specific contaminants of concern to be addressed and those rule chapters should be referenced for use and application of the tables

and figures.

(2) Chapter 62-770, F.A.C., Table A, titled “Petroleum Products’ Contaminants of Concern”, identifies the specific petroleum products’ contaminants of concern for use at sites being addressed pursuant to Chapter 62-770, F.A.C.

(3) Contaminants of concern for sites pursuant to Chapters 62-730 and 62-780, F.A.C., are based on the site-specific circumstances and may include other contaminants of concern not listed in the tables and figures contained in this rule chapter.

(4) Chapter 62-782, F.A.C., Table A, titled “Drycleaning Contaminants of Concern”, identifies the specific drycleaning contaminants of concern for use at sites being addressed pursuant to Chapter 62-782, F.A.C.

(5) Contaminants of concern for sites that are governed by the terms of a brownfield site rehabilitation agreement pursuant to Chapter 62-785, F.A.C., are based on the site-specific circumstances and may include other contaminants of concern not listed in the tables and figures contained in this rule chapter.

(6) Contaminants of concern for soil treated pursuant to Chapter 62-713, F.A.C., are based on the types of soil that the facility is permitted to treat.

(7) As further provided in substantive provisions of the above-referenced rule chapters, contaminant cleanup target levels (CTLs) are default cleanup criteria and do not establish standards pursuant to Chapters 62-302, 62-520, or 62-550, F.A.C. Deviations from the default cleanup criteria are allowed if approved by the Department pursuant to applicable provisions of Chapters 62-713, 62-730, 62-770, 62-780, 62-782, and 62-785, F.A.C. Nothing herein is intended to limit the use of risk assessments and site-specific considerations to establish site-specific CTLs.

Specific Authority 376.303, 376.30701, 376.3071, 376.3078(4), 376.81, 403.061, 403.704 FS. Law Implemented 376.30701, 376.3071, 376.3078(4), 376.81, 403.707 FS. History—New 8-5-99, Amended 4-17-05.

62-777.170 Derivation of Cleanup Target Levels.

(1) Groundwater and Surface Water. In deriving groundwater and surface water CTLs, the methodology presented in the technical report referenced in subsection 62-777.100(2), F.A.C., was utilized.

(a) CTLs for contaminants found in groundwater are provided in Table I. The CTLs for contaminants are not to be construed to create any new water quality standards pursuant to Chapters 62-520 and 62-550, F.A.C. The numerical standards promulgated pursuant to Chapter 62-520, F.A.C., or CTLs derived using the minimum criteria specified in Chapter 62-520, F.A.C., are the CTLs referenced in Table I. In deriving groundwater CTLs based upon the minimum criteria specified in Chapter 62-520, F.A.C., the following factors were considered: calculations using a lifetime excess cancer risk level of $1.0E-6$ and; a hazard quotient of 1 or less; and nuisance, organoleptic, and aesthetic considerations. For contaminants not listed in Table I, the equations provided in Figures 1 and 2 and nuisance, organoleptic, and aesthetic considerations may be used to calculate CTLs for contaminants found in groundwater for sites or facilities subject to Chapter 62-713, 62-730, 62-780, or 62-785, F.A.C.

(b) CTLs for contaminants found in surface water or in contaminated groundwater that is discharging into surface water or that may discharge into surface water in the future based on available information (for example, monitoring well data, groundwater flow rate and direction, or fate and transport modeling), are also provided in Table I. The CTLs for contaminants are not to be construed to create any new water quality standards pursuant to Chapter 62-302, F.A.C. The numerical standards promulgated in Chapter 62-302, F.A.C., CTLs derived based on human health endpoints and calculated using Figure 3A, or CTLs derived using the toxicity criteria specified in Chapter 62-302, F.A.C., and calculated using Figure 3B, are the CTLs referenced in Table I. For contaminants not listed in Table I, the equations provided in Figure 3A and the methodology provided in Figure 3B may be used to calculate CTLs for contaminants found in surface water, or groundwater that is discharging into surface water for sites or facilities subject to Chapter 62-713, 62-730, 62-780, or 62-785, F.A.C.

(c) Table IV provides site-specific conditions and geochemical parameters that may be used for a technical evaluation of the appropriateness of natural attenuation.

(d) Table V provides default source concentrations that may be used for a technical evaluation of the appropriateness of natural attenuation.

(2) Soil. In deriving soil CTLs, the methodology presented in the technical report referenced in subsection 62-777.100(2), F.A.C., was utilized.

(a) CTLs for contaminants found in soil are provided in Table II. As further provided in other substantive provisions of those rule chapters, the soil CTLs contained herein are default criteria. Deviations from the default criteria are allowed if approved by the Department pursuant to applicable provisions of Chapters 62-713, 62-730, 62-770, 62-780, 62-782, and 62-785, F.A.C. In deriving soil CTLs for human exposure to each contaminant found in soil, the following factors were considered: calculations using a lifetime excess cancer risk level of $1.0E-6$ and a hazard quotient of 1 or less. The leachability-based soil CTLs for protection of the groundwater and surface water were derived based on the groundwater and surface water CTLs provided in Table I. The equations provided in Figures 4, 5, 6, 7, and 8 may be used to calculate CTLs for contaminants found in soil not listed in Table II for sites or facilities subject to Chapter 62-713, 62-730, 62-780, or 62-785, F.A.C. To calculate 2,3,7,8-TCDD equivalent concentrations for evaluation of samples that contain dioxins and furans, the Toxic Equivalent Factors (TEFs) and approach described in the technical report referenced in subsection 62-777.100(2), F.A.C., shall be used. To calculate benzo(a)pyrene equivalent concentrations for evaluation of samples that contain carcinogenic Polycyclic Aromatic Hydrocarbons (PAHs), the TEFs and approach described in the technical report referenced in subsection 62-777.100(2), F.A.C., shall be used.

(b) Table III provides soil properties, and test methods that may be used for determining soil properties, for the derivation of alternative CTLs based on site-specific soil characteristics [refer to the technical report referenced in subsection 62-777.100(2), F.A.C., for guidance on the derivation of alternative CTLs].

(c) Table VI provides default parameters that may be used in Figures 4, 5, and 7.

Specific Authority 376.303, 376.30701, 376.3071, 376.3078(4), 376.81, 403.061, 403.704 FS. Law Implemented 376.3071, 376.30701, 376.3078(4), 376.81, 403.707 FS. History—New 8-5-99, Amended 4-17-05.

PLEASE SEE TABLES I, II, III, IV, V, VI, FIGURE 1, FIGURE 2, FIGURE 3A, FIGURE 3B, FIGURE 4, FIGURE 5, FIGURE 6, FIGURE 7, FIGURE 8, FIGURE 9, FIGURE 10

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
Ametryn	834-12-8	63 Minimum Criteria Systemic Toxicant	6.2 Toxicity Criteria	6.2 Toxicity Criteria	630	-Liver
Ammonia (a)	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
Benzidine	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
Benzotrichloride	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)						

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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]						

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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]						

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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
Captafol	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

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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

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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]						
Chlorothalonil [or Bravo]	1897-45-6	3.2 Minimum Criteria Carcinogen	0.8 Toxicity Criteria	0.8 Toxicity Criteria	32	-Carcinogen -Kidney

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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
Chlorpropham	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	* Primary Standard	11 (f)	50 (f)	***	-Carcinogen
Chromium (trivalent)	16065-83-1	*	**	520 Toxicity Criteria (e)	***	-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	* Secondary Standard	**	**	***	-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

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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

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		(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

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		(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

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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

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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
Dichlorprop	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
Dicofol [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

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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

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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 (c)	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

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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

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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

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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
Fensulfothion	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

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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

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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	0.00006	-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

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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 Dicofo]						
Kepone	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

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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-]						
MCPPP [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

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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
Methomyl	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-]						

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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

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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]						
Mirex	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

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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
Propham	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 MCPPE]	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 TCMTB]	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 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)	
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
Trinitrophenylmethylnitramine	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 (d)	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	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)	
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	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)	
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	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)	
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
Benzotrichloride	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	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	Commercial/Industrial	(mg/kg)	(mg/kg)	(mg/kg)	(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	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)	
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	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	Commercial/Industrial					
		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	
CFC 113 [see Trichloro-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
Chloroaniline, 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	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)	
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
Chlorothalonil [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
Chlorpropham	101-21-3	16000	310000	51	7	7	510	-Bone Marrow -Kidney -Liver -Spleen
Chlorpyrifos	2921-88-2	250	5000	15	0.001	0.001	150	-Neurological
Chromium (hexavalent) (b)	18540-29-9	210	470	NA	4.2	19	NA	-Carcinogen -Respiratory
Chromium (total) (b,g)	NOCAS	210	470	38	4.2	19	380	-Carcinogen
Chromium (trivalent) (b)	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	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	Commercial/Industrial					
		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(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	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)	
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	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	Commercial/Industrial					
		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(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	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)	
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	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)	
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	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	Commercial/ Industrial					
		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(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	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	Commercial/Industrial					
		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(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
Fensulfothion	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	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	Commercial/ Industrial					
		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(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	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)	
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 (d)	7439-92-1	400	1400	***	NA	***	***	-Neurological

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)	
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	0.006	-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	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	Commercial/ Industrial					
		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(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	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	Commercial/Industrial					
		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(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	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)	
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	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)	
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
Octamethylpyrophosphoramidate	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	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	Commercial/Industrial					
		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(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	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)	
Propionic acid, 2-(2-methyl-4-chlorophenoxy) [or MCPPE]	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 (b,c)	7782-49-2	440	11000	5.2	0.5	7.4	52	-Hair Loss -Neurological -Skin
Sevin [see Carbaryl]								
Silver (b)	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	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)	
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	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)	
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	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)	
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
Trinitrophenylmethylnitramine	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 (b)	7440-62-2	67**	10000	980	NA	NA	9800	-Hair Loss

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	Commercial/Industrial					
		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	
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	Commercial/Industrial					
		(mg/kg)	(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 III
Soil Properties and Test Methods

Soil Properties	Data Source	Methods
Dry Bulk Density	Field Measurement	ASTM ¹ Methods D-1556, D-2167, D-2922 or D-2937
Infiltration Rate	Field Measurement	Double-Ring Infiltrometer
Moisture Content (average)	Lab Measurement	ASTM ¹ D-2216
Organic Carbon Content (%)	Lab Measurement	Nelson & Sommers (1982) ²
pH	Field Measurement	McLean (1982) ³
Texture	Lab Measurement	Particle size analysis (Gee & Bauder, 1986) ⁴ ; USDA Classification

¹American Society for Testing and Materials. Annual Book of ASTM Standards; Section 4, Construction, Volume 04.08, Soil and Rock; Dimension Stone; Geosynthetics.

²Nelson, D.W. and Sommers, L.E. (1982). Total carbon, organic carbon, and organic matter. Methods of Soil Analysis. Part 2. Chemical and Microbiological Properties. 2nd Edition, Number 9 (Part 2) in series. Pages: 539-579. American Society of Agronomy, Madison, WI.

³McLean, E.O. (1982). Soil pH and lime requirement. Methods of Soil Analysis. Part 2. Chemical and Microbiological Properties. 2nd Edition, Number 9 (Part 2) in series. Pages: 199-224. American Society of Agronomy, Madison, WI.

⁴Gee, G.W. and Bauder, J.W. (1986). Particle size analysis. In: A. Klute (ed.), Methods of Soil Analysis. Part 1. Physical and Mineralogical Methods. 2nd Edition, Number 9 (Part 1) in series. Pages: 383-411, American Society of Agronomy, Madison, WI.

Table IV
Site-Specific Conditions and Geochemical Parameters
For Technical Evaluation of Natural Attenuation

Site-Specific Conditions	Geochemical Parameters
Aeration	Ammonia (as Nitrogen)
Bulk Density	BOD
Chemical Properties of the Contaminants	Carbon Dioxide
Contaminant Degradation Products	Carbon Monoxide
Groundwater Flow Rate	Chlorides
Groundwater Geochemistry	COD
Microbial Communities Present	Conductivity
Permeability	Dissolved Ferrous Iron
Physical Properties of the Contaminants	Dissolved Hydrogen
Porosity	Dissolved Methane
Precipitation	Dissolved Oxygen
Soil Organic Carbon	Ferric Iron
Soil Structure and Texture	Hydrogen Sulfide
Temperature	Iron (total and dissolved)
	Manganese (total and dissolved)
	Nitrate
	Nitrite
	Nitrogen
	Sulfide

NOTE: All of the listed site-specific conditions or geochemical parameters may not be applicable to every site for testing. Some parameters may apply only to the unsaturated soil.

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	MA 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-]			
MCPPE [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

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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 MCPP]	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.

Table VI
Default Parameters for Figures 4, 5, and 7

Symbol	Definition (units)	Receptor	Default	Reference
BW	body weight (kg)	aggregate resident ¹	51.9	Derived from equation using child and adult body weights (See Appendix A)
		child ²	16.8	Derived from NHANES III data (See Appendix A)
		adult/worker	76.1	Derived from NHANES III data (See Appendix A)
IRo	ingestion rate, oral (mg/day)	aggregate resident	120	Derived from equation using child and adult ingestion rates (Technical Report, page 21)
		child	200	USEPA (1996b)
		worker	50	
EF	exposure frequency (days/yr)	aggregate resident	350	USEPA (1996b)
		child	350	
		worker	250	
ED	exposure duration (years)	aggregate resident	30	USEPA (1996b)
		child	6	
		worker	25	
SA	surface area exposed (cm ² /day)	aggregate resident	4810	Derived from NHANES III data using allometric scaling (See Appendix A)
		child	2960	
		worker	3500	
AF	adherence factor (mg/cm ²)	aggregate resident	0.1	RAGS (part E), USEPA 2000 Supplemental Guidance for Dermal Risk Assessment – Interim Guidance
		child	0.2	
		worker	0.2	
AT	averaging time (days) (carcinogens)		25550 (70 years)	RAGS (part A), USEPA 1989a (EPA/540/1-89/002) (AT=ED)
	averaging time (days) (non-carcinogens)	aggregate resident	10950 (30 years)	
		child	2190 (6 years)	
		worker	9125 (25 years)	
IRi	inhalation rate (m ³ /day)	aggregate resident	12.2	Exposure Factors Handbook, USEPA 1997 (See Appendix A)
		child	8.1	
		worker	20	
DA	dermal absorption (unitless) (organics)		0.01	USEPA Region 4 Guidance
	dermal absorption (unitless) (inorganics)		0.001	
VF	volatilization factor (m ³ /kg)		chemical-specific	Soil Screening Guidance, USEPA 1996b (EPA/540/R-95/128) (See Fig. 7)
PEF ³	particulate emission factor (m ³ /kg)		1.24 x 10 ⁹	Soil Screening Guidance, USEPA 1996b (EPA/540/R-95/128) (See Fig. 6)
TR	target cancer risk (unitless)		10 ⁻⁶	Per Sections 376.3071, 376.30701, 376.3078(4) 376.81, F.S.
THI	target hazard index (unitless)		1	Per Sections 376.3071, 376.30701, 376.3078(4) 376.81, F.S.

¹ Aggregate Resident: Age 1 to 31 years.

² Child: Age 1 to 7 years.

³ The default PEF is for 0.5 acre sites with undisturbed soil. Site-specific PEFs must be calculated for sites with contaminated areas which are significantly larger in size or if warranted based on site-specific conditions.

Figure 1
Equation for Deriving Site-Specific Cleanup Target Levels
for Carcinogens in Groundwater

The formula for calculation is:

$$GCTL(\mu\text{g/L}) = \frac{1 \times 10^{-6} \times BW \times CF}{CSF_o \times WC}$$

Parameter	Definition	Default Value
GCTL	groundwater cleanup target level (μg/L)	-
TR	target cancer risk (unitless)	1×10^{-6}
BW	average body weight (kg)	70.0
CF	conversion factor (μg/mg)	1000
CSF _o	oral cancer slope factor (mg/kg-day) ⁻¹	chemical-specific ^a
WC	average water consumption rate (L/day)	2

^aToxicity values from IRIS, HEAST or other sources as provided in Table 5a of the technical report referenced in subsection 62-777.100(2), F.A.C., for carcinogens.

Example: hexachloro-1,3-butadiene, CSF_o = 0.078 (mg/kg-day)⁻¹

$$GCTL(\mu\text{g/L}) = \frac{1 \times 10^{-6} \times 70.0 \times 1000}{0.078 \times 2} = \frac{0.070}{0.156}$$

$$GCTL = 0.4 \mu\text{g/L}$$

Figure 2
Equation for Deriving Site-Specific Cleanup Target Levels
for Non-Carcinogens in Groundwater

The formula for calculation is:

$$GCTL(\mu\text{g/L}) = \frac{RfD_o \times BW \times RSC \times CF}{WC}$$

Parameter	Definition (units)	Default Value
GCTL	groundwater cleanup target level (μg/L)	-
BW	average body weight (kg)	70
RfD _o	oral reference dose (mg/kg-day)	chemical-specific ^a
RSC	relative source contribution (%)	20
CF	conversion factor (μg/mg)	1000
WC	average water consumption rate (L/day)	2

^aToxicity values from IRIS, HEAST, or other sources as provided in Table 5b of the technical report referenced in subsection 62-777.100(2), F.A.C., for non-carcinogens.

Example: 2-chlorophenol, RfD_o = 0.005 mg/kg-day

$$GCTL(\mu\text{g/L}) = \frac{0.005 \times 70.0 \times 0.2 \times 1000}{2} = \frac{70.0}{2}$$

$$GCTL = 35 \mu\text{g/L}$$

Figure 3A
Equations Used to Calculate Freshwater or Marine Surface Water Cleanup Target Levels
Based on Human Health Endpoints^a

For non-carcinogens:

$$SWCTL (\mu\text{g/L}) = \frac{(RfD_o \times BW)}{(FI \times BCF)} \times CF$$

For carcinogens:

$$SWCTL(\mu\text{g/L}) = \frac{(TR \times BW)}{(CSF_o \times [FI \times BCF])} \times CF$$

Parameter	Definition	Default Value
SWCTL	Surface Water Cleanup Target Level (μg/L)	-
BW	body weight (kg)	70
RfD _o	oral reference dose (mg/kg-day)	chemical-specific ^a
FI	fish ingestion rate (kg/day)	0.0175 ^b
BCF	bioconcentration factor (mg toxicant/kg fish per mg toxicant/L water)	chemical-specific ^c
CF	conversion factor (μg/mg)	1000
TR	target cancer risk (unitless)	1 × 10 ⁻⁶
CSF _o	oral cancer slope factor (mg/kg-day) ⁻¹	chemical-specific ^b

^aToxicity values from IRIS, HEAST, or other sources as provided in Tables 5a and 5b of the technical report referenced in subsection 62-777.100(2), F.A.C.

^bEquations and default fish consumption from USEPA (2000).

^cBioconcentration factors obtained from USEPA sources (USEPA 2000a) or calculated using the EPIWin software package.

Example: dimethylphenol, 3,4-, RfD_o = 0.001 mg/kg-day and BCF = 10.4 L/kg

$$SWCTL(\mu\text{g} / \text{L}) = \frac{0.001 \times 70}{0.0175 \times 10.4} \times 1000 = 380$$

Example: acrylonitrile, CSF_o = 0.54 (mg/kg-day)⁻¹ and BCF 30 L/kg

$$SWCTL(\mu\text{g} / \text{L}) = \frac{1 \times 10^{-6} \times 70}{0.54 \times 0.0175 \times 30} \times 1000 = 0.2$$

Figure 3B
Methodology Used to Calculate Freshwater and Marine Surface Water Criteria
Based on Chronic Toxicity

Steps:

1. Select data with document codes of "C" or "M" from the USEPA Aquatic Toxicity Information Retrieval (AQUIRE) Database.
2. Take no action for substances for which insufficient data are retrieved to allow a reasonable choice of sensitive organisms.
3. Select only animal LC₅₀ data, except that plant data should be selected in the case of substances in which plant EC₅₀ values for growth or photosynthesis, or LC₅₀ values for biomass, are several orders of magnitude lower than animal LC₅₀ values.
4. Ignore data from salmonid fishes (salmon and freshwater trout).
5. Select the test and organism showing the greatest sensitivity to the toxicant. Extreme outliers should be ignored during this procedure, and several other types of data (such as data in which the endpoint or concentration had to be recalculated by the USEPA for entry into the database, and data based only on active ingredients) should also be removed from consideration if more clearly applicable data are available for sensitive organisms.
6. A factor of 5% (1/20) should be applied to the animal LC₅₀ data to generate a surface water cleanup target level. If a plant LC₅₀ or EC₅₀ value was chosen, then that value becomes the guideline, without the use of a factor.

Figure 4
Model Equation for Developing Acceptable Risk-Based Concentrations in Soil.
Acceptable Soil Cleanup Target Levels for Carcinogens

$$SCTL = \frac{TR \times BW \times AT \times RBA}{CSF \times FC \times IR \times \left[\left(\frac{kg \times 10^{-6}}{mg \times + / } \right) \left(CSF_d \times SA \times 10^{-6} AF + / \right) \left(DA \times VF \left(\frac{1}{kg} + \frac{1}{PEF} \right) \right) \right]} \quad CSF$$

SCTL = Soil Cleanup Target Level

TR = target cancer risk (unitless)

BW = body weight (kg)

AT = averaging time (days)

EF = exposure frequency (days/yr)

ED = exposure duration (years)

RBA = relative bioavailability factor (unitless)

FC = fraction from contaminated source (unitless)

IR_o = ingestion rate, oral (mg/day)

SA = surface area of skin exposed (cm²/day)

AF = adherence factor (mg/cm²)

DA = dermal absorption (unitless)

IR_i = inhalation rate (m³/day)

VF = volatilization factor (m³/kg)

PEF = particulate emission factor (m³/kg)

CSF = cancer slope factor (mg/kg-day)⁻¹

CSF_o = oral

CSF_d = dermal

CSF_i = inhalation

Sample SCTL Calculation for Direct Exposure (Aggregate Resident): benzene:

$$SCTL = \frac{0.000001 \times 51.9 \times 25500 \times 1.0}{30 \times 1.0 \times \left[\left(0.055 \times \frac{0}{4810} \right) + \left(0.0611 \times \frac{10}{0.1} \times 0.01 \right) + \left(0.0273 \times 12.2 \times \left(\frac{1}{3.572 \times 10^3} + \frac{1}{1.24 \times 10^9} \right) \right) \right]}$$

$$SCTL = \frac{1.323}{6 \times 10^{-6} \times \left[\left(0.055 \times 10^{-6} \right) + \left(0.0611 \times 10^{-7} \right) + \left(0.0273 \times 12.2 \times \left(\frac{1}{9.210 \times 10^6} + \frac{1}{1.1405 \times 10^9} \right) \right) \right]} = \frac{1.323}{1.1405 \times 10^{-5}} = 115,990 \text{ mg / kg}$$

TR = 0.000001 (unitless)

BW = 51.9 kg

AT = 25500 days

RBA = 1.0

CSF_o = 0.055 (mg/kg-day)⁻¹

CSF_d = 0.0611 (mg/kg-day)⁻¹

CSF_i = 0.0273 (mg/kg-day)⁻¹

EF = 350 days/year

ED = 30 years

FC = 1.0 (unitless)

IR_o = 120 mg/day

SA = 4810 cm²

AF = 0.1 mg/cm²

DA = 0.01 (unitless)

IR_i = 12.2 m³/day

VF = 3.572 x 10³ m³/kg

PEF = 1.24 x 10⁹ m³/kg

Note: All calculations carried out to 18 decimal places. For simplicity of demonstration, the calculated values above are not shown to the same precision. Final SCTL value is rounded to two significant figures if >1 and to one significant figure if <1.

Figure 5
Model Equation for Developing Acceptable Risk-Based Concentrations in Soil.
Acceptable Soil Cleanup Target Levels for Non-Carcinogens

$$SCTL = \frac{THI \times BW \times AT \times RBA}{EF \times ED \times \left[\left(\frac{FC}{RfD_o} \times IR_o \times 10^{-6} \text{ kg/mg} \right) \left(\frac{SA}{RfD_d} \times AF \times DA \times 10^{-6} \text{ kg/mg} \right) \left(\frac{1}{RfD_i} \times IR_i \times \left(\frac{1}{VF} + \frac{1}{PEF} \right) \right) \right]}$$

SCTL = Soil Cleanup Target Level	FC = fraction from contaminated source (unitless)	PEF = particulate emission factor (m ³ /kg)
THI = target hazard index (unitless)	IR _o = ingestion rate, oral (mg/day)	RfD = reference dose (mg/kg-day)
BW = body weight (kg)	SA = surface area of skin exposed (cm ² /day)	RfD _o = oral
AT = averaging time (days)	AF = adherence factor (mg/cm ²)	RfD _d = dermal
EF = exposure frequency (days/yr)	DA = dermal absorption (unitless)	RfD _i = inhalation
ED = exposure duration (years)	IR _i = inhalation rate (m ³ /day)	
RBA = relative bioavailability factor (unitless)	VF = volatilization factor (m ³ /kg)	

Sample SCTL Calculation for Direct Exposure (Child Resident): fluorine

$$SCTL = \frac{1.0 \times 16.8 \times 2190 \times 1.0}{350 \times 6 \times \left[\left(\frac{1}{0.04} \times 200 \times 10^{-6} \text{ kg/mg} \right) \left(\frac{2960}{0.02} \times 0.2 \times 0.01 \times 10^{-6} \text{ kg/mg} \right) \left(\frac{1}{0.02} \times 8.1 \times \left(\frac{1}{2.80802 \times 10^5} + \frac{1}{1.24 \times 10^9} \right) \right) \right]}$$

$$SCTL = \frac{36792}{2100 \times 5.04 \times 10^3} = \frac{36792}{10584000} = \frac{36792}{10584000} = 0.003476 \text{ mg/kg}$$

THI = 1.0 (unitless)	RfD _i = 0.02 mg/kg-day	AF = 0.2 mg/cm ²
BW = 16.8 kg	EF = 350 days/year	DA = 0.01 (unitless)
AT = 2190 days	ED = 6 years	IR _i = 8.1 m ³ /day
RBA = 1.0	FC = 1.0 (unitless)	VF = 2.80802 x 10 ⁵ m ³ /kg
RfD _o = 0.04 mg/kg-day	IR _o = 200 mg/day	PEF = 1.24 x 10 ⁹ m ³ /kg
RfD _d = 0.02 mg/kg-day	SA = 2960 cm ²	

Note: All calculations carried out to 18 decimal places. For simplicity of demonstration, the calculated values above are not shown to the same precision. Final SCTL value is rounded to two significant figures if >1 and to one significant figure if <1.

Figure 6
Derivation of the Particulate Emission Factor ^a

$$PEF \left(\frac{m^3}{kg} \right) = \frac{Q/C \left(\frac{g}{m^2 \cdot s} \right) \times 3600 \left(\frac{s}{h} \right)}{V \left(\frac{m^3}{kg} \right) \times U_m \left(\frac{m}{s} \right) \times U_t \left(\frac{m}{s} \right) \times F(x)}$$

Parameter	Definition (units)	Default
PEF	particulate emission factor (m ³ /kg)	1.241005 x 10 ⁹
Q/C	inverse of mean conc. at center of a 0.5-acre-square source (g/m ² -s per kg/m ³)	85.61 ^b
V	fraction of vegetative cover (unitless)	0.5 (50%) ^c
U _m	mean annual windspeed (m/s)	4.69 ^c
U _t	equivalent threshold value of windspeed at 7 m (m/s)	11.32
F(x)	function dependent on U _m /U _t , (unitless) ^d	0.194

^a Equation taken from USEPA (1996b).

^b Based on Q/C Value for Zone IX (Miami, FL) as listed in USEPA (1996b). The default is for 0.5 acre sites with undisturbed soil. Site-specific PEFs must be calculated for sites with contaminated areas which are significantly larger in size or if warranted based on site-specific conditions.

^c Value may be substituted with documented, FDEP accepted site-specific information.

^d USEPA (1985).

Note: All calculations carried out to 18 decimal places. For simplicity of demonstration, the calculated values below are not shown to the same precision.

Calculation of PEF based on Zone IX Q/C Value:

$$PEF \left(\frac{m^3}{kg} \right) = \frac{85.61 \left(\frac{g}{m^2 \cdot s} \right) \times 3600 \left(\frac{s}{h} \right)}{0.5 \left(\frac{m^3}{kg} \right) \times 4.69 \left(\frac{m}{s} \right) \times 11.32 \left(\frac{m}{s} \right) \times 0.194}$$

Figure 7

Equation Used for the Determination of the Volatilization Factor ^a

$$VF = Q/C \times CF \times \frac{(3.14 \times D_A \times T)^{1/2}}{2 \times \rho_b \times D_A}$$

$$D_A = \frac{\left[\left(\theta_a^{10/3} D_i H' + \theta_w^{10/3} D_w \right) / n^2 \right]}{\rho_b K_d + \theta_w + \theta_a H'}$$

Where:

Model Parameters (Units)	Default Value
VF volatilization factor (m ³ /kg)	-
D _A apparent diffusivity (cm ² /s)	-
CF conversion factor (m ² /cm ²)	10 ⁻⁴
Q/C inverse of the mean concentration (g/m ² -s)	85.61 ^b
T exposure interval (s)	ED × 3.1536 × 10 ⁷
ED exposure duration (years)	Exposure-specific
η total soil porosity (L _{pore} /L _{soil})	1 - (ρ _b /ρ _s) ^e
ω average soil moisture content (g _{water} /g _{soil})	0.1 (10%) ^e
ρ _b dry soil bulk density (g/cm ³)	1.5 ^e
ρ _s soil particle density (g/cm ³)	2.65
θ _a air-filled soil porosity (L _{air} /L _{soil})	η - θ _w
θ _w water-filled soil porosity (L _{water} /L _{soil})	ω ρ _b
K _d soil-water partition coefficient L/kg	K _{oc} × f _{oc}
D _i diffusivity in air (cm ² /s)	Chemical-specific
D _w diffusivity in water (cm ² /s)	Chemical-specific
H Henry's Law constant (atm-m ³ /mol)	Chemical-specific
H' Henry's Law constant (unitless)	H × 41
K _{oc} soil-organic carbon partition coefficient (L/	Chemical-specific
f _{oc} organic carbon content of soil (g/g)	0.006 (0.6%) ^c

^a Model equation taken from USEPA (1996b).

^b Value derived for an undisturbed 0.5-acre site in Miami, FL (USEPA 1996b). Site-specific PEFs must be calculated for disturbed sites, or sites significantly larger than 0.5 acres.

^c Listed in Table 4.

^d See Table 3 for exposure durations for the child, aggregate resident, and worker exposure scenarios.

^e Value may be substituted with appropriate site-specific information upon approval by the FDEP.

Sample VF Calculation for Aggregate Resident Exposure, Benzene:

Note: All calculations carried out to 18 decimal places. For simplicity of demonstration, the calculated values below are not shown to the same precision.

Given: D_i = 0.088 cm²/s
D_w = 1.02 × 10⁻⁵ cm²/s
H' = 0.22755000
T = 9.460800 × 10⁸ s
K_{oc} = 59 L/kg
K_d = 0.35400 L/kg

Then:

$$D_A = \frac{[(1.504996 \times 10^{-4} \times 0.088 \times 2.27550 \times 10^{-3}) + (1.02 \times 10^{-5} \times 0.227550 \times 10^{-3})]}{1.5 \times (1 - \frac{2.65}{1.5}) + 0.1 \times 2.65 + 0.227550 \times 10^{-3} \times 0.35400} = 2.146 \times 10^{-2} \text{ cm}^2/\text{s}$$

And:

$$VF = 85.61 \times 10^{-4} \times \frac{(3.14 \times 2.146 \times 10^{-2} \times 9.46080 \times 10^8)^{0.5}}{2 \times 1.5 \times 2.146 \times 10^{-2}} = \frac{2.1617 \times 10^1}{6.4390 \times 10^{-3}} = 3572 \times \left(\frac{\text{m}^3}{\text{kg}} \right)$$

Figure 8
Equation for the Determination of Soil Cleanup Target Levels (SCTLs)
Based on Leachability

$$\text{SCTL}(\text{mg/kg}) = \text{GCTL}(\mu\text{g/L}) \times \text{CF}(\text{mg}/\mu\text{g}) \times \text{DF} \times \left[K_{oc}(\text{L/kg}) \times f_{oc}(\text{g/g}) + \frac{\theta_w (L_{\text{water}}/L_{\text{soil}}) + \theta_a (L_{\text{air}}/L_{\text{soil}}) \times H'}{\rho_b(\text{g/cm}^3)} \right]$$

Parameter	Definition (units)	Variables and Default
GCTL	groundwater cleanup target level ($\mu\text{g/L}$)	table-specific value ¹
CF	conversion factor ($\text{mg}/\mu\text{g}$)	0.001
DAF	dilution attenuation factor (unitless)	20 ²
K_{oc}	soil-organic carbon partition coefficient (L/kg)	chemical-specific value ³
f_{oc}	fraction organic carbon in soil (g/g)	0.002 ⁴
θ_w	water-filled soil porosity ($L_{\text{water}}/L_{\text{soil}}$)	$\omega \rho_b$
θ_a	air-filled soil porosity ($L_{\text{air}}/L_{\text{soil}}$)	$\eta - \theta_w$
H	Henry's Law constant ($\text{atm}\cdot\text{m}^3/\text{mol}$)	chemical-specific value ³
H'	Henry's Law constant (unitless)	$H \times 41$
ρ_b	dry soil bulk density (g/cm^3)	1.5 ⁴
ω	average soil moisture content ($\text{g}_{\text{water}}/\text{g}_{\text{soil}}$)	0.2 (20%) ⁴
η	total soil porosity ($L_{\text{pore}}/L_{\text{soil}}$)	$1 - (\rho_b/\rho_s)$
ρ_s	soil particle density (g/cm^3)	2.65

¹ Groundwater Cleanup Target Levels (see Table 1).

² If the site is significantly larger than 0.5 acres or if warranted by site-specific conditions (such as a shallow water table), a lower DAF may be required.

³ Listed in Table 4 of the technical report referenced in subsection 62-777.100(2), F.A.C.

⁴ Value may be substituted with appropriate site-specific information upon approval by the FDEP. It should be noted that the default values for f_{oc} , ω , and θ_w in the calculation of leachability-based SCTLs differ from those used to calculate the VF and C_{sat} as per guidance in USEPA (1996b).

Note: All calculations carried out to 18 decimal places. For simplicity of demonstration, the calculated values below are not shown to the same precision. Final SCTL is rounded to two significant figures if >1 and to one significant figure if <1.

Sample SCTL calculation for benzene migration into groundwater:

Given: GCTL = 1 $\mu\text{g/L}$
 K_{oc} = 59 L/kg
 H' = 0.227550

Then:

$$\text{SCTL} = 1.0 \times 0.001 \times 20 \times \left[59 \times 0.002 + \frac{0.3 + (0.13396 \times 0.22755)}{1.5} \right] =$$

$$\text{SCTL} = 0.007 \text{ mg/kg}$$

Figure 9
Equation^a Used for the Determination of C_{sat}

$$C_{\text{sat}} = \frac{S}{\rho_b} (K_d \rho_b + \theta_w + H' \theta_a)$$

Parameter	Definition (Units)	Default Value
C _{sat}	soil saturation concentration (mg/kg)	-
S	solubility in water (mg/L)	chemical-specific ^b
ρ _s	soil particle density (g/cm ³)	2.65
ρ _b	dry soil bulk density(g/cm ³)	1.5 ^c
η	total soil porosity (L _{pore} /L _{soil})	1 - (ρ _b /ρ _s)
θ _a	air-filled soil porosity (L _{air} /L _{soil})	η - θ _w
θ _w	water-filled soil porosity (L _{water} /L _{soil})	ωρ _b
K _d	soil-water partition coefficient (cm ³ /g)	K _{oc} × f _{oc}
ω	average soil moisture content (kg _{water} /kg _{soil})	0.1 (10%) ^c
H	Henry's Law constant (atm-m ³ /mol)	chemical-specific ^b
H'	Henry's Law constant (unitless)	H × 41
K _{oc}	soil-organic carbon partition coefficient (L/kg)	chemical-specific ^b
f _{oc}	fraction organic carbon in soil (g/g)	0.006 (0.6%) ^c

^a Model equation taken from USEPA (1996b).

^b Listed in Table 4 of the technical report referenced in subsection 62-777.100(2), F.A.C.

^c Value may be substituted with appropriate site-specific information upon approval by the FDEP.

Note: All calculations carried out to 18 decimal places. For simplicity of demonstration, the calculated values below are not shown to the same precision. C_{sat} values used as SCTLs are rounded to two significant figures if > 1 and to one significant figure if < 1.

Sample C_{sat} Calculation for ethylbenzene

Given:

S = 169 mg/L
K_d = 2.178 L/kg
K_{oc} = 363 L/kg
H' = 0.32308

Then:

$$C_{\text{sat}} = \frac{169}{1.5} ((2.178 \times 1.5) + (0.15) + (0.32308 \times 0.2839362))$$

$$C_{\text{sat}} = 112.6667 \times 3.5087$$

$$C_{\text{sat}} = 400 \text{ mg/kg}$$

Figure 10
Apportionment of CTLs with the Same Target Organs or Effects

To ensure that cancer risks and hazards do not exceed one in a million or one, respectively, GCTLs and direct contact SCTLs for each carcinogen and for each non-carcinogen acting on the same organ should, when appropriate, be apportioned so that the sum of risks posed by the CTLs meets FDEP risk goals of 1×10^{-6} and a hazard index of 1. Exceptions to this procedure are CTLs based on natural background or quantitation limits, and in the case of GCTLs, values based on promulgated standards.

Example 1:

Calculation of apportioned direct exposure SCTLs for comparison with mean (95%upper confidence of the mean) site concentrations using simple apportionment.

Each SCTL should be divided by the number of contaminants with the same target organ or effect. In this case, SCTLs for carcinogens are divided by 5, those for contaminants acting on the liver by 3, and those with neurological effects by 2.

Contaminants	Target Organs/Effects	Residential SCTL	Site-Specific Apportioned SCTL
benzo(a)pyrene	carcinogen	0.1	0.02
benzo(k)fluoranthene	carcinogen	13	2.6
chrysene	carcinogen	130	26
dichlorodiphenyldichloroethane, p,p' [or DDD, 4,4'-]	carcinogen	4.2	0.84
dichlorodiphenyldichloroethylene, p,p'- [or DDE, 4, 4']	carcinogen	2.9	0.58
butylate	liver	3200	1067
chlorobenzene	liver	120	40
endrin	liver	25	8.3
aldicarb [or Temik]	neurological	68	34
carbophenothion [or Trithion]	neurological	11	5.5
Number of contaminants with same target or effect:	carcinogens	5	
	liver	3	
	neurological	2	

Example 2:

Calculation of site-specific apportioned SCTLs for Total Recoverable Petroleum Hydrocarbons (TRPH) fractions for comparison with mean (95% upper confidence of the mean) site concentrations based on simple apportionment.

Each SCTL should be divided by the number of contaminants with the same target organ or effect. TRPH classes are evaluated as individual chemicals.

Contaminants	Target Organ/Effect	Residential SCTL	Apportionment factor	Site-Specific Apportioned SCTL
benzo(a)pyrene	carcinogen	0.1	2	0.05
benzene	carcinogen	1.2	2	0.6
C ₅ -C ₇ Aromatic TRPH Class	liver, neurological	340	3	110
C ₁₀ -C ₁₂ Aromatic TRPH Class	body weight	900	3	300
C ₁₆ -C ₂₁ Aromatic TRPH Class	kidney	1300	1	1300
C ₅ -C ₆ Aliphatic TRPH Class	neurological	6200	3	2000
C ₈ -C ₁₀ Aliphatic TRPH Class	liver, blood	850	3	280
C ₁₂ -C ₁₆ Aliphatic TRPH Class	liver, blood	2900	3	970
Naphthalene	body weight, nasal	2	3	0.7
Xylenes	body weight, neurological	8000	3	2700
Number of contaminants with same target or effect:	carcinogens	2		
	liver	3		
	neurological	3		
	body weight	3		
	kidney	1		
	blood	2		
	nasal	1		

Example 3:
Calculation of site-specific SCTLs using weighted apportionment.

Steps that may be followed to apportion SCTLs:

1. 95% UCL concentrations are compared to natural background concentrations or quantitation limits, if applicable.
2. If background concentrations or quantitation limits are exceeded, then an exceedance ratio between the 95% UCL concentration, and the alternative SCTL is calculated for each contaminant.
3. Exceedance ratios for contaminants having the same target organ or effect are summed.
4. The alternative, apportioned SCTL is then calculated by dividing the 95% UCL concentration by the largest total exceedance ratio applicable to each contaminant.

Contaminants	Target Organs/ Effects	Site 95% UCL	Site Back- ground	Alternative SCTL	Exceedance Ratio	Total Exceedance Ratio	Site-Specific Apportioned SCTL
benzo(a)pyrene	carcinogen	5.6		0.8	7	7.9	0.7
arsenic	carcinogen cardiovascular skin	2.9	3.1	3	NA ¹	NA	NA
cobalt	Cardiovascular immunological neurological reproductive	4	5.5	340	NA	NA	NA
dichlorophenol, 2,3-	Immunological	1200		1000	1.2	3.2	370
dichlorophenol, 2,4-	Immunological	1500		750	2	3.2	470
PCBs	Carcinogen immunological	3	5	3.2	0.9	7.9	0.4
Naphthalene	body weight nasal	18		11	1.6	2.2	8
Xylenes	body weight neurological	7000		13000	0.5	2.2	3200
Sum of exceedances ratios of contaminants with same target or effect	Carcinogens				7.9		
	cardiovascular				0.0		
	immunological				4.1		
	neurological				0.5		
	body weight				2.2		
	reproductive				0.0		
	nasal				1.6		

¹ = NA, Not applicable. Apportionment is not indicated because site concentration is less than the background reference value.

**APPENDIX E – LABORATORY QUALITY MANUAL/COC REPORTING LIMIT
SPECIFICATIONS**

Quality Assurance Manual Cover Page

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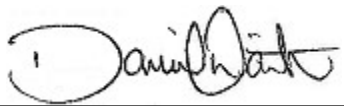
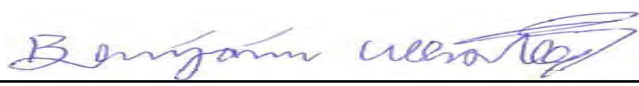
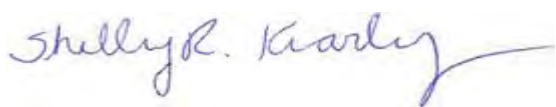
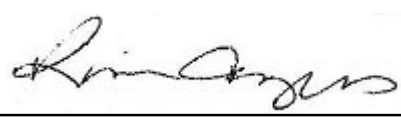
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Title Page:**Quality Assurance Manual
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SECTION 2. TABLE OF CONTENTS

Revision 12a updates the 2016 TNI Standards in Section 2. Table of Contents.

Revision 12b updates the 2016 TNI Standards references in the QAM content.

Revision 12c updates Section 24.6.2, bullet 4; addition of bullet 5.

Revision 12d updates Sections 16.2, 4.3, Deputies, and Figure 19-1 Demonstration of Capability Certification Statement

Revision 12e updates, Laboratory Name, Signature page, Section 4.3 Deputies, and Figure 19-1 Demonstration of Capability Certification Statement

Revision 12f update TA to Eurofins, Sig page

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REFERENCED CORPORATE SOPs AND POLICIES

SOP / Policy Reference	Title
CA-C-S-001	Work Sharing Process
CA-I-P-002	Electronic Reporting and Signature Policy
CA-L-P-002	Contract Compliance Policy
CA-Q-M-002	Corporate Quality Management Plan
CA-Q-QM-001	Policy on Tentatively Identified Compounds (TICs) – GC/MS Analysis
CA-Q-S-001	Acid and Solvent Lot Testing and Approval Program
CA-Q-S-002	Manual Integrations
CA-Q-S-006	Detection and Quantitation Limits
CA-Q-S-009	Root Cause Analysis
CA-T-P-001	Qualified Products List
CW-E-M-001	Corporate Environmental Health & Safety Manual
CW-F-P-002	Company-Wide Authorization Matrix
CW-F-P-004	Procurement and Contracts Policy
CW-F-S-007	Fixed Asset Acquisition, Retention and Safeguarding
CW-I-M-001	IT Change Control Procedure Manual
CW-L-P-001	Records Retention Policy
CW-L-P-004	Ethics Policy
CW-L-S-002	Internal Investigation
CW-L-S-004	Subcontracting
CW-Q-S-001	Corporate Document Control and Archiving
CW-Q-S-002	Writing a Standard Operating Procedure (SOPs)
CW-Q-S-003	Internal Auditing
CW-Q-S-004	Management Systems Review
CW-Q-S-005	Data Recall Process
CW-Q-S-001	Corporate Document Control and Archiving

REFERENCED LABORATORY SOPs

SOP Reference	Title
PS-CSD-004	Client Service Departmental Policies
PS-CSD-007	Log In Review and Final Job Approval
PS-EXT-025	Self-Heating Test
PS-LAB-003	Sample Homogenization and Subsampling
PS-LAB-006	Out of Control Events and Corrective Actions
PS-LAB-007	Records Management
PS-LAB-008	Nonconforming Events
PS-LAB-011	Pipette, Syringe, Dispenser, and Digital Burette Calibration and Verification
PS-LAB-014	Training Program and Documentation
PS-LAB-015	Waste Disposal
PS-LAB-016	Process for Creation, Review, Revision and Control of Laboratory Documents
PS-LAB-019	Procedure for Handling a Data Inquiry by a Client
PS-LAB-022	Data Generation, Review, Approval, and Reporting
PS-QAD-003	Calculation of Control Limits
PS-QAD-014	Thermometers and Temperature Control
PS-QAD-016	Calibration and Use of Laboratory Balances and Laboratory Weights
PS-QAD-021	Demonstrations of Capability
PS-SCD-007	Procedure for Receiving Samples and Logging Samples into the LIMS
PS-WCD-001	pH [EPA 150.1 / SM 4500H+ B / SW-846 9040B / SW-846 9040C / SW-846 9045C / SW-846 9045D]
PS-WCD-006	Odor [EPA 140.1/SM2150B]
PS-WCD-010	Total Volatile Solids and Fixed Solids [EPA Method 160.4 / SM 2540E AND 2540G]
PS-WCD-019	Total Coliform Analysis by Membrane Filtration (MF) and Fecal Coliform Analysis by Membrane Filtration (MF) [SM9222B and SM9222D]
PS-WCD-027	Presence-Absence (P-A) Coliform Test for Total and E. Coli in Drinking Water [SM 9223]
PS-WCD-033	Paint Filter Liquids Test [SW-846 9095B]
PS-WCD-036	Konelab Analyses

SECTION 3. INTRODUCTION, SCOPE AND APPLICABILITY

3.1 Introduction and Compliance References

Eurofins Pensacola's Quality Assurance Manual (QAM) is a document prepared to define the overall policies, organization objectives and functional responsibilities for achieving Eurofins's data quality goals. The laboratory maintains a local perspective in its scope of services and client relations and maintains a national perspective in terms of quality.

The QAM has been prepared to assure compliance with the NELAC Institute (TNI) Standards, dated 2009 and 2016, Volume 1 Modules 2 and 4; and ISO/IEC Guide 17025:2017. In addition, the policies and procedures outlined in this manual are compliant with Eurofins's Corporate Quality Management Plan (CQMP) and the various accreditation and certification programs listed in Appendix 3. The CQMP provides a summary of Eurofins's quality and data integrity system. It contains requirements and general guidelines under which all Eurofins facilities shall conduct their operations.

The QAM has been prepared to be consistent with the requirements of the following documents:

- ANSI/ASQC, E4-1994, "Specifications and Guidelines for Quality Management Systems for Environmental Data Collection and Environmental Technology Programs" (American National Standard, January 5, 1995, or most recent version).
- "EPA Requirements for Quality Management Programs" (QA/R-2) (EPA/240/B-01/002, May 31, 2006).
- EPA 600/4-88/039, *Methods for the Determination of Organic Compounds in Drinking Water*, EPA, Revised July 1991.
- EPA 600/R-95/131, *Methods for the Determination of Organic Compounds in Drinking Water*, Supplement III, EPA, August 1995.
- EPA 600/4-79-019, *Handbook for Analytical Quality Control in Water and Wastewater Laboratories*, EPA, March 1979.
- *Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846)*, Third Edition, September 1986, Final Update I, July 1992, Final Update IIA, August 1993, Final Update II, September 1994; Final Update IIB, January 1995; Final Update III, December 1996; Final Update IV, January 2008; Final Update V, August 2015.
- Federal Register, 40 CFR Parts 136, 141, 172, 173, 178, 179 and 261.
- *Manual for the Certification of Laboratories Analyzing Drinking Water (EPA 815-R-05-004, January 2005) (DW labs only)*.
- *Statement of Work for Inorganics & Organics Analysis, SOM and ISM, current versions, USEPA Contract Laboratory Program Multi-media, Multi-concentration*.
- APHA, *Standard Methods for the Examination of Water and Wastewater*, 18th Edition, 19th, 20th, 21st, 22nd and on-line Editions.
- Nuclear Regulatory Commission (NRC) Quality Assurance Requirements.
- Marine Protection, Research, and Sanctuaries Act (MPRSA).
- Toxic Substances Control Act (TSCA).

3.2 Terms and Definitions

A Quality Assurance Program is a company-wide system designed to ensure that data produced by the laboratory conforms to the standards set by state and/or federal regulations. The program functions at the management level through company goals and management policies, and at the analytical level through Standard Operating Procedures (SOPs) and quality control. The Eurofins program is designed to minimize systematic error, encourage constructive, documented problem solving, and provide a framework for continuous improvement within the organization.

Refer to Appendix 2 for the Glossary/Acronyms.

3.3 Scope / Fields of Testing

The laboratory analyzes a broad range of environmental and industrial samples. Sample matrices vary among air, drinking water, effluent water, groundwater, hazardous waste, sludge and soils. The Quality Assurance Program contains specific procedures and methods to test samples of differing matrices for chemical, physical and biological parameters. The Program also contains guidelines on maintaining documentation of analytical processes, reviewing results, servicing clients and tracking samples through the laboratory. The technical and service requirements of all analytical requests are thoroughly evaluated before commitments are made to accept the work. Measurements are made using published reference methods or methods developed and validated by the laboratory.

The methods covered by this manual include the most frequently requested methodologies needed to provide analytical services in the United States and its territories. The specific list of test methods used by the laboratory can be found in the laboratory LIMS (TALS). The approach of this manual is to define the minimum level of quality assurance and quality control necessary to meet these requirements. All methods performed by the laboratory shall meet these criteria as appropriate. In some instances, quality assurance project plans (QAPPs), project specific data quality objectives (DQOs) or local regulations may require criteria other than those contained in this manual. In these cases, the laboratory will abide by the requested criteria following review and acceptance of the requirements by the Laboratory Director and the Quality Assurance (QA) Manager. In some cases, QAPPs and DQOs may specify less stringent requirements. The Laboratory Director and the QA Manager must determine if it is in the lab's best interest to follow the less stringent requirements.

3.4 Management of the Manual

3.4.1 Review Process

The template on which this manual is based is reviewed annually by Corporate Quality Management Personnel to assure that it remains in compliance with Section 3.1. This manual itself is reviewed every two years by senior laboratory management to assure that it reflects current practices and meets the requirements of the laboratory's clients and regulators as well as the CQMP. Occasionally, the manual may need changes in order to meet new or changing regulations and operations. The QA Manager will review the changes in the normal course of business and incorporate changes into revised sections of the document. All updates will be reviewed by the senior laboratory management staff. The laboratory updates and approves such changes according to our Document Control & Updating procedures (refer to SOP PS-LAB-016).

SECTION 4. MANAGEMENT REQUIREMENTS

4.1 Overview

Eurofins Pensacola is a local operating unit of Eurofins Laboratories, Inc.. The organizational structure, responsibilities and authorities of the corporate staff of Eurofins Laboratories, Inc. are presented in the CQMP. The laboratory has day-to-day independent operational authority overseen by corporate officers (e.g., President and Chief Executive Officer (CEO), Chief Operating Officer (COO), Executive Vice President (VP) Operations, Corporate Quality, etc.). The laboratory operational and support staff work under the direction of the Laboratory Director. The organizational structure for both Corporate & Eurofins Pensacola is presented in Figure 4-1.

4.2 Roles and Responsibilities

In order for the Quality Assurance Program to function properly, all members of the staff must clearly understand and meet their individual responsibilities as they relate to the quality program. The following descriptions briefly define each role in its relationship to the Quality Assurance Program.

4.2.1 Additional Requirements for Laboratories

The responsibility for quality resides with every employee of the laboratory. All employees have access to the QAM, are trained to this manual, and are responsible for upholding the standards therein. Each person carries out his/her daily tasks impartially and in a manner consistent with the goals and in accordance with the procedures in this manual and the laboratory's SOPs. Role descriptions for corporate personnel are defined in the CQMP. This manual is specific to the operations of Eurofins's Pensacola laboratory.

4.2.2 President and Chief Executive Officer (CEO)

The President and CEO is a member of the Board of Directors and is ultimately responsible for the quality and performance of all Eurofins facilities. The President and CEO establishes the overall quality standard and data integrity program for the Analytical Business, providing the necessary leadership and resources to assure that the quality standard and integrity program are met.

4.2.3 Chief Operation Officer (COO)

The COO reports directly to the President and CEO of Eurofins. The COO is responsible for the operations of Eurofins's subsidiary companies and the company's strategic growth.

4.2.4 Senior Vice President of Operations and Client Service

The SVP of Operations and Client Services leads the Client Service Organization (CSO); and oversees the operations of all Eurofins laboratories, the Corporate Technical Services group and the Sales Opportunity Optimization efforts. The SVP provides direction to the VPs of Operations, Client Service Directors, Manager of Project Managers, Director of Technical Services and a Director of Sales. The SVP of Operations and Client Services reports directly to the President and CEO of Eurofins.

4.2.5 Vice President of Operations (VPO)

Each VP of Operations (VPO) reports directly to the SVP of Operations and Clients Services. Each VPO is responsible for the overall administrative and operational management of their respective laboratories. The VPO's responsibilities include allocation of personnel and resources, long-term planning, goal setting, and achieving the financial, business, and quality objectives of Eurofins. The VPO's ensure timely compliance with Corporate Management directives, policies, and management systems reviews. The VPO's are also responsible for restricting any laboratory from performing analyses that cannot be consistently and successfully performed to meet the standards set forth in this manual.

4.2.6 Vice President of Quality and Environmental Health and Safety (VP-QA/EHS)

The Vice President (VP) of QA/EHS reports directly to the President and CEO. With the aid of the Executive Committee, Laboratory Directors, Quality Directors, Safety Managers, EH&S Coordinators and QA Managers, the VP-QA/EHS has the responsibility for the establishment, general overview and Corporate maintenance of the Quality Assurance and EH&S Programs within Eurofins. Additional responsibilities include:

- Review of QA/QC and EHS aspects of Corporate SOPs & Policies, national projects and expansions or changes in services.
- Work with various organizations outside of Eurofins to further the development of quality standards and represent Eurofins at various trade meetings.
- Prepare monthly reports for quality and EH&S metrics across the analytical laboratories and a summary of any quality and EH&S related initiatives and issues.
- With the assistance of the Corporate Senior Management Teams and the EHS development and implementation of the Eurofins Environmental, Health and Safety Program.

4.2.7 Quality Assessment Director

The Quality Assessment Director reports to the VP-QA/EHS. The Quality Assessment Director has QA oversight of laboratories; is responsible for the internal audit system, schedule and procedure; monitors laboratory internal audit findings; identifies common laboratory weaknesses; and monitors corrective action closures. Together with the Quality Compliance Director, the Quality Systems Director, and the VP-QA/EHS, the Quality Assessment Director has the responsibility for the establishment, general overview and maintenance of the Analytical Quality Assurance Program within Eurofins.

4.2.8 Quality Compliance Director

The Quality Compliance Director reports to the VP-QA/EHS. The Quality Compliance Director has QA oversight of laboratories; monitors and communicates DoD / DoE requirements; develops corporate tools for ensuring and improving compliance; develops corporate assessment tools; identifies common laboratory weaknesses; and monitors corrective action closures. Together with the Quality Assessment Director, Quality Systems Director and the VP-QA/EHS, the Quality Compliance Director has the responsibility for the establishment, general overview and maintenance of the Analytical Quality Assurance Program within Eurofins.

4.2.9 Quality Systems Director

The Quality Systems Director reports to the VP-QA/EHS. The Quality Systems Director has QA oversight of laboratories; develops quality policies, procedures and management tools; monitors and communicates regulatory and certification requirements; identifies common laboratory weaknesses; and monitors corrective action closures. Together with the Quality Assessment Director, Quality Compliance Director and the VP-QA/EHS, the Quality Systems Director has the responsibility for the establishment, general overview and maintenance of the Analytical Quality Assurance Program within Eurofins.

4.2.10 Quality Information Manager

The Quality Information Manager is responsible for managing all company official documents (e.g., Policies, Procedures, Work Instructions), the company's accreditation database, intranet websites, external laboratory subcontracting, regulatory limits for clients on the company's TotalAccess website; internal and external client support for various company groups (e.g., Client Services, EH&S, Legal, IT, Sales) for both quality and operational functions. The Quality Information Manager reports to the VP-QA/EHS; and works alongside the Quality Assessment, Quality Compliance and Quality System Directors and EHS Managers to support both the Analytical Quality Assurance and EHS Programs within Eurofins.

4.2.11 Technical Services Director

The Technical Services Director is responsible for establishing, implementing and communicating Eurofins's Analytical Business's Technical Policies, SOPs, and Manuals. Other responsibilities include conducting technical assessments as required, acting as a technical resource in national contracts review, coordinating new technologies, establishing best practices, advising staff on technology advances, innovations, and applications.

4.2.12 Ethics and Compliance Officers (ECOs)

Eurofins has designated two senior members of the corporate staff to fulfill the role of Ethics and Compliance Officer (ECO) – i.e., the Corporate Counsel & VP of Human Resources and the VP-QA/EHS. Each ECO acts as a back-up to the other ECO and both are involved when data investigations occur. Each ECO has a direct line of communication to the entire senior Corporate and lab management staff.

The ECOs ensure that the organization distributes the data integrity and ethical practices policies to all employees and ensures annual trainings and orientation of new hires to the ethics program and its policies. The ECO is responsible for establishing a mechanism to foster employee reporting of incidents of illegal, unethical, or improper practices in a safe and confidential environment.

The ECOs monitor and audit procedures to determine compliance with policies and to make recommendations for policy enhancements to the President and CEO, VPOs, Laboratory Director or other appropriate individuals within the laboratory. The ECO will assist the laboratory QA Manager in the coordination of internal auditing of ethical policy related activities and processes within the laboratory, in conjunction with the laboratory's regular internal auditing function.

The ECOs will also participate in investigations of alleged violations of policies and work with the appropriate internal departments to investigate misconduct, remedy the situation, and prevent recurrence of any such activity.

4.2.13 Chief Information Officer (CIO)

The CIO is responsible for establishing, implementing and communicating Eurofins's Information Technology (IT) Policies, SOPs and Manuals. Other responsibilities include coordinating new technologies, development of electronic communication tools such as Eurofins's intranet and internet sites, ensuring data security and documentation of software, ensuring compliance with the NELAC standard, and assistance in establishing, updating, and maintaining the TALS at the various Eurofins facilities.

4.2.14 Environmental Health and Safety Managers (Corporate)

The EHS Managers report directly to the VP-QA/EHS. The EHS Managers are responsible for the development and implementation of the Eurofins Environmental, Health and Safety program. Responsibilities include:

- Consolidation and tracking all safety and health-related information and reports for the company, and managing compliance activities for Eurofins locations.
- Coordination/preparation of the corporate Environmental, Health and Safety Manual Template that is used by each laboratory to prepare its own laboratory-specific Safety Manual/ CHP.
- Preparation of information and training materials for laboratory EHS Coordinators.
- Assistance in the coordination of employee exposure and medical monitoring programs to insure compliance with applicable safety and health regulations.
- Serving as Department of Transportation (D.O.T.) focal point and providing technical assistance to location management.
- Serving as Hazardous Waste Management main contact and providing technical assistance to location management.

4.2.15 Laboratory Director

Eurofins Pensacola's Laboratory Director is responsible for the overall quality, safety, financial, technical, human resource and service performance of the whole laboratory and reports to their respective VPO. The Laboratory Director is also responsible for any service centers connected with their laboratory that perform analytical tests, such as short holding time analyses for pH. The Laboratory Director provides the resources necessary to implement and maintain an effective and comprehensive Quality Assurance and Data Integrity Program.

Specific responsibilities include, but are not limited to:

- Provides one or more technical managers for the appropriate fields of testing. If the Technical Director is absent for a period of time exceeding 15 consecutive calendar days, the Laboratory Director must designate another full time staff member meeting the qualifications of the Technical Manager to temporarily perform this function. If the absence

exceeds 35 consecutive calendar days, the primary accrediting authority must be notified in writing.

- Ensures that all analysts and supervisors have the appropriate education and training to properly carry out the duties assigned to them and ensures that this training has been documented.
- Ensures that personnel are free from any commercial, financial and other undue pressures which might adversely affect the quality of their work.
- Ensures Eurofins's human resource policies are adhered to and maintained.
- Ensures that sufficient numbers of qualified personnel are employed to supervise and perform the work of the laboratory.
- Ensures that appropriate corrective actions are taken to address analyses identified as requiring such actions by internal and external performance or procedural audits. Procedures that do not meet the standards set forth in the QAM or laboratory SOPs may be temporarily suspended by the Laboratory Director.
- Reviews and approves all SOPs prior to their implementation and ensures all approved SOPs are implemented and adhered to.
- Pursues and maintains appropriate laboratory certification and contract approvals. Supports ISO 17025 requirements.
- Ensures client specific reporting and quality control requirements are met.
- Captains the management team, consisting of the QA Manager, and the Technical Director as direct reports.

4.2.16 Quality Assurance (QA) Manager

The QA Manager has responsibility and authority to ensure the continuous implementation of the quality system at the laboratory where they work. The QA Manager is also responsible for any service centers connected with their laboratory that perform analytical tests, such as short holding time analyses for pH.

The QA Manager reports directly to the Laboratory Director and their Corporate Quality Director. This position is able to evaluate data objectively and perform assessments without outside (e.g., managerial) influence. Corporate QA may be used as a resource in dealing with regulatory requirements, certifications and other quality assurance related items. The QA Manager directs the activities of the QA officers to accomplish specific responsibilities, which include, but are not limited to:

- Serves as the focal point for QA/QC in the laboratory.
- Have functions independent from laboratory operations for which he has quality assurance oversight.
- Have documented training and/or experience in QA/QC procedures and the laboratory's Quality System.
- Have a general knowledge of the analytical test methods for which data audit/review is performed (and/or having the means of getting this information when needed).

- Arrange for or conducting internal audits on quality systems and the technical operation
- Notifying laboratory management of deficiencies in the quality system and ensuring corrective action is taken. Procedures that do not meet the standards set forth in the QAM or laboratory SOPs shall be investigated following procedures outlined in Section 12 and if deemed necessary may be temporarily suspended during the investigation.
- Maintaining and updating the QAM.
- Monitoring and evaluating laboratory certifications and communication of any changes to lab management including project managers;
- Scheduling and monitoring proficiency testing samples.
- Monitoring and communicating regulatory changes that may affect the laboratory to management.
- Training and advising the laboratory staff on quality assurance/quality control procedures that are pertinent to their daily activities.
- The laboratory QA Manager will maintain records of all ethics-related training, including the type and proof of attendance.
- Maintain, improve, and evaluate the corrective action database and the corrective and preventive action systems.
- Objectively monitor standards of performance in quality control and quality assurance without outside (e.g., managerial) influence.
- Coordinating of document control of SOPs, MDLs, control limits, and miscellaneous forms and information.
- Review a percentage of all final data reports for internal consistency. Review of Chain of Custody (COC), correspondence with the analytical request, batch QC status, completeness of any corrective action statements, evaluate manual calculations, format, holding time, sensibility and completeness of the project file contents.
- Review of external audit reports and data validation requests.
- Follow-up with audits to ensure client QAPP requirements are met.
- Establishment of reporting schedule and preparation of various quality reports for the Laboratory Director, clients and/or Corporate QA.
- Development of suggestions and recommendations to improve quality systems.
- Research of current state and federal requirements and guidelines.
- Captains the QA team to enable communication and to distribute duties and responsibilities.
- Ensuring Communication & monitoring standards of performance to ensure that systems are in place to produce the level of quality as defined in this document.
- Evaluation of the thoroughness and effectiveness of training.
- Compliance with ISO 17025.

4.2.17 Technical Director

The Technical Director reports directly to the Laboratory Director. He is accountable for all analyses and analysts under their experienced supervision and for compliance with the ISO 17025:2017 Standard. The scope of responsibility ranges from the new-hire process and existing technology through the ongoing training and development programs for existing analysts and new instrumentation. Specific responsibilities include, but are not limited to:

- Exercises day-to-day supervision of laboratory operations for the appropriate field of accreditation and reporting of results. Coordinating, writing, and reviewing preparation of all test methods, i. e., SOPs, with regard to quality, integrity, regulatory and optimum and efficient production techniques, and subsequent analyst training and interpretation of the SOPs for implementation and unusual project samples. He insures that the SOPs are properly managed and adhered to at the bench. He develops standard costing of SOPs to include supplies, labor, overhead, and capacity (design vs. demonstrated versus first-run yield) utilization.
- Reviewing and approving, with input from the QA Manager, proposals from marketing, in accordance with an established procedure for the review of requests and contracts. This procedure addresses the adequate definition of methods to be used for analysis and any limitations, the laboratory's capability and resources, the client's expectations. Differences are resolved before the contract is signed and work begins. A system documenting any significant changes is maintained, as well as pertinent discussions with the client regarding their requirements or the results of the analyses during the performance of the contract. All work subcontracted by the laboratory must be approved by the client. Any deviations from the contract must be disclosed to the client. Once the work has begun, any amendments to the contract must be discussed with the client and so documented.
- Monitoring the validity of the analyses performed and data generated in the laboratory. This activity begins with reviewing and supporting all new business contracts, insuring data quality, analyzing internal and external non-conformances to identify root cause issues and implementing the resulting corrective and preventive actions, facilitating the data review process (training, development, and accountability at the bench), and providing technical and troubleshooting expertise on routine and unusual or complex problems.
- Providing training and development programs to applicable laboratory staff as new hires and, subsequently, on a scheduled basis. Training includes instruction on calculations, instrumentation management to include troubleshooting and preventive maintenance.
- Enhancing efficiency and improving quality through technical advances and improved TALS utilization. Capital forecasting and instrument life cycle planning for second generation methods and instruments as well as asset inventory management.
- Coordinating sample management from "cradle to grave," insuring that no time is lost in locating samples.
- Scheduling all QA/QC-related requirements for compliance, e.g., MDLs, etc..
- Captains department personnel to communicate quality, technical, personnel, and instrumental issues for a consistent team approach.
- Coordinates audit responses with the QA Manager.
- Compliance with ISO 17025.

4.2.18 Department Manager

The Department Manager manages a department to organize samples after login and distribute them, in the portions needed, to the applicable department(s). She reports directly to the Technical Director. She is knowledgeable about sample preservation, holding time, and turnaround time requirements, as well as volume/mass of sample needed for each method. The goal is to deliver the sample or aliquot to the bench as quickly as possible, while complying with all considerations.

4.2.19 Supervisors

Supervisors report to the Department Manager. Each one is responsible to:

- Ensure that analysts in their department adhere to applicable SOPs and the QA Manual. They perform frequent SOP and QA Manual review to determine if analysts are in compliance and if new, modified, and optimized measures are feasible and should be added to these documents.
- With regard to analysts, participates in the selection, training (as documented in Section 17.3), development of performance objectives and standards of performance, appraisal (measurement of objectives), scheduling, counseling, discipline, and motivation of analysts and documents these activities in accordance with systems developed by the QA and Personnel Departments. They evaluate staffing sufficiency and overtime needs. Training consists of familiarization with SOP, QC, Safety, and computer systems.
- Encourage the development of analysts to become cross-trained in various methods and/or operate multiple instruments efficiently while performing maintenance and documentation, self-supervise, and function as a department team.
- Provide guidance to analysts in resolving problems encountered daily during sample prep/analysis in conjunction with the Technical Manager, Operations Manager, and/or QA Manager. Each is responsible for 100% of the data review and documentation, non-conformance and CPAR issues, the timely and accurate completion of performance evaluation samples and MDLs, for his department.
- Ensure all logbooks are maintained, current, and properly labeled or archived.
- Report all non-conformance conditions to the QA Manager, Technical Manager, Operations Manager, and/or Laboratory Director.
- Ensure that preventive maintenance is performed on instrumentation as detailed in the QA Manual or SOPs. He is responsible for developing and implementing a system for preventive maintenance, troubleshooting, and repairing or arranging for repair of instruments.
- Maintain adequate and valid inventory of reagents, standards, spare parts, and other relevant resources required to perform daily analysis.
- Achieve optimum turnaround time on analyses and compliance with holding times.
- Conduct efficiency and cost control evaluations on an ongoing basis to determine optimization of labor, supplies, overtime, first-run yield, capacity (designed vs. demonstrated), second- and third-generation production techniques/instruments, and long-term needs for budgetary planning.
- Develop, implement, and enhance calibration programs.

- Provide written responses to external and internal audit issues.

4.2.20 Laboratory Analysts

Laboratory analysts are responsible for conducting analysis and performing all tasks assigned to them by the group leader or supervisor. The responsibilities of the analysts are listed below:

- Perform analyses by adhering to analytical and quality control protocols prescribed by current SOPs, this QA Manual, and project-specific plans honestly, accurately, timely, safely, and in the most cost-effective manner.
- Document standard and sample preparation, instrument calibration and maintenance, data calculations, sample matrix effects, and any observed non-conformance on worklists, benchsheets, lab notebooks and/or the Non-Conformance Database.
- Report all non-conformance situations, instrument problems, matrix problems and QC failures, which might affect the reliability of the data, to their supervisor, the Technical Manager, and/or the QA Manager or member of QA staff.
- Perform 100% review of the data generated prior to entering and submitting for secondary level review.
- Suggest method improvements to their supervisor, the Technical Manager, and the QA Manager. These improvements, if approved, will be incorporated. Ideas for the optimum performance of their assigned area, for example, through the proper cleaning and maintenance of the assigned instruments and equipment, are encouraged.
- Work cohesively as a team in their department to achieve the goals of accurate results, optimum turnaround time, cost effectiveness, cleanliness, complete documentation, and personal knowledge of environmental analysis.
- **[Helpful wording for those using work cells.]** Work Cell: A “work cell” is considered to be all those individuals who see a sample through the complete process of preparation, extraction, and analysis. To ensure that the entire preparation, extraction, and analysis process is completed by a group of capable individuals, the laboratory shall ensure that each member of the work cell (including a new member entering an already existing work cell) demonstrates capability in his/her area of responsibility in the sequence. Even though the work cell operates as a “team,” the demonstration of capability at each individual step in the sequence, as performed by each individual analyst/team member, remains of utmost importance. A work cell may NOT be defined as a group of analysts who perform the same step in the same process (for example, extractions for Method 8270), represented by one analyst who has demonstrated capability for that step.

4.2.21 Environmental Health & Safety Coordinator (EHSC)

The EHSC reports to the Laboratory Director and ensures that systems are maintained for the safe operation of the laboratory. The EHSC is responsible to:

- Conduct ongoing, necessary safety training and conduct new employee safety orientation.
- Assist in developing and maintaining the Chemical Hygiene/Safety Manual.
- Administer dispersal of all Material Safety Data Sheet (MSDS) information.
- Perform regular chemical hygiene and housekeeping instruction.

- Give instruction on proper labeling and practice.
- Serve as chairman of the laboratory safety committee.
- Provide and train personnel on protective equipment.
- Oversee the inspection and maintenance of general safety equipment – fire extinguishers, safety showers, eyewash fountains, etc. and ensure prompt repairs as needed.
- Supervise and schedule fire drills and emergency evacuation drills.
- Determine what initial and subsequent exposure monitoring, if necessary to determine potential employee exposure to chemicals used in the laboratory.
- When determined necessary, conduct exposure monitoring assessments.
- Determine when a complaint of possible over-exposure is “reasonable” and should be referred for medical consultation.
- Assist in the internal and external coordination of the medical consultation/monitoring program conducted by Eurofins’s medical consultants.
- Stay current with the hazardous waste regulations.
- Continue training on hazardous waste issues.
- Review and update annually the Hazardous Waste Contingency Plan in the Environmental Health & Safety Manual.
- Audit the staff with regard to compliance with the Hazardous Waste Contingency Plan.
- Contact the hazardous waste subcontractors for review of procedures and opportunities for minimization of waste.

4.2.22 Manager of Project Management

The Manager of Project Management reports to the Laboratory Director and serves as the interface between the laboratory’s technical departments and the laboratory’s clients. The staff consists of the Project Management team, the Sample Control team and the Bottle Prep team. With the overall goal of total client satisfaction, the functions of this position are outlined below:

- Technical training and growth of the Project Management team.
- Technical liaison for the Project Management team.
- Human resource management of the Project Management team.
- Responsible to ensure that clients receive the proper sampling supplies.
- Accountable for response to client inquiries concerning sample status.
- Responsible for assistance to clients regarding the resolution of problems concerning COC.
- Ensuring that client specifications, when known, are met by communicating project and quality assurance requirements to the laboratory.
- Notifying the Department Managers of incoming projects and sample delivery schedules.
- Responsible for discussing with client any project-related problems, resolving service issues, and coordinating technical details with the laboratory staff.

- Responsible for staff familiarization with specific quotes, sample log-in review, and final report completeness.
- Monitor the status of all data package projects in-house to ensure timely and accurate delivery of reports.
- Inform clients of data package-related problems and resolve service issues.
- Coordinate requests for sample containers and other services (data packages).
- Ensures the timely and correct shipment of sample containers, including proper preservatives and instructions to clients.
- Maintains accurate records of sample container shipments.
- Supervises the organized storage and appropriate climate control of samples.
- Supervises the disposal of samples in accordance with the Waste Disposal SOP, the Hazardous Waste Contingency Plan in the Chemical Hygiene/Safety Manual, and the U. S. Department of Agriculture requirements.
- Direct the logging in of incoming samples into the TALS.
- Ensure the verification of data entry from login.

4.2.23 Project Manager (PM)

The PM reports to the Manager of Project Management (MPM) and serves as the interface between the laboratory's technical departments and the laboratory's clients. There is an entire staff of Project Managers that makes up the Project Management team. With the overall goal of total client satisfaction, the functions of this position are outlined below:

- Technical training and growth of the Project Management team.
- Technical liaison for the Project Management team.
- Human resource management of the Project Management team.
- Responsible to ensure that clients receive the proper sampling supplies.
- Accountable for response to client inquiries concerning sample status.
- Responsible for assistance to clients regarding the resolution of problems concerning COC.
- Ensuring that client specifications, when known, are met by communicating project and quality assurance requirements to the laboratory.
- Notifying the supervisors of incoming projects and sample delivery schedules.
- Accountable to clients for communicating sample progress in daily status meeting with agreed-upon due dates.
- Responsible for discussing with client any project-related problems, resolving service issues, and coordinating technical details with the laboratory staff.
- Responsible for staff familiarization with specific quotes, sample log-in review, and final report completeness.
- Monitor the status of all data package projects in-house to ensure timely and accurate delivery of reports.

- Inform clients of data package-related problems and resolve service issues.
- Coordinate requests for sample containers and other services (data packages).

4.2.24 Project Manager Assistant

The Project Manager Assistants report to the Customer Service Manager and serve as the interface between the laboratory's technical departments and the Project Managers. With the overall goal of total client satisfaction, the functions of this position are outlined below:

- Responsible to ensure that clients receive the proper sampling supplies.
- Ensuring that client specifications, when known, are met by communicating project and quality assurance requirements to the laboratory.
- Notifying the Department Managers of incoming projects and sample delivery schedules.
- Monitor the status of all data package projects in-house to ensure timely and accurate delivery of reports.
- Coordinate requests for sample containers and other services (data packages).

4.2.25 Quality Assurance (QA) Specialist

The QA Specialist is responsible for QA documentation and involvement in the following activities:

- Assist the QA Manager in performing the annual internal laboratory audits, compiling the evaluation, and coordinating the development of an action plan to address any deficiency identified.
- Facilitate external audits, coordinating with the QA Manager and Laboratory Staff to address any deficiencies noted at the time of the audit and subsequently presented in the final audit report.
- Assist the QA Manager in the preparation of new SOP's and in the maintenance of existing SOPs, coordinating annual reviews and updates.

4.2.26 Quality Assurance (QA) Assistant

The QA Assistant is responsible for QA documentation and involvement in the following activities:

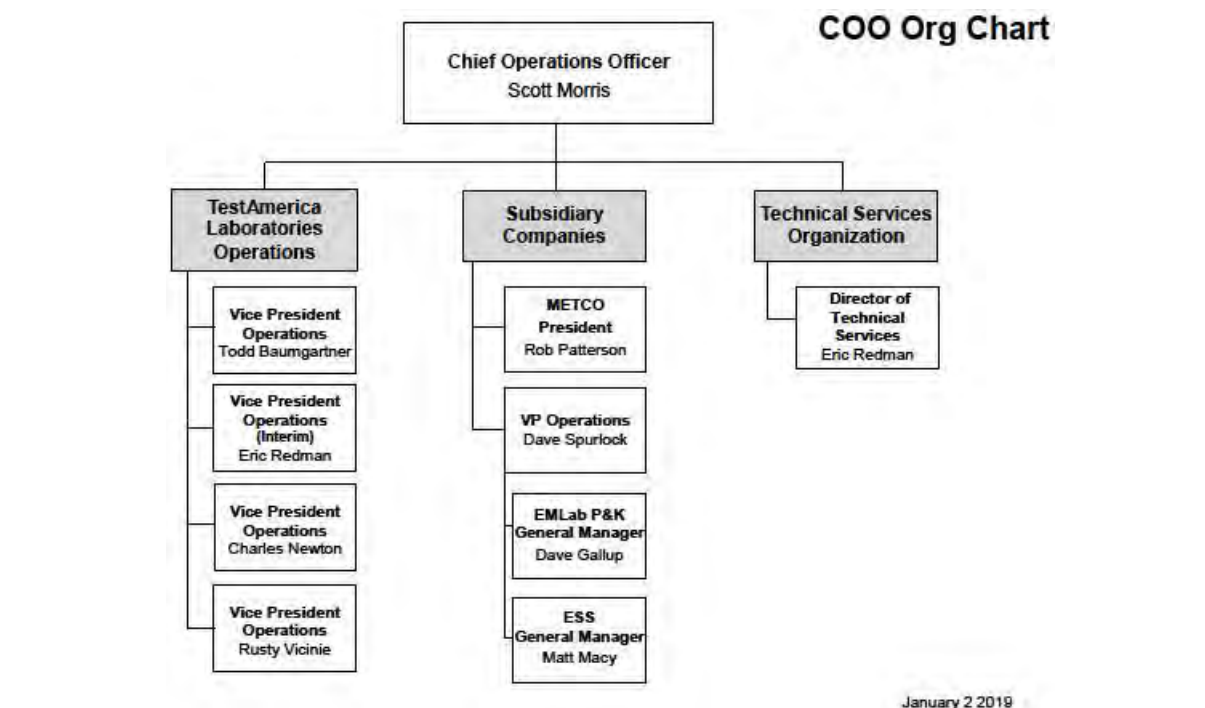
- Manages the performance testing (PT) studies, coordinates follow up studies for failed analytes and works with QA Manager and Laboratory Staff to complete needed corrective action reports.
- Personnel training records review and maintenance.
- Document control maintenance.
- Manages certifications and accreditations.
- Maintains the Total Access certification module for the laboratory

4.3 Deputies

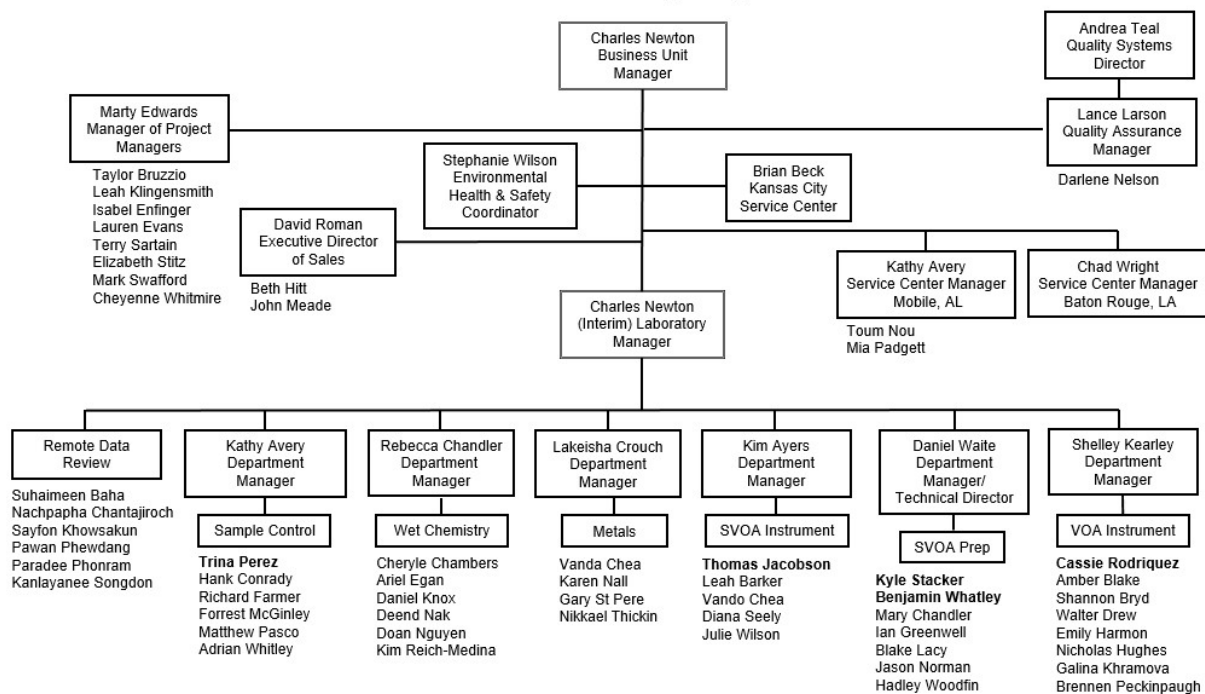
The following table defines who assumes the responsibilities of key personnel in their absence:

Key Personnel	Deputy
Daniel Waite Laboratory Manager/Technical Director	Garrett Ervin Business Unit Manager
Lance Larson Quality Manager	Darlene Nelson Quality Assurance Assistant
Shelley Kearley Organics Department Manager	Daniel Waite Laboratory Manager/Technical Director
Rebecca Chandler Inorganics Department Manager	Daniel Waite Laboratory Manager/Technical Director
Lakeisha Crouch Metals Department Manager	Daniel Waite Laboratory Manager/Technical Director
Kathy Avery Sample Receiving Department Manager	Trina Perez Sample Receiving Supervisor
Marty Edwards Manager of Project Management	Cheyenne Whitmire Sr. Project Manager

Figure 4-1. Corporate and Laboratory Organization Charts



Pensacola Laboratory Organization



SECTION 5. QUALITY SYSTEM

5.1 Quality Policy Statement

It is Eurofins's Policy to:

- ❖ Provide data of known quality to its clients by adhering to approved methodologies, regulatory requirements and the QA/QC protocols.
- ❖ Effectively manage all aspects of the laboratory and business operations by the highest ethical standards.
- ❖ Continually improve systems and provide support to quality improvement efforts in laboratory, administrative and managerial activities. Eurofins recognizes that the implementation of a quality assurance program requires management's commitment and support as well as the involvement of the entire staff.
- ❖ Provide clients with the highest level of professionalism and the best service practices in the industry.
- ❖ To comply with the ISO/IEC 17025:2017 International Standard, the 2009 and 2016 TNI Standards and to continually improve the effectiveness of the management system.

Every staff member at the laboratory plays an integral part in quality assurance and is held responsible and accountable for the quality of their work. It is, therefore, required that all laboratory personnel are trained and agree to comply with applicable procedures and requirements established by this document.

5.2 Ethics and Data Integrity

Eurofins is committed to ensuring the integrity of its data and meeting the quality needs of its clients. The elements of Eurofins's Ethics and Data Integrity Program include:

- An Ethics Policy (Corporate Policy No. CW-L-P-004) and Employee Ethics Statements.
- Ethics and Compliance Officers (ECOs).
- A Training Program.
- Self-governance through disciplinary action for violations.
- A confidential mechanism for anonymously reporting alleged misconduct and a means for conducting internal investigations of all alleged misconduct. (Corporate SOP No. CW-L-S-002).
- Procedures and guidance for recalling data if necessary (Corporate SOP No. CW-Q-S-005).
- Effective external and internal monitoring system that includes procedures for internal audits (Section 15).
- Produce results, which are accurate and include QA/QC information that meets client pre-defined Data Quality Objectives (DQOs).
- Present services in a confidential, honest and forthright manner.

- Provide employees with guidelines and an understanding of the Ethical and Quality Standards of our Industry.
- Provide procedures and guidance to ensure the impartiality and confidentiality of all data and customer information.
- Operate our facilities in a manner that protects the environment and the health and safety of employees and the public.
- Obey all pertinent federal, state and local laws and regulations and encourage other members of our industry to do the same.
- Educate clients as to the extent and kinds of services available.
- Assert competency only for work for which adequate personnel and equipment are available and for which adequate preparation has been made.
- Promote the status of environmental laboratories, their employees, and the value of services rendered by them.

5.3 Quality System Documentation

The laboratory's Quality System is communicated through a variety of documents.

- Quality Assurance Manual – Each laboratory has a lab-specific quality assurance manual.
- Corporate SOPs and Policies – Corporate SOPs and Policies are developed for use by all relevant laboratories. They are incorporated into the laboratory's normal SOP distribution, training and tracking system. Corporate SOPs may be general or technical.
- Work Instructions – A subset of procedural steps, tasks or forms associated with an operation of a management system (e.g., checklists, preformatted bench sheets, forms).
- Laboratory SOPs – General and Technical
- Laboratory QA/QC Policy Memorandums

5.3.1 Order of Precedence

In the event of a conflict or discrepancy between policies, the order of precedence is as follows:

- Corporate Quality Management Plan (CQMP)
- Corporate SOPs and Policies
- Laboratory QA/QC Policy Memorandum
- Laboratory Quality Assurance Manual (QAM)
- Laboratory SOPs and Policies
- Other (Work Instructions (WI), memos, flow charts, etc.)

NOTE: The laboratory has the responsibility and authority to operate in compliance with regulatory requirements of the jurisdiction in which the work is performed. Where the CQMP conflicts with those regulatory requirements, the regulatory requirements of the jurisdiction shall hold primacy. The laboratory's QAM shall take precedence over the CQMP in those cases.

5.4 QA/QC Objectives for the Measurement of Data

Quality Assurance (QA) and Quality Control (QC) are activities undertaken to achieve the goal of producing data that accurately characterize the sites or materials that have been sampled. Quality Assurance is generally understood to be more comprehensive than Quality Control. Quality Assurance can be defined as the integrated system of activities that ensures that a product or service meets defined standards.

Quality Control is generally understood to be limited to the analyses of samples and to be synonymous with the term “*analytical quality control*”. QC refers to the routine application of statistically based procedures to evaluate and control the accuracy of results from analytical measurements. The QC program includes procedures for estimating and controlling precision and bias and for determining reporting limits.

Request for Proposals (RFPs) and Quality Assurance Project Plans (QAPP) provide a mechanism for the client and the laboratory to discuss the data quality objectives in order to ensure that analytical services closely correspond to client needs. In order to ensure the ability of the laboratory to meet the Data Quality Objectives (DQOs) specified in the QAPP, clients are advised to allow time for the laboratory to review the QAPP before being finalized. The client is responsible for developing the QAPP; however, the laboratory will provide support to the client for developing the sections of the QAPP that concern laboratory activities.

Historically, laboratories have described their QC objectives in terms of precision, accuracy, representativeness, comparability, completeness, selectivity and sensitivity (PARCCSS).

5.4.1 Precision

The laboratory objective for precision is to meet the performance for precision demonstrated for the methods on similar samples and to meet data quality objectives of the EPA and/or other regulatory programs. Precision is defined as the degree of reproducibility of measurements under a given set of analytical conditions (exclusive of field sampling variability). Precision is documented on the basis of replicate analysis, usually duplicate or matrix spike (MS) duplicate samples.

5.4.2 Accuracy

The laboratory objective for accuracy is to meet the performance for accuracy demonstrated for the methods on similar samples and to meet data quality objectives of the EPA and/or other regulatory programs. Accuracy is defined as the degree of bias in a measurement system. Accuracy may be documented through the use of laboratory control samples (LCS) and/or MS. A statement of accuracy is expressed as an interval of acceptance recovery about the mean recovery.

5.4.3 Representativeness

The laboratory objective for representativeness is to provide data which is representative of the sampled medium. Representativeness is defined as the degree to which data represent a characteristic of a population or set of samples and is a measurement of both analytical and field sampling precision. The representativeness of the analytical data is a function of the

procedures used in procuring and processing the samples. The representativeness can be documented by the relative percent difference between separately procured, but otherwise identical samples or sample aliquots.

The representativeness of the data from the sampling sites depends on both the sampling procedures and the analytical procedures. The laboratory may provide guidance to the client regarding proper sampling and handling methods in order to assure the integrity of the samples.

5.4.4 Comparability

The comparability objective is to provide analytical data for which the accuracy, precision, representativeness, and reporting limit statistics are similar to these quality indicators generated by other laboratories for similar samples, and data generated by the laboratory over time.

The comparability objective is documented by inter-laboratory studies carried out by regulatory agencies or carried out for specific projects or contracts, by comparison of periodically generated statements of accuracy, precision, and reporting limits with those of other laboratories.

5.4.5 Completeness

The completeness objective for data is 90% (or as specified by a particular project), expressed as the ratio of the valid data to the total data over the course of the project. Data will be considered valid if they are adequate for their intended use. Data usability will be defined in a QAPP, project scope, or regulatory requirement. Data validation is the process for reviewing data to determine its usability and completeness. If the completeness objective is not met, actions will be taken internally and with the data user to improve performance. This may take the form of an audit to evaluate the methodology and procedures as possible sources for the difficulty or may result in a recommendation to use a different method.

5.4.6 Selectivity

Selectivity is defined as the capability of a test method or instrument to respond to a target substance or constituent in the presence of non-target substances. Target analytes are separated from non-target constituents and subsequently identified/detected through one or more of the following, depending on the analytical method: extractions (separation), digestions (separation), interelement corrections (separation), use of matrix modifiers (separation), specific retention times (separation and identification), confirmations with different columns or detectors (separation and identification), specific wavelengths (identification), specific mass spectra (identification), and specific electrodes (separation and identification).

5.4.7 Sensitivity

Sensitivity refers to the amount of analyte necessary to produce a detector response that can be reliably detected (above the Method Detection Limit) or quantified (above the Reporting Limit).

5.5 Criteria for Quality Indicators

The laboratory maintains tables, housed in the TALS that summarize the precision and accuracy acceptability limits for performed analyses. This summary includes an effective date, is updated each time new limits are generated, and are managed by the laboratory's QA department. Unless otherwise noted, limits within these tables are laboratory generated. Some acceptability limits are derived from US EPA methods when they are required. Where US EPA method limits are not required, the laboratory has developed limits from evaluation of data from similar matrices. Criteria for development of control limits is contained in PS-QAD-003.

5.6 Statistical Quality Control

Statistically-derived precision and accuracy limits are required by selected methods (such as SW-846) and programs [such as the Ohio Voluntary Action Plan (VAP)]. The laboratory routinely utilizes statistically-derived limits to evaluate method performance and determine when corrective action is appropriate. The analysts use the current limits entered into the TALS. The Quality Assurance department maintains an archive of all limits used within the laboratory. If a method defines the QC limits, the method limits are used.

If a method requires the generation of historical limits, the lab develops such limits from recent data in the QC database of the TALS following the guidelines described in Section 24. All calculations and limits are documented and dated when approved and effective. On occasion, a client requests contract-specified limits for a specific project.

Current QC limits are entered and maintained in the TALS analyte database. As sample results and the related QC are entered into TALS, the sample QC values are compared with the limits in TALS to determine if they are within the acceptable range. The analyst then evaluates if the sample needs to be rerun or re-extracted/rerun or if a comment should be added to the report explaining the reason for the QC outlier.

5.6.1 QC Charts

QC limits are calculated annually through the use QC charts which are generated in TALS showing warning and control limits for the purpose of evaluating trends. The charts generated and maintained by the QA Manager. The QA Manager evaluates these to determine if adjustments need to be made to the limits or if corrective action investigations need to be initiated for the method. Control charts and trend evaluation procedures are detailed further in SOP PS-QAD-003_Calculation of Control Limits.

5.7 Quality System Metrics

The entire Quality System is evaluated on a monthly basis through the use of specific metrics (refer to Section 16). These metrics are used to drive continuous improvement in the laboratory's Quality System.

SECTION 6. DOCUMENT CONTROL

6.1 Overview

The QA Department is responsible for the control of documents used in the laboratory to ensure that approved, up-to-date documents are in circulation and out-of-date (obsolete) documents are archived or destroyed. The following documents, at a minimum, must be controlled:

- Laboratory Quality Assurance Manual
- Laboratory Standard Operating Procedures (SOP)
- Laboratory Policies
- Work Instructions and Forms
- Corporate Policies and Procedures

The Corporate QA Department posts Corporate Manuals, SOPs, Policies, Work Instructions, White Papers and Training Materials on the company intranet site. These Corporate documents are only considered controlled when they are read on the intranet site. Printed copies are considered uncontrolled unless the laboratory physically distributes them as controlled documents. A detailed description of the procedure for issuing, authorizing, controlling, distributing, and archiving Corporate documents is found in Corporate SOP No. CW-Q-S-001, Corporate Document Control and Archiving. The laboratory's internal document control procedure is defined in SOP PS-LAB-016 (Process for Creation, Review, Revision and Control of Laboratory Documents).

The laboratory QA Department also maintains access to various references and document sources integral to the operation of the laboratory. This includes reference methods and regulations. Instrument manuals (hard or electronic copies) are also maintained by the laboratory.

The laboratory maintains control of records for raw analytical data and supporting records such as audit reports and responses, logbooks, standard logs, training files, MDL studies, Proficiency Testing (PT) studies, certifications and related correspondence, and corrective action reports (*however named*). Raw analytical data consists of bound logbooks, instrument printouts, any other notes, magnetic media, electronic data, and final reports.

6.2 Document Approval and Issue

The pertinent elements of a document control system for each document include a unique document title and number, pagination, the total number of pages of the item or an 'end of document' page, the effective date, revision number, and the laboratory's name. The QA personnel are responsible for the maintenance of this system.

Controlled documents are authorized by the QA in order to develop a new document. A responsible manager submits an electronic draft to the QA Department for suggestions and approval before use. Upon approval, QA personnel add the identifying version information to the document and retain that document as the official document on file. That document is then provided to all applicable operational units. Controlled documents are identified as such and

records of their distribution are kept by the QA Department. Document control may be achieved by either electronic or hardcopy distribution.

The QA Department maintains a list of the official versions of controlled documents.

Quality System Policies and Procedures will be reviewed at a minimum of every two years and revised as appropriate. Changes to documents occur when a procedural change warrants.

6.3 Procedures for Document Control Policy

For changes to the QA Manual, refer to SOP PS-LAB-016. Uncontrolled copies must not be used within the laboratory. Previous revisions and back-up data are stored by the QA department. Electronic copies are stored on the Public server in the DMQC folder for the applicable revision.

For changes to SOPs, refer to SOP No. CW-Q-S-002, Writing a Standard Operating Procedure SOP or list your labs SOP on this topic. The SOP identified above also defines the process of changes to SOPs.

Forms, worksheets, work instructions and information are organized by department in the QA office. There is a table of contents. Electronic versions are kept on a hard drive in the QA department; hard copies are kept in QA files. The procedure for the care of these documents is in SOP PS-LAB-016.

6.4 Obsolete Documents

All invalid or obsolete documents are removed, or otherwise prevented from unintended use. The laboratory has specific procedures as described above to accomplish this. In general, obsolete documents are collected from employees according to distribution lists and are marked obsolete on the cover or destroyed. At least one copy of the obsolete document is archived according to SOP PS-LAB-016.

SECTION 7. SERVICE TO THE CLIENT

7.1 Overview

The laboratory has established procedures for the review of work requests and contracts, oral or written. The procedures include evaluation of the laboratory's capability and resources to meet the contract's requirements within the requested time period. All requirements, including the methods to be used, must be adequately defined, documented and understood. For many environmental sampling and analysis programs, testing design is site or program specific and does not necessarily fit into a standard laboratory service or product. It is the laboratory's intent to provide both standard and customized environmental laboratory services to our clients.

A thorough review of technical and QC requirements contained in contracts is performed to ensure project success. The appropriateness of requested methods, and the lab's capability to perform them must be established. Projects, proposals, and contracts are reviewed for adequately defined requirements and the laboratory's capability to meet those requirements. Alternate test methods that are capable of meeting the clients' requirements may be proposed by the lab. A review of the lab's capability to analyze non-routine analytes is also part of this review process.

All projects, proposals and contracts are reviewed for the client's requirements in terms of compound lists, test methodology requested, sensitivity (detection and reporting levels), accuracy, and precision requirements (% Recovery and RPD). The reviewer ensures that the laboratory's test methods are suitable to achieve these requirements and that the laboratory holds the appropriate certifications and approvals to perform the work. The laboratory and any potential subcontract laboratories must be certified, as required, for all proposed tests.

The laboratory must determine if it has the necessary physical, personnel, and information resources to meet the contract, and if the personnel have the expertise needed to perform the testing requested. Each proposal is checked for its impact on the capacity of the laboratory's equipment and personnel. As part of the review, the proposed turnaround time will be checked for feasibility.

Electronic or hard copy deliverable requirements are evaluated against the laboratory's capacity for production of the documentation.

If the laboratory cannot provide all services but intends to subcontract such services, whether to another Eurofins facility or to an outside firm, this will be documented and discussed with the client prior to contract approval. (Refer to Section 8 for Subcontracting Procedures.)

The laboratory informs the client of the results of the review if it indicates any potential conflict, deficiency, lack of accreditation, or inability of the lab to complete the work satisfactorily. Any discrepancy between the client's requirements and the laboratory's capability to meet those requirements is resolved in writing before acceptance of the contract. It is necessary that the contract be acceptable to both the laboratory and the client. Amendments initiated by the client and/or Eurofins are documented in writing.

All contracts, QAPPs, Sampling and Analysis Plans (SAPs), contract amendments, and documented communications become part of the project record.

The same contract review process used for the initial review is repeated when there are amendments to the original contract by the client, and the participating personnel are informed of the changes.

7.2 Review Sequence and Key Personnel

Appropriate personnel will review the work request at each stage of evaluation.

For routine projects and other simple tasks, a review by the Project Manager (PM) is considered adequate. The PM confirms that the laboratory has any required certifications, that it can meet the clients' data quality and reporting requirements and that the lab has the capacity to meet the clients turn around needs. ***[You can expand on this as appropriate.]*** It is recommended that, where there is a sales person assigned to the account, an attempt should be made to contact that sales person to inform them of the incoming samples.

For new, complex or large projects, the proposed contract is given to the Client Relationship Manager or Proposal Team, who will decide which lab will receive the work based on the scope of work and other requirements, including certification, testing methodology, and available capacity to perform the work. The contract review process is outlined in Eurofins's Corporate SOP No. CA-L-P-002, Contract Compliance Policy.

This review encompasses all facets of the operation. The scope of work is distributed to the appropriate personnel, as needed based on scope of contract, to evaluate all of the requirements shown above (not necessarily in the order below:

- Contract Administrator
- VP of Operations
- Laboratory Project Manager
- Laboratory Directors and Technical Directors
- Corporate Information Technology Managers
- Account Executives
- Laboratory and/or Corporate Quality
- Laboratory and/or Corporate Environmental Health and Safety Officers
- The Laboratory Director reviews the formal laboratory quote and makes final acceptance for their facility.

The ***Sales Director, Contract Administrator, Account Executive or Proposal Coordinator*** then submits the final proposal to the client.

In the event that one of the above personnel is not available to review the contract, his or her back-up will fulfill the review requirements.

7.3 Documentation

The Project Manager, Lab Manager, and/or Office Administrator maintain copies of all signed contracts applicable to the lab.

Appropriate records are maintained for every contract or work request. All stages of the contract review process are documented and include records of any significant change requests submitted to, and maintained by the Account Executive.

Client contracts will be distributed to and maintained by the appropriate sales/marketing personnel and the Account Executive. A copy of the contract and formal quote will be filed with the laboratory PM and the Laboratory Director.

Records are maintained of pertinent discussions with a client relating to the client's requirements or the results of the work during the period of execution of the contract. The PM keeps a phone, or email, log of communications with the client.

7.3.1 Project-Specific Quality Planning

Communication of contract specific technical and QC criteria is an essential activity in ensuring the success of site specific testing programs. To achieve this goal, a PM is assigned to each client. It is the PM's responsibility to ensure that project-specific technical and QC requirements are effectively evaluated and communicated to the laboratory personnel before and during the project. QA department involvement may be needed to assist in the evaluation of custom QC requirements.

PM's are the primary client contact and they ensure resources are available to meet project requirements. Although PM's do not have direct reports or staff in production, they coordinate opportunities and work with laboratory management and supervisory staff to ensure available resources are sufficient to perform work for the client's project. Project management is positioned between the client and laboratory resources.

Prior to work on a new project, the dissemination of project information and/or project opening meetings may occur to discuss schedules and unique aspects of the project. Items to be discussed may include the project technical profile, turnaround times, holding times, methods, analyte lists, reporting limits, deliverables, sample hazards, or other special requirements. The PM introduces new projects to the laboratory staff through project kick-off meetings or to the supervisory staff during production meetings. These meetings provide direction to the laboratory staff in order to maximize production and client satisfaction, while maintaining quality. In addition, project notes may be associated with each sample batch as a reminder upon sample receipt and analytical processing.

During the project, any change that may occur within an active project is agreed upon between the client/regulatory agency and the PM/laboratory. These changes (e.g., use of a non-standard method or modification of a method) and approvals must be documented prior to implementation. Documentation pertains to any document (e.g., letter, e-mail, variance, contract addendum), which has been signed by both parties.

Such changes are also communicated to the laboratory during production meetings. Such changes are updated to the project notes and are introduced to the managers at these meetings. The laboratory staff is then introduced to the modified requirements via the PM or the individual laboratory Technical Manager. After the modification is implemented into the laboratory process, documentation of the modification is made in the case narrative of the data report(s).

The laboratory strongly encourages client visits to the laboratory and for formal/informal information sharing session with employees in order to effectively communicate ongoing client needs as well as project specific details for customized testing programs.

7.4 Special Services

The laboratory cooperates with clients and their representatives to monitor the laboratory's performance in relation to work performed for the client. It is the laboratory's goal to meet all client requirements in addition to statutory and regulatory requirements. The laboratory has procedures to ensure confidentiality to clients (Section 15 and 25).

The laboratory's standard procedures for reporting data are described in Section 25. Special services are also available and provided upon request. These services include:

- Reasonable access for our clients or their representatives to the relevant areas of the laboratory for the witnessing of tests performed for the client.
- Assisting client-specified third party data validators as specified in the client's contract.
- Supplemental information pertaining to the analysis of their samples. Note: An additional charge may apply for additional data/information that was not requested prior to the time of sample analysis or previously agreed upon.

When the client requests a statement of conformity to a specification or standard based on the analysis performed by the laboratory (e.g., pass/fail, in-tolerance/out-of-tolerance), the decision rule shall be clearly defined. Unless inherent in the requested specification or standard, the decision rule selected shall be communicated to the client. Associated reporting requirements are addressed in Section 25.2.18.

7.5 Client Communication

Project managers are the primary communication link to the clients. They shall inform their clients of any delays in project completion as well as any non-conformances in either sample receipt or sample analysis. Project management will maintain ongoing client communication throughout the entire client project.

Technical Directors are available to discuss any technical questions or concerns that the client may have.

7.6 Reporting

The laboratory works with our clients to produce any special communication reports required by the contract.

7.7 Client Surveys

The laboratory assesses both positive and negative client feedback. The results are used to improve overall laboratory quality and client service. Eurofins's Sales and Marketing teams periodically develop lab and client specific surveys to assess client satisfaction.

SECTION 8. SUBCONTRACTING OF TESTS

8.1 Overview

For the purpose of this quality manual, the phrase subcontract laboratory refers to a laboratory external to the Eurofins laboratories. The phrase “work sharing” refers to internal transfers of samples between the Eurofins laboratories. The term outsourcing refers to the act of subcontracting tests.

When contracting with our clients, the laboratory makes commitments regarding the services to be performed and the data quality for the results to be generated. When the need arises to outsource testing for our clients because project scope, changes in laboratory capabilities, capacity, or unforeseen circumstances, we must be assured that the subcontractors or work sharing laboratories understand the requirements and will meet the same commitments we have made to the client. Refer to Eurofins’s Corporate SOP’s on Subcontracting Procedures (CW-L-S-004) and the Work Sharing Process (CA-C-S-001).

When outsourcing analytical services, the laboratory will assure, to the extent necessary, that the subcontract or work sharing laboratory maintains a program consistent with the requirements of this document, the requirements specified in TNI/ISO 17025 and/or the client’s Quality Assurance Project Plan (QAPP). All QC guidelines specific to the client’s analytical program are transmitted to the subcontractor and agreed upon before sending the samples to the subcontract facility. Additionally, work requiring accreditation will be placed with an appropriately accredited laboratory. The laboratory performing the subcontracted work will be identified in the final report, as will non-TNI accredited work where required.

Project Managers (PMs) or other responsible CSO members for the export Eurofins laboratory that transfers samples to another laboratory) are responsible for obtaining client approval prior to subcontracting any samples. The laboratory will advise the client of a subcontract arrangement in writing and when possible approval from the client shall be obtained and retained in the project folder. Standard Eurofins Terms & Conditions include the flexibility to subcontract samples within the Eurofins laboratories. Therefore, additional advance notification to clients for intra-laboratory subcontracting is not necessary unless specifically required by a client contract.

Note: In addition to the client, some regulating agencies (e.g., USDA) or contracts require notification prior to placing such work.

8.2 Qualifying and Monitoring Subcontractors

Whenever a PM, Account Executive (AE), or Client Relationship Manager, becomes aware of a client requirement or laboratory need where samples must be outsourced to another laboratory, the other laboratory(s) shall be selected based on the following:

- Subcontractors specified by the client - In these circumstances, the client assumes responsibility for the quality of the data generated from the use of a subcontractor.
- Subcontractors reviewed by Eurofins – Firms which have been reviewed by the company and are known to meet standards for accreditations (e.g., State, TNI and DoD/DOE); technical specifications; legal and financial information.

A listing of vendors is available on the Eurofins intranet site.

All Eurofins laboratories are pre-qualified for work sharing provided they hold the appropriate accreditations and can adhere to the project/program requirements. Client approval is not necessary unless specifically required by the contract. In these cases, the client must provide acknowledgement that the samples can be sent to that facility (an e-mail is sufficient documentation or if acknowledgement is verbal, the date, time, and name of person providing acknowledgement must be documented). The originating laboratory is responsible for communicating all technical, quality, and deliverable requirements as well as other contract needs. (Corporate SOP No. CA-C-S-001, Work Sharing Process).

8.2.1 When the potential sub-contract laboratory has not been previously approved, Account Executives or PMs may nominate a laboratory as a subcontractor based on need. The decision to nominate a laboratory must be approved by the Client Relations Manager (CRM) or Laboratory Director. The CRM or Laboratory Director requests that the QA Manager or PM begin the process of approving the subcontract laboratory as outlined in Corporate SOP No. CW-L-S-004, Subcontracting Procedures.

Once the appropriate accreditation and legal information is received by the laboratory, it is evaluated for acceptability and forwarded to the Corporate Quality Information Manager (QIM) for review. After the Corporate QIM reviews the documents for completeness, the information is forwarded to the Finance Department for formal signature and contracting with the laboratory. The approved vendor will be added to the approved subcontractor list on the intranet site, and the finance group is concurrently notified.

The client will assume responsibility for the quality of the data generated from the use of a subcontractor they have requested the lab to use. The qualified subcontractors on the intranet site are known to meet minimal standards. Eurofins does not certify laboratories. The subcontractors on our approved list can only be recommended to the extent that we would use them.

8.3 Oversight and Reporting

8.3.1 The status and performance of qualified subcontractors will be monitored by the Corporate Quality department, and includes an annual review process (see Subcontracting SOP CW-L-S-004). Any problems identified will be brought to the attention of Eurofins's Corporate Finance, Legal and Corporate Quality personnel.

- Complaints shall be investigated. Documentation of the complaint, investigation, and corrective action will be maintained in the subcontractor's file on the intranet site. Complaints are posted using the Vendor Performance Report.
- Information shall be updated on the intranet when new information is received from the subcontracted laboratories.
- Subcontractors in good standing will be retained on the intranet listing. CSO personnel will notify all Eurofins laboratories, Corporate Quality, and Corporate Contracts if any laboratory requires removal from the intranet site. This notification will be posted on the intranet site and e-mailed to all CSO Personnel, Laboratory Directors, QA Managers, and Sales Personnel.

Prior to initially sending samples to the subcontracted laboratory, the PM confirms their certification status to determine if it's current and scope-inclusive. The information is documented within the project records.

8.3.2 For continued use of a subcontractor, verification of certification is placed upon the subcontractor for the defined project. Samples are subcontracted under Chain of Custody with the program defined as 'Accreditation Required' and the following statement for verification upon sample receipt:

Note: Since laboratory accreditations are subject to change, Eurofins Laboratories, Inc. places the ownership of method, analyte & accreditation compliance upon our subcontract laboratories. This sample shipment is forwarded under Chain of Custody. If the laboratory does not currently maintain accreditation in the State of Origin listed above for analytes/tests/matrix being analyzed, the samples must be shipped back to the Eurofins laboratory or other instructions will be provided. Any changes to accreditation status should be brought to Eurofins Laboratories, Inc. attention immediately. If all requested accreditations are current to date, return the signed Chain of Custody attesting to said compliance to Eurofins Laboratories, Inc.

For Eurofins laboratories, certifications can be viewed on the company's TotalAccess Database.

8.3.3 All subcontracted samples must be accompanied by a Eurofins Chain of Custody (COC). A copy of the original COC sent by the client must be available in TALS for all samples workshared within Eurofins. Client COCs are only forwarded to external subcontractors when samples are shipped directly from the project site to the subcontractor lab. Under routine circumstances, client COCs are not provided to external subcontractors.

Through communication with the subcontracted laboratory, the PM monitors the status of the subcontracted analyses, facilitates successful execution of the work, and ensures the timeliness and completeness of the analytical report.

Non-TNI accredited work must be identified in the subcontractor's report as appropriate. If TNI accreditation is not required, the report does not need to include this information.

Reports submitted from subcontractor laboratories are not altered and are included in their original form in the final project report. This clearly identifies the data as being produced by a subcontractor facility. If subcontract laboratory data is incorporated into the laboratory's EDD (i.e., imported), the report must explicitly indicate which lab produced the data for which methods and samples.

Note: The results submitted by a Eurofins work sharing laboratory may be transferred electronically and the results reported by the Eurofins work sharing lab are identified on the final report. The report must explicitly indicate which lab produced the data for which methods and samples. The final report must include a copy of the completed COC for all work sharing reports.

8.4 **Contingency Planning**

The full qualification of a subcontractor may be waived to meet emergency needs. This decision and justification must be documented in the project files, and the 'Purchase Order Terms And Conditions For Subcontracted Laboratory Services' must be sent with the samples and COC.

In the event this provision is utilized, the laboratory (e.g., PM) will be required to verify and document the applicable accreditations of the subcontractor. All other quality and accreditation requirements will still be applicable, but the subcontractor need not have signed a subcontract agreement with Eurofins at this time.

The use of any emergency subcontractor will require the PM to complete a ~~JDE~~ New Vendor Add Form in order to process payment to the vendor and add them to TALS. This form requires the user to define the subcontractor's category/s of testing and the reason for testing.

SECTION 9. PURCHASING SERVICES AND SUPPLIES

9.1 Overview

Evaluation and selection of suppliers and vendors is performed, in part, on the basis of the quality of their products, their ability to meet the demand for their products on a continuous and short term basis, the overall quality of their services, their past history, and competitive pricing. This is achieved through evaluation of objective evidence of quality furnished by the supplier, which can include certificates of analysis, recommendations, and proof of historical compliance with similar programs for other clients. To ensure that quality critical consumables and equipment conform to specified requirements, which may affect quality, all purchases from specific vendors are approved by a member of the supervisory or management staff. Capital expenditures are made in accordance with Eurofins's Fixed Asset Acquisition, Retention and Safeguarding SOP No. CW-F-S-007.

Contracts will be signed in accordance with Eurofins's Company-Wide Authorization Matrix Policy, Policy No. CW-F-P-002. Request for Proposals (RFP's) will be issued where more information is required from the potential vendors than just price. Process details are available in Eurofins's Corporate Procurement and Contracts Policy (Policy No. CW-F-P-004). RFP's allow Eurofins to determine if a vendor is capable of meeting requirements such as supplying all of the Eurofins facilities, meeting required quality standards and adhering to necessary ethical and environmental standards. The RFP process also allows potential vendors to outline any additional capabilities they may offer.

9.2 Glassware

Glassware used for volumetric measurements must be Class A or verified for accuracy according to laboratory procedure. Pyrex (or equivalent) glass should be used where possible. For safety purposes, thick-wall glassware should be used where available.

9.3 Reagents, Standards & Supplies

Purchasing guidelines for equipment, consumables, and reagents must meet the requirements of the specific method and testing procedures for which they are being purchased. Solvents and acids are pre-tested in accordance with Eurofins's Corporate SOP on Solvent & Acid Lot Testing & Approval, SOP No. CA-Q-S-001. Approval information for the solvents and acids tested under SOP CA-Q-S-001 is stored on the Eurofins SharePoint, under Solvent Approvals. A master list of all tested materials, as well as the certificates of analysis for the materials, is stored in the same location.

9.3.1 Purchasing

Chemical reagents, solvents, glassware, and general supplies are ordered as needed to maintain sufficient quantities on hand. Materials used in the analytical process must be of a known quality. The wide variety of materials and reagents available makes it advisable to specify recommendations for the name, brand, and grade of materials to be used in any determination. This information is contained in the method SOP. The analyst completes the Material Request Sheet when requesting reagents, standards, or supplies. The analyst may

check the item out of the on-site consignment system that contains items approved for laboratory use.

The analyst must provide the master item number (from the master item list that has been approved by the technical director for department manager), item description, package size, catalogue page number, and the quantity needed. If an item being ordered is not the exact item requested, approval must be obtained from the technical director or department manager prior to placing the order. The purchasing manager, Kathy Avery places the order.

9.3.2 Receiving

It is the responsibility of the purchasing manager to receive the shipment. It is the responsibility of the analyst who ordered the materials to document the date materials were received. Once the ordered reagents or materials are received, the analyst compares the information on the label or packaging to the original order to ensure that the purchase meets the quality level specified. This is documented through the addition of the received date and initials to the information present on the daily order log.

The purchasing manager verifies the lot numbers of received solvents and acids against the pre-approval lists. If a received material is listed as unapproved, or is not listed, it is sequestered and returned to the vendor. Alternatively, the laboratory may test the material for the intended use, and if it is acceptable, document the approval on the approval list. Records of any testing performed locally are maintained on the shared "public" folder on the computer network.

Materials may not be released for use in the laboratory until they have been inspected, verified as suitable for use, and the inspection/verification has been documented.

Safety Data Sheets (SDSs) are available online through the Company's intranet website. Anyone may review these for relevant information on the safe handling and emergency precautions of on-site chemicals.

9.3.3 Specifications

Methods in use in the laboratory specify the grade of reagent that must be used in the procedure. If the quality of the reagent is not specified, analytical reagent grade will be used. It is the responsibility of the analyst to check the procedure carefully for the suitability of grade of reagent.

Chemicals must not be used past the manufacturer's expiration date and must not be used past the expiration time noted in a method SOP. If expiration dates are not provided, the laboratory may contact the manufacturer to determine an expiration date.

The laboratory assumes a five year expiration date on inorganic dry chemicals and solvents unless noted otherwise by the manufacturer or by the reference source method. Chemicals/ solvents should not be used past the manufacturer's or SOP expiration date unless verified as outlined below.

- An expiration date **cannot** be extended if the dry chemical/solvent is discolored or appears otherwise physically degraded. In this case, the dry chemical/solvent must be discarded.
- Expiration dates can be extended if the dry chemical/solvent is found to be satisfactory based on acceptable performance of quality control samples (Continuing Calibration Verification (CCV), Blanks, Laboratory Control Sample (LCS), etc.).
- If the dry chemical/solvent is used for the preparation of standards, the expiration dates can be extended 6 months if the dry chemical/solvent is compared to an unexpired independent source in performing the method and the performance of the dry chemical/solvent is found to be satisfactory. The comparison must show that the dry chemical/solvent meets CCV limits. The comparison studies are maintained on-file and available for review in the QA directory.

Wherever possible, standards must be traceable to national or international standards of measurement or to national or international reference materials. Records to that effect are available to the user.

Compressed gases in use are checked for pressure and secure positioning daily. To prevent a tank from going to dryness, or introducing potential impurities, the pressure should be closely watched as it decreases to approximately 15% of the original reading, at which point it should be replaced. For example, a standard sized laboratory gas cylinder containing 3,000 psig of gas should be replaced when it drops to approximately 500 psig. The quality of the gases must meet method or manufacturer specification or be of a grade that does not cause any analytical interference.

Water used in the preparation of samples, standards or reagents must have a specific conductivity of less than 1- $\mu\text{mho/cm}$ (or specific resistivity of greater than 1.0 megohm-cm) at 25°C. The specific conductivity is checked and recorded daily. If the water's specific conductivity is greater than the specified limit, the Facility Manager and appropriate Technical Managers must be notified immediately in order to notify all departments, decide on cessation (based on intended use) of activities, and make arrangements for correction.

The laboratory may purchase reagent grade (or other similar quality) water for use in the laboratory. This water must be certified clean by the supplier for all target analytes or otherwise verified by the laboratory prior to use. This verification is documented.

Standard lots are verified before first time use if the laboratory switches manufacturers or has historically had a problem with the type of standard.

Purchased bottleware used for sampling must be certified clean and the certificates must be maintained. If uncertified sampling bottleware is purchased, all lots must be verified clean prior to use. This verification must be maintained.

Records of manufacturer's certification and traceability statements are maintained in files or binders in each laboratory section. These records include date of receipt, lot number (when applicable), and expiration date (when applicable). Incorporation of the item into the record indicates that the analyst has compared the new certificate with the previous one for the same purpose and that no difference is noted, unless approved and so documented by the Technical Director or QA Manager.

9.3.4 Storage

Reagent and chemical storage is important from the aspects of both integrity and safety. Light-sensitive reagents may be stored in brown-glass containers. Storage conditions are per the Corporate Environmental Health & Safety Manual (Corp. Doc. No. CW-E-M-001) and method SOPs or manufacturer instructions.

9.4 Purchase of Equipment / Instruments / Software

When a new piece of equipment is needed, either for additional capacity or for replacing inoperable equipment, the analyst or supervisor makes a supply request to the Technical Director and/or the Laboratory Director. If they agree with the request, the procedures outlined in Eurofins's Corporate Policy No. CA-T-P-001, Qualified Products List, are followed. A decision is made as to which piece of equipment can best satisfy the requirements. The appropriate written requests are completed and purchasing places the order.

Upon receipt of a new or used piece of equipment, an identification name is assigned and added to the equipment list. IT must also be notified so that they can synchronize the instrument for back-ups. Its capability is assessed to determine if it is adequate or not for the specific application. For instruments, a calibration curve is generated, followed by MDLs, Demonstration of Capabilities (DOCs), and other relevant criteria (refer to Section 19). For software, its operation must be deemed reliable and evidence of instrument verification must be retained by the IT Department or QA Department. Software certificates supplied by the vendors are filed with the TALS Administrator. The manufacturer's operation manual is retained at the bench.

9.5 Services

Service to analytical instruments (except analytical balances) is performed on an as needed basis. Routine preventative maintenance is discussed in Section 20. The need for service is determined by analysts and/or technical directors. The service providers that perform the services are approved by the Laboratory Director.

Analytical balances are serviced and calibrated annually in accordance with SOP PS-QAD-016. The calibration and maintenance services are performed on-site, and the balances are returned to use immediately following successful calibration. When the calibration certificates are received (usually within two weeks of the service), they are reviewed and documentation of the review is filed with the certificates. If the calibration was unsuccessful, the balance is immediately removed from service and segregated pending either further maintenance or disposal.

Calibration services for support equipment such as thermometers, weight sets, autopipettors, etc., are obtained from vendors with current and valid ISO 17025 accreditation for calibration of the specific piece of equipment. Prior to utilizing the vendor's services, the vendor's accreditation status is verified. Once the equipment has been calibrated, the calibration certificates are reviewed by the QA department, and documentation of the review is filed with the calibration certificates. The equipment is then returned to service within the laboratory.

9.6 Suppliers

Eurofins selects vendors through a competitive proposal / bid process, strategic business alliances or negotiated vendor partnerships (contracts). This process is defined in the Procurement & Contracts Policy (Policy No. CW-F-P-004). The level of control used in the selection process is dependent on the anticipated spending amount and the potential impact on Eurofins business. Vendors that provide test and measuring equipment, solvents, standards, certified containers, instrument related service contracts or subcontract laboratory services shall be subject to more rigorous controls than vendors that provide off-the-shelf items of defined quality that meet the end use requirements. The ~~JD-Edwards~~ purchasing system includes all suppliers/vendors that have been approved for use.

Evaluation of suppliers is accomplished by ensuring the supplier ships the product or material ordered and that the material is of the appropriate quality. This is documented by signing off on packing slips or other supply receipt documents. The purchasing documents contain the data that adequately describe the services and supplies ordered.

Any issues of vendor performance are to be reported immediately by the laboratory staff to the Corporate Purchasing Group by completing a Vendor Performance Report.

The Corporate Purchasing Group will work through the appropriate channels to gather the information required to clearly identify the problem and will contact the vendor to report the problem and to make any necessary arrangements for exchange, return authorization, credit, etc.

Suppliers are subject to re-evaluation, as deemed appropriate, through the use of Vendor Performance Reports used to summarize and review to determine corrective action necessary, or service improvements required by vendors.

The laboratory has access to a listing of all approved suppliers of critical consumables, supplies and services. This information is provided through the purchasing system.

9.6.1 New Vendor Procedure

Eurofins employees who wish to request the addition of a new vendor must complete Vendor Add Request Form.

New vendors are evaluated based upon criteria appropriate to the products or services provided as well as their ability to provide those products and services at a competitive cost. Vendors are also evaluated to determine if there are ethical reasons or potential conflicts of interest with Eurofins employees that would make it prohibitive to do business with them as well as their financial stability. The QA Department and/or the Laboratory Director are consulted with vendor and product selection that have an impact on quality.

SECTION 10. COMPLAINTS

10.1 Overview

The laboratory considers an effective client complaint handling processes to be of significant business and strategic value. Listening to and documenting client concerns captures client knowledge that enables our operations to continually improve processes and client satisfaction. An effective client complaint handling process also provides assurance to the data user that the laboratory will stand behind its data, service obligations and products.

A client complaint is any expression of dissatisfaction with any aspect of our business services (e.g., communications, responsiveness, data, reports, invoicing and other functions) expressed by any party, whether received verbally or in written form. Client inquiries, complaints or noted discrepancies are documented, communicated to management, and addressed promptly and thoroughly.

The laboratory has procedures for addressing both external and internal complaints with the goal of providing satisfactory resolution to complaints in a timely and professional manner.

The nature of the complaint is identified, documented and investigated, and an appropriate action is determined and taken. In cases where a client complaint indicates that an established policy or procedure was not followed, the QA Department must evaluate whether a special audit must be conducted to assist in resolving the issue. A written confirmation or letter to the client, outlining the issue and response taken is recommended as part of the overall action taken.

The process of complaint resolution and documentation utilizes the procedures outlined in Section 12 (Corrective Actions) and is documented by the CSM, following SOP PS-CSD-004 Client Service Departmental Policies. A copy of this procedure will be made available to any interested party on request.

10.2 External Complaints

An employee that receives a complaint initiates the complaint resolution process by first documenting the complaint according to SOP PS-CSD-004 Client Service Departmental Policies.

Complaints fall into two categories: correctable and non-correctable. An example of a correctable complaint would be one where a report re-issue would resolve the complaint. An example of a non-correctable complaint would be one where a client complains that their data was repeatedly late. Non-correctable complaints should be reviewed for preventive action measures to reduce the likelihood of future occurrence and mitigation of client impact.

The general steps in the complaint handling process are:

- Receiving and documenting complaints
- Acknowledging receipt of complaint, whenever possible.
- Complaint investigation and service recovery
- Process improvement

The laboratory shall inform the initiator of the complaint of the results of the investigation and the corrective action taken, if any.

10.3 Internal Complaints

Internal complaints include, but are not limited to: errors and non-conformances, training issues, internal audit findings, and deviations from methods. Corrective actions may be initiated by any staff member who observes a nonconformance and shall follow the procedures outlined in Section 12. In addition, Corporate Management, Sales and Marketing and IT may initiate a complaint by contacting the laboratory or through the corrective action system described in Section 12.

10.4 Management Review

The number and nature of client complaints is reported by the QA Manager to the Laboratory Director and Quality Director in the QA Monthly report. Monitoring and addressing the overall level and nature of client complaints and the effectiveness of the solutions is part of the Annual Management Systems Review (Section 16).

SECTION 11. CONTROL OF NON-CONFORMING WORK

11.1 Overview

When data discrepancies are discovered or deviations and departures from laboratory SOPs, policies and/or client requests have occurred, corrective action is taken immediately. First, the laboratory evaluates the significance of the nonconforming work. Then, a corrective action plan is initiated based on the outcome of the evaluation. If it is determined that the nonconforming work is an isolated incident, the plan could be as simple as adding a qualifier to the final results and/or making a notation in the case narrative. If it is determined that the nonconforming work is a systematic or improper practices issue, the corrective action plan could include a more in depth investigation and a possible suspension of an analytical method. In all cases, the actions taken are documented using the laboratory's corrective action system (refer to Section 12).

Due to the frequently unique nature of environmental samples, sometimes departures from documented policies and procedures are needed. When an analyst encounters such a situation, the problem is presented to the supervisor for resolution. The supervisor may elect to discuss it with the Department Manager, Technical Director, or have a PM contact the client to decide on a logical course of action. Once an approach is agreed upon, the analyst documents it using the laboratories corrective action system described in Section 12. This information can then be supplied to the client in the form of a footnote or a case narrative with the report.

Project Management may encounter situations where a client may request that a special procedure be applied to a sample that is not standard lab practice. Based on a technical evaluation, the lab may accept or opt to reject the request based on technical or ethical merit. An example might be the need to report a compound that the lab does not normally report. The lab would not have validated the method for this compound following the procedures in Section 19. The client may request that the compound be reported based only on the calibration. Such a request would need to be approved by the Technical Director and QA Manager, documented and included in the project folder. Deviations **must** also be noted on the final report with a statement that the compound is not reported in compliance with TNI (or the analytical method) requirements and the reason. Data being reported to a non-TNI state would need to note the change made to how the method is normally run.

11.2 Responsibilities and Authorities

Under certain circumstances, the Laboratory Director, a Technical Director, or a member of the QA team may authorize departures from documented procedures or policies. The departures may be a result of procedural changes due to the nature of the sample; a one-time procedure for a client; QC failures with insufficient sample to reanalyze, etc. In most cases, the client will be informed of the departure prior to the reporting of the data. Any departures must be well documented using the laboratory's corrective action procedures. This information may also be documented in logbooks and/or data review checklists as appropriate. Any impacted data must be referenced in a case narrative and/or flagged with an appropriate data qualifier.

Any misrepresentation or possible misrepresentation of analytical data discovered by any laboratory staff member must be reported to facility Senior Management within 24-hours. The Senior Management staff is comprised of the Laboratory Director, the QA Manager, and the Technical Director. The reporting of issues involving alleged violations of the company's Data

Integrity or Manual Integration procedures must be conveyed to an ECO (e.g., the VP-QA/EHS) and the laboratory's Quality Director within 24 hours of discovery.

Whether an inaccurate result was reported due to calculation or quantitation errors, data entry errors, improper practices, or failure to follow SOPs, the data must be evaluated to determine the possible effect.

The Laboratory Director, QA Manager, ECOs, VP of Operations and the Quality Directors have the authority and responsibility to halt work, withhold final reports, or suspend an analysis for due cause as well as authorize the resumption of work.

11.3 Evaluation of Significance and Actions Taken

For each nonconforming issue reported, an evaluation of its significance and the level of management involvement needed is made. This includes reviewing its impact on the final data, whether or not it is an isolated or systematic issue, and how it relates to any special client requirements.

Corporate SOP entitled Data Recalls (CW-Q-S-005) is the procedure to be followed when it is discovered that erroneous or biased data may have been reported to clients or regulatory agencies.

Corporate SOP entitled Internal Investigations (CW-L-S-002) is the procedure to be followed for investigation and correction of situations involved alleged incidents of misconduct or violation of the company's ethics policy.

Laboratory level decisions are documented and approved using the laboratory's standard nonconformance/corrective action reporting in lieu of the data recall determination form contained in Eurofins's Corporate SOP No. CW-Q-S-005.

11.4 Prevention of Nonconforming Work

If it is determined that the nonconforming work could recur, further corrective actions must be made following the laboratory's corrective action system. Periodically as defined by the laboratory's preventive action schedule, the QA Department evaluates non-conformances to determine if any nonconforming work has been repeated multiple times. If so, the laboratory's corrective action process may be followed.

11.5 Method Suspension / Restriction (Stop Work Procedures)

In some cases, it may be necessary to suspend/restrict the use of a method or target analyte which constitutes significant risk and/or liability to the laboratory. Suspension/restriction procedures can be initiated by any of the persons noted in Section 11.2, Paragraph 5.

Prior to suspension/restriction, confidentiality will be respected, and the problem with the required corrective and preventive action will be stated in writing and presented to the Laboratory Director.

The Laboratory Director shall arrange for the appropriate personnel to meet with the QA Manager as needed. This meeting shall be held to confirm that there is a problem, that suspension/restriction of the method is required and will be concluded with a discussion of the steps necessary to bring the method/target or test fully back on line. In some cases, that may not be necessary if all appropriate personnel have already agreed there is a problem and there is agreement on the steps needed to bring the method, target or test fully back on line. The QA Manager will also initiate a corrective action report as described in Section 12 if one has not already been started. A copy of any meeting notes and agreed upon steps should be e-mailed by the laboratory to the appropriate VP of Operations and member of Corporate QA. This e-mail acts as notification of the incident.

After suspension/restriction, the lab will hold all reports to clients pending review. No faxing, mailing or distributing through electronic means may occur. The report must not be posted for viewing on the internet. It is the responsibility of the Laboratory Director to hold all reporting and to notify all relevant laboratory personnel regarding the suspension/restriction (e.g., Project Management, Log-in, etc.). Clients will NOT generally be notified at this time. Analysis may proceed in some instances depending on the non-conformance issue.

Within 72 hours, the QA Manager will determine if compliance is now met and reports can be released, OR determine the plan of action to bring work into compliance, and release work. A team, with all principals involved (e.g., Laboratory Director, Technical Director, QA Manager) can devise a start-up plan to cover all steps from client notification through compliance and release of reports. Project Management and the Directors of Client Services and Sales and Marketing must be notified if clients must be notified or if the suspension/restriction affects the laboratory's ability to accept work. The QA Manager must approve start-up or elimination of any restrictions after all corrective action is complete.

SECTION 12. CORRECTIVE ACTION

12.1 Overview

A major component of Eurofins's Quality Assurance (QA) Program is the problem investigation and feedback mechanism designed to keep the laboratory staff informed on quality related issues and to provide insight to problem resolution. When nonconforming work or departures from policies and procedures in the quality system or technical operations are identified, the corrective action procedure provides a systematic approach to assess the issues, restore the laboratory's system integrity, and prevent reoccurrence. Eurofins employs two systems to manage non-conformances. Issues suspected of being systematic in nature and for which root cause analysis and a formal Corrective Action Report (CAR) are documented in the Incident Corrective Action Tracking (ICAT) database. Routine batch non-conformances, events that are understood to be isolated in nature, are documented in the TALS non-conformance memo (NCM) system. See Figure 12-1 for an example ICAT report.

12.2 General

Problems within the quality system or within analytical operations may be discovered in a variety of ways, such as QC sample failures, internal or external audits, proficiency testing (PT) performance, client complaints, staff observation, etc.

The purpose of a corrective action system is to:

- Identify non-conformance events and assign responsibility for investigating.
- Resolve non-conformance events and assign responsibility for any required corrective action.
- Identify systematic problems before they become serious.
- Identify and track client complaints and provide resolution.

12.2.1 Non-Conformance Memo (NCM) - is used to document the following types of corrective actions:

- Deviations from an established procedure or SOP
- QC outside of limits
- Isolated reporting / calculation errors
- Client complaints
- Discrepancies in materials / goods received vs. manufacturer packing slips (Forms of documentation other than NCMs in TALS are also acceptable).

12.2.2 Corrective Actions Documented In the ICAT

- Internal and external audit findings
- Failed or unacceptable PT results
- Identified poor process or method performance trends
- Systematic reporting / calculation errors
- Data recall investigations

- Questionable trends that are found in the review of NCMs.
- Client complaints
- Excessive revised reports

The ICAT database is used to document background information, track the results of corrective action investigations and root cause analysis, and to provide reports of corrective action plans.

12.3 Closed Loop Corrective Action Process

Any employee in the company can initiate a corrective action. There are four main components to a closed-loop corrective action process once an issue has been identified: Cause Analysis, Selection and Implementation of Corrective Actions (both short and long term), Monitoring of the Corrective Actions, and Follow-up.

12.3.1 Cause Analysis

- Upon discovery of a non-conformance event, the event must be defined and documented. An entry into the ICAT system must be initiated, someone is assigned to investigate the issue and the event is investigated for cause. Table 12-1 provides some general guidelines on determining responsibility for assessment.
- The cause analysis step is the key to the process as a long term corrective action cannot be determined until the cause is determined.
- If the cause is not readily obvious, the Technical Director, Laboratory Director, or QA Manager (or QA designee) is consulted.

12.3.2 Selection and Implementation of Corrective Actions

- Where corrective action is needed, the laboratory shall identify potential corrective actions. The action(s) most likely to eliminate the problem and prevent recurrence are selected and implemented. Responsibility for implementation is assigned.
- Corrective actions shall be to a degree appropriate to the magnitude of the problem identified through the cause analysis.
- Whatever corrective action is determined to be appropriate, the laboratory shall document and implement the changes. The ICAT record is used for this documentation.

12.3.3 Root Cause Analysis

Root Cause Analysis is a class of problem solving (investigative) methods aimed at identifying the basic or causal factor(s) that underlie variation in performance or the occurrence of a significant failure. The root cause may be buried under seemingly innocuous events, many steps preceding the perceived failure. At first glance, the immediate response is typically directed at a symptom and not the cause. Typically, root cause analysis would be best with three or more incidents to triangulate a weakness. Corporate SOP Root Cause Analysis (No. CA-Q-S-009) describes the procedure.

Systematically analyze and document the root causes of the more significant problems that are reported. Identify, track, and implement the corrective actions required to reduce the likelihood of recurrence of significant incidents. Trend the root cause data from these incidents to identify root causes that, when corrected, can lead to dramatic improvements in performance by eliminating entire classes of problems.

Identify the one event associated with problem and ask why this event occurred. Brainstorm the root causes of failures; for example, by asking why events occurred or conditions existed; and then why the cause occurred consecutive times until you get to the root cause. For each of these sub events or causes, ask why it occurred. Repeat the process for the other events associated with the incident.

Root cause analysis does not mean the investigation is over. Look at technique or other systems outside the normal indicators. Often creative thinking will find root causes that ordinarily would be missed and continue to plague the laboratory or operation.

12.3.4 Monitoring of the Corrective Actions

- The Department Manager and QA Manager are responsible to ensure that the corrective action taken was effective.
- Ineffective actions are documented and re-evaluated until acceptable resolution is achieved. Department Managers are accountable to the Laboratory Director to ensure final acceptable resolution is achieved and documented appropriately.
- The QA Manager reviews monthly NCM and ICAT records for trends. Highlights are included in the QA monthly report (refer to Section 16). If a significant trend develops that adversely affects quality, an audit of the area is performed and corrective action implemented.
- Any out-of-control situations that are not addressed acceptably at the laboratory level may be reported to the Corporate Quality Director by the QA Manager, indicating the nature of the out-of-control situation and problems encountered in solving the situation.

12.3.5 Follow-up Audits

- Follow-up audits may be initiated by the QA Manager and shall be performed as soon as possible when the identification of a nonconformance casts doubt on the laboratory's compliance with its own policies and procedures, or on its compliance with state or federal requirements.
- These audits often follow the implementation of the corrective actions to verify effectiveness. An additional audit would only be necessary when a critical issue or risk to business is discovered.

(Also refer to Section 15.1.4, Special Audits.)

12.4 Technical Corrective Actions

In addition to providing acceptance criteria and specific protocols for technical corrective actions in the method SOPs, the laboratory has general procedures to be followed to determine when

departures from the documented policies and procedures and quality control have occurred (refer to Section 11). The documentation of these procedures is through the use of an NCM or record in the ICAT system.

Table 12-1 includes examples of general technical corrective actions. For specific criteria and corrective actions refer to the method SOPs, the analytical methods and SOP PS-LAB-006 (Out of Control Events and Corrective Actions).

Table 12-1 provides some general guidelines for identifying the individual(s) responsible for assessing each QC type and initiating corrective action. The table also provides general guidance on how a data set should be treated if associated QC measurements are unacceptable. Specific procedures are included in method SOPs, and QAM Sections 19 and 20. All corrective actions are reviewed monthly, at a minimum, by the QA Manager and highlights are included in the QA monthly report.

To the extent possible, samples shall be reported only if all quality control measures are acceptable. If the deficiency does not impair the usability of the results, data will be reported with an appropriate data qualifier and/or the deficiency will be noted in the case narrative. Where sample results may be impaired, the Project Manager is notified by an NCM and appropriate corrective action (e.g., reanalysis) is taken and documented.

12.5 Basic Corrections

When mistakes occur in records, each mistake shall be crossed-out, [not obliterated (e.g. no white-out)], and the correct value entered alongside. All such corrections shall be initialed (or signed) and dated by the person making the correction. In the case of records stored electronically, the original uncorrected file must be maintained intact and a second corrected file is created. This same process applies to adding additional information to a record. All additions made later than the initial must also be initialed (or signed) and dated. When corrections are due to reasons other than obvious transcription errors, the reason for the corrections (or additions) shall also be documented.

Figure 12-1. ICAT report



Incident and Corrective Action Tracker

[Home](#)
[About](#)
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Incident 4143 [Edit](#)

Login 400-157506 labeled incorrectly
Status: Closed

Opened By:	Mark Swafford
Incident Group:	Data Quality
Client:	A & E Testing
Client Location:	Baton Rouge, LA
Client JDE Code:	1371127
Project:	
Job:	400-157506
Contact/Auditor:	

Opened On:	Monday, August 20, 2018
Incident/Audit Date:	Monday, Aug 20, 2018
Date Report Received:	
Response Due to Client:	Friday, Aug 24, 2018
Planned Closure Date:	Friday, Aug 24, 2018
Date Incident Closed:	Friday, Nov 30, 2018

Incident Description:
The samples were labeled in correctly which caused us to have to reissue report. I have pictures if you would like to see them.

[Summary Report](#) Cannot export summary report with no associated corrective actions.

Table 12-1. Example – General Corrective Action Procedures

QC Activity (Individual Responsible for Initiation/Assessment)	Acceptance Criteria	Recommended Corrective Action
Initial Instrument Blank (Analyst)	- Instrument response < MDL.	- Prepare another blank. - If same response, determine cause of contamination: reagents, environment, instrument equipment failure, etc..
Initial Calibration Standards (Analyst, Department Manager)	- Correlation coefficient > 0.99 or standard concentration value. - % Recovery within acceptance range. - See details in Method SOP.	- Reanalyze standards. - If still unacceptable, remake standards and recalibrate instrument.
Independent Calibration Verification (Second Source) (Analyst, Department Manager)	- % Recovery within control limits.	- Remake and reanalyze standard. - If still unacceptable, then remake calibration standards or use new primary standards and recalibrate instrument.
Continuing Calibration Standards (Analyst, Data Reviewer)	% Recovery within control limits.	- Reanalyze standard. - If still unacceptable, then recalibrate and rerun affected samples.

QC Activity (Individual Responsible for Initiation/Assessment)	Acceptance Criteria	Recommended Corrective Action
Matrix Spike / Matrix Spike Duplicate (MS/MSD) (Analyst, Data Reviewer)	- % Recovery within limits documented in TALS Method Limit Group module.	- If the acceptance criteria for duplicates or matrix spikes are not met because of matrix interferences, the acceptance of the analytical batch is determined by the validity of the LCS. - If the LCS is within acceptable limits the batch is acceptable. - The results of the duplicates, matrix spikes and the LCS are reported with the data set. - For matrix spike or duplicate results outside criteria the data for that sample shall be reported with qualifiers.
Laboratory Control Sample (LCS) (Analyst, Data Reviewer)	- % Recovery within limits specified in TALS Method Limit Group module.	- Batch must be re-prepared and re-analyzed. This includes any allowable marginal exceedance. - When not using marginal exceedances, the following exceptions apply: 1) when the acceptance criteria for the positive control are exceeded high (i.e., high bias) and there are associated samples that are non-detects, then those non-detects may be reported with data qualifying codes; 2) when the acceptance criteria for the positive control are exceeded low (i.e., low bias), those sample results may be reported if they exceed a maximum regulatory limit/decision level with data qualifying codes. Note: If there is insufficient sample or the holding time cannot be met, contact client and report with flags.
Surrogates (Analyst, Data Reviewer)	- % Recovery within limits of method or within three standard deviations of the historical mean.	- Individual sample must be repeated. Place comment in TALS. - Surrogate results outside criteria shall be reported with qualifiers.
Method Blank (MB) (Analyst, Data Reviewer)	< Reporting Limit ¹	- Reanalyze blank. - If still positive, determine source of contamination. If necessary, reprocess (i.e. digest or extract) entire sample batch. Report blank results. - Qualify the result(s) if the concentration of a targeted analyte in the MB is at or above the reporting limit AND is > 1/10 of the amount measured in the sample.

QC Activity (Individual Responsible for Initiation/Assessment)	Acceptance Criteria	Recommended Corrective Action
Proficiency Testing (PT) Samples (QA Manager, Department Manager, Technical Director)	- Criteria supplied by PT Supplier.	- Any failures or warnings must be investigated for cause. Failures may result in the need to repeat a PT sample to show the problem is corrected.
Internal / External Audits (QA Manager, Department Manager, Technical Director, Laboratory Director)	- Defined in Quality System documentation such as SOPs, QAM, etc..	- Non-conformances must be investigated through ICAT system and necessary corrections must be made.
Reporting / Calculation Errors (Depends on issue – possible individuals include: Analysts, Data Reviewers, Project Managers, Department Managers, Technical Director, QA Manager, Corporate QA, Corporate Management)	- SOP CW-Q-S-005, Data Recall	- Corrective action is determined by type of error. Follow the procedures in SOP CW-L-S-002 or SOP PS-LAB-008.
Client Complaints (Project Managers, Laboratory Director, Sales and Marketing)	-	- Corrective action is determined by the type of complaint. For example, a complaint regarding an incorrect address on a report will result in the report being corrected and then follow- up must be performed on the reasons the address was incorrect (e.g., database needs to be updated).
QA Monthly Report (Refer to Section 16 for an example) (QA Manager, Laboratory Director, Department Managers)	- QAM, SOPs.	- Corrective action is determined by the type of issue. For example, CARs for the month are reviewed and possible trends are investigated.

QC Activity (Individual Responsible for Initiation/Assessment)	Acceptance Criteria	Recommended Corrective Action
Health and Safety Violation (EH&S Officer, Laboratory Director, Department Managers, Technical Director)	- Environmental Health and Safety (EHS) Manual.	- Non-conformance is investigated and corrected through ICAT system.

Note:

1. Except as noted below for certain compounds, the method blank should be below the detection limit. Concentrations up to five times the reporting limit will be allowed for the ubiquitous laboratory and reagent contaminants: methylene chloride, toluene, acetone, 2-butanone and phthalates **provided** they appear in similar levels in the reagent blank and samples. This allowance presumes that the detection limit is significantly below any regulatory limit to which the data are to be compared and that blank subtraction will not occur. For benzene and ethylene dibromide (EDB) and other analytes for which regulatory limits are extremely close to the detection limit, the method blank must be below the method detection limit

SECTION 13. PREVENTIVE ACTION / IMPROVEMENT

13.1 Overview

The laboratory's preventive action programs improve or eliminate potential causes of nonconforming product and/or nonconformance to the quality system. This preventive action process is a proactive and continuous process of improvement activities that can be initiated through feedback from clients, employees, business providers, and affiliates. The QA Department has the overall responsibility to ensure that the preventive action process is in place, and that relevant information on actions is submitted for management review.

Dedicating resources to an effective preventive action system emphasizes the laboratory's commitment to its Quality Program. It is beneficial to identify and address negative trends before they develop into complaints, problems and corrective actions. Additionally, the laboratory continually strives to improve customer service and client satisfaction through continuous improvements to laboratory systems.

Opportunities for improvement may be discovered through any of the following:

- review of the monthly QA Metrics Report,
- trending NCMs,
- review of control charts and QC results,
- trending proficiency testing (PT) results,
- performance of management system reviews,
- trending client complaints,
- review of processing operations, or
- staff observations.

The monthly Management Systems Metrics Report shows performance indicators in all areas of the laboratory and quality system. These areas include revised reports, corrective actions, audit findings, internal auditing and data authenticity audits, client complaints, PT samples, holding time violations, SOPs, ethics training, etc. The metrics report is reviewed monthly by the laboratory management, Corporate QA and Eurofins's Executive Committee. These metrics are used in evaluating the management and quality system performance on an ongoing basis and provide a tool for identifying areas for improvement.

Items identified as continuous improvement opportunities to the management system may be issued as goals from the annual management systems review, recommendations from internal audits, white papers, Lessons Learned, Technical Services audit report, Technical Best Practices, or as Corporate or management initiatives.

The laboratory's corrective action process is integral to implementation of preventive actions. A critical piece of the corrective action process is the implementation of actions to prevent further occurrence of a non-compliance event. Historical review of corrective action and non-conformances provides a valuable mechanism for identifying preventive action opportunities.

13.1.1 The following elements are part of a preventive action/process improvement system:

- Identification of an opportunity for preventive action or process improvement.
- Process for the preventive action or improvement.
- Define the measurements of the effectiveness of the process once undertaken.
- Execution of the preventive action or improvement.
- Evaluation of the plan using the defined measurements.
- Verification of the effectiveness of the preventive action or improvement.
- Close-Out by documenting any permanent changes to the Quality System as a result of the Preventive Action or Process Improvement. Documentation of Preventive Action/process Improvement is incorporated into the monthly QA reports, corrective action process and management review.

13.1.2 Any preventive actions/process improvement undertaken or attempted shall be taken into account during the annual Management Systems Review (Section 16). A highly detailed report is not required; however, a summary of successes and failures within the preventive action program is sufficient to provide management with a measurement for evaluation.

SECTION 14. CONTROL OF RECORDS

The laboratory maintains a records management system appropriate to its needs and that complies with applicable standards or regulations as required. The system produces unequivocal, accurate records that document all laboratory activities. The laboratory retains all original observations, calculations and derived data, calibration records and a copy of the analytical report for a minimum of five years after it has been issued. Exceptions for programs with longer retention requirements are discussed in Section 14.1.2.

14.1 Overview

The laboratory has established procedures for identification, collection, indexing, access, filing, storage, maintenance and disposal of quality and technical records. A record index is listed in Table 14-1. More detailed information on retention of specific records is provided in CW-L-P-001, Records Retention Policy and CW-L-WI-001, Eurofins Records Retention/Storage Schedule. Quality records are maintained by the QA department electronically, which is backed up as part of the regular laboratory backup. Records are of two types; either electronic or hard copy paper formats depending on whether the record is computer or hand generated (some records may be in both formats). Technical records are maintained by Supervisors and Department Managers.

Table 14-1. Record Index¹

	<u>Record Types ¹:</u>	<u>Retention Time:</u>
Technical Records	- Raw Data - Logbooks² - Standards - Certificates - Analytical Records - MDLs/IDLs/DOCs - Lab Reports	5 Years from analytical report issue*
Official Documents	- Quality Assurance Manual (QAM) - Work Instructions - Policies - SOPs - Policy Memorandums - Manuals - Published Methods	Indefinitely
QA Records	- Certifications - Method and Software Validation / Verification Data	Indefinitely
QA Records	- Internal & External Audits/Responses - Corrective/Preventive Actions - Management Reviews - Data Investigation	5 Years from archival* <u>Data Investigation:</u> 5 years or the life of the affected raw data storage whichever is greater (beyond 5 years if ongoing project or pending investigation)

	<u>Record Types ¹:</u>	<u>Retention Time:</u>
Project Records	- Sample Receipt & COC Documents - Contracts and Amendments - Correspondence - QAPP - SAP - Telephone Logbooks - Lab Reports	5 Years from analytical report issue*
Administrative Records	Financial and Business Operations	Refer to CW-L-WI-001
	EH&S Manual, Permits	Indefinitely
	Disposal Records	Indefinitely
	Employee Handbook	Indefinitely
	Personnel files, Employee Signature & Initials, Administrative Training Records (e.g., Ethics)	Refer to HR Manual
	Administrative Policies	Indefinitely
	Technical Training Records	7 years
	Legal Records	Indefinitely
	HR Records	Refer to CW-L-WI-001
	IT Records	Refer to CW-L-WI-001
	Corporate Governance Records	Refer to CW-L-WI-001
	Sales & Marketing	5 years
	Real Estate	Indefinitely

¹ Record Types encompass hardcopy and electronic records.

² Examples of Logbook types: Maintenance, Instrument Run, Preparation (standard and samples), Standard and Reagent Receipt, Archiving, Balance Calibration, Temperature (hardcopy or electronic records).

* Exceptions listed in Table 14-2.

14.1.1 All records are stored and retained in such a way that they are secure and readily retrievable at the laboratory facility or Gilmore data storage facility that provides a suitable environment to prevent damage or deterioration and to prevent loss. All records shall be protected against fire, theft, loss, environmental deterioration, and vermin. In the case of electronic records, electronic or magnetic sources, storage media are protected from deterioration caused by magnetic fields and/or electronic deterioration.

Access to the data is limited to laboratory and company employees and shall be documented with an access log. Records archived off-site are stored in a secure location where a record is maintained of any entry into the storage facility. A list of employees allowed to obtain data is kept with Gilmore and a record is kept of all requests. Whether on-site or off-site storage is used, logs are maintained in each storage box to note removal and return of records. Retention of records are maintained on-site at the laboratory for at least 6 months after their generation and moved offsite for the remainder of the required storage time. Records are maintained for a minimum of ten years unless otherwise specified by a client or regulatory requirement.

For raw data and project records, record retention shall be calculated from the date the project report is issued. For other records, such as Controlled Documents, QA, or Administrative Records, the retention time is calculated from the date the record is formally retired. Records

related to the programs listed in Table 14-2 have lengthier retention requirements and are subject to the requirements in Section 14.1.3.

14.1.2 Programs with Longer Retention Requirements

Some regulatory programs have longer record retention requirements than the standard record retention time. These are detailed in Table 14-2 with their retention requirements. In these cases, the longer retention requirement is enacted. If special instructions exist such that client data cannot be destroyed prior to notification of the client, the container or box containing that data is marked as to who to contact for authorization prior to destroying the data.

Table 14-2. Special Record Retention Requirements

Program	¹ Retention Requirement
Drinking Water – All States	10 years (lab reports and raw data) 10 years - Radiochemistry (project records)
Commonwealth of MA – All environmental data 310 CMR 42.14	10 years
Louisiana – All	10 years
Michigan Department of Environmental Quality – all environmental data	10 years
OSHA	30 years

¹Note: Extended retention requirements must be noted with the archive documents or addressed in facility-specific records retention procedures.

14.1.3 The laboratory has procedures to protect and back-up records stored electronically and to prevent unauthorized access to or amendment of these records. All analytical data is maintained as hard copy or in a secure readable electronic format. For analytical reports that are maintained as copies in PDF format, refer to Section 19.15.1 (Computer and Electronic Data Related Requirements) for more information.

14.1.4 The record keeping system allows for historical reconstruction of all laboratory activities that produced the analytical data, as well as rapid recovery of historical data (Records stored off site should be accessible within 2 days of a request for such records). The history of the sample from when the laboratory took possession of the samples must be readily understood through the documentation. This shall include inter-laboratory transfers of samples and/or extracts.

- The records include the identity of personnel involved in sampling, sample receipt, preparation, or testing. All analytical work contains the initials (at least) of the personnel involved. The laboratory's copy of the COC is scanned and stored with the invoice and the work order sheet in TALS. The Eurofins chain of custody would indicate the name of the sampler. If any sampling notes are provided with a work order, they are scanned and kept with this package.
- All information relating to the laboratory facilities' equipment, analytical test methods, and related laboratory activities, such as sample receipt, sample preparation, or data verification

are documented.

- The record keeping system facilitates the retrieval of all working files and archived records for inspection and verification purposes (e.g., set format for naming electronic files, set format for what is included with a given analytical data set see SOP PS-LAB-007 (Records Management). Instrument data is stored sequentially by instrument. A given day's analyses are maintained in the order of the analysis. Run logs are maintained for each instrument or method; a copy of each day's run log or instrument sequence is stored with the data to aid in re-constructing an analytical sequence. Where an analysis is performed without an instrument, bound logbooks or bench sheets are used to record and file data. Standard and reagent information is recorded in logbooks or entered into TALS for each method as required.
- Changes to hardcopy records shall follow the procedures outlined in Section 12 and 19. Changes to electronic records in TALS or instrument data are recorded in audit trails.
- The reason for a signature or initials on a document is clearly indicated in the records such as "sampled by," "prepared by," "reviewed by", or "analyzed by".
- All generated data except those that are generated by automated data collection systems, are recorded directly, promptly and legibly in permanent dark ink.
- Hard copy data may be scanned into PDF format for record storage as long as the scanning process can be verified in order to ensure that no data is lost and the data files and storage media must be tested to verify the laboratory's ability to retrieve the information prior to the destruction of the hard copy that was scanned.
- Also refer to Section 19.15.1 'Computer and Electronic Data Related Requirements'.

14.2 Technical and Analytical Records

14.2.1 The laboratory retains records of original observations, derived data and sufficient information to establish an audit trail, calibration records, staff records and a copy of each analytical report issued, for a minimum of five years unless otherwise specified by a client or regulatory requirement. The records for each analysis shall contain sufficient information to enable the analysis to be repeated under conditions as close as possible to the original. The records shall include the identity of laboratory personnel responsible for the sampling, performance of each analysis and reviewing results.

14.2.2 Observations, data and calculations are recorded real-time and are identifiable to the specific task.

14.2.3 Changes to hardcopy records shall follow the procedures outlined in Section 12 and 19. Changes to electronic records in TALS or instrument data are recorded in audit trails.

The essential information to be associated with analysis, such as strip charts, tabular printouts, computer data files, analytical notebooks, and run logs, include:

- laboratory sample ID code;

- Date of analysis; time of analysis is also required if the holding time is seventy-two (72) hours or less, or when time critical steps are included in the analysis (e.g., drying times, incubations, etc.); instrumental analyses have the date and time of analysis recorded as part of their general operations. Where a time critical step exists in an analysis, location for such a time is included as part of the documentation in a specific logbook or on a benchsheet.
- Instrumentation identification and instrument operating conditions/parameters. Operating conditions/parameters are typically recorded in instrument maintenance logs where available.
- analysis type;
- all manual calculations and manual integrations;
- analyst's or operator's initials/signature;
- sample preparation including cleanup, separation protocols, incubation periods or subculture, ID codes, volumes, weights, instrument printouts, meter readings, calculations, reagents;
- test results;
- standard and reagent origin, receipt, preparation, and use;
- calibration criteria, frequency and acceptance criteria;
- data and statistical calculations, review, confirmation, interpretation, assessment and reporting conventions;
- quality control protocols and assessment;
- electronic data security, software documentation and verification, software and hardware audits, backups, and records of any changes to automated data entries; and
- Method performance criteria including expected quality control requirements. These are indicated both in TALS and on specific analytical report formats.

14.2.4 All logbooks used during receipt, preparation, storage, analysis, and reporting of samples or monitoring of support equipment shall undergo a periodic, documented supervisory or peer review.

14.3 Laboratory Support Activities

In addition to documenting all the above-mentioned activities, the following are retained QA records and project records (previous discussions in this section relate where and how these data are stored):

- all original raw data, whether hard copy or electronic, for calibrations, samples and quality

control measures, including analysts' work sheets and data output records (chromatograms, strip charts, and other instrument response readout records);

- a written description or reference to the specific test method used which includes a description of the specific computational steps used to translate parametric observations into a reportable analytical value;
- copies of final reports;
- archived SOPs;
- correspondence relating to laboratory activities for a specific project;
- all corrective action reports, audits and audit responses;
- proficiency test results and raw data; and
- results of data review, verification, and crosschecking procedures

14.3.1 Sample Handling Records

Records of all procedures to which a sample is subjected while in the possession of the laboratory are maintained. These include but are not limited to records pertaining to:

- sample preservation including appropriateness of sample container and compliance with holding time requirement;
- sample identification, receipt, acceptance or rejection and login;
- sample storage and tracking including shipping receipts, sample transmittal / COC forms; and
- procedures for the receipt and retention of samples, including all provisions necessary to protect the integrity of samples.

14.4 Administrative Records

The laboratory also maintains the administrative records in either electronic or hard copy form. Refer to Table 14-1.

14.5 Records Management, Storage and Disposal

All records (including those pertaining to test equipment), certificates and reports are safely stored, held secure and in confidence to the client. Certification related records are available upon request.

All information necessary for the historical reconstruction of data is maintained by the laboratory. Records that are stored only on electronic media must be supported by the hardware and software necessary for their retrieval.

Records that are stored or generated by computers or personal computers have hard copy, write-protected backup copies, or an electronic audit trail controlling access.

The laboratory has a record management system (a.k.a., document control) for control of laboratory notebooks, instrument logbooks, standards logbooks, and records for data reduction, validation, storage and reporting Laboratory notebooks for instrument maintenance, sequence

logs or operating conditions are issued on a per instrument or per analysis basis, and are numbered sequentially. All data recorded on benchsheets is scanned and archived in the TALs in lieu of storage in notebooks. Standards are maintained in the TALs – no logbooks are used to record that data. Records are considered archived when noted as such in the records management system (a.k.a., document control.)

14.5.1 Transfer of Ownership

In the event that the laboratory transfers ownership or goes out of business, the laboratory shall ensure that the records are maintained or transferred according to client's instructions. Upon ownership transfer, record retention requirements shall be addressed in the ownership transfer agreement and the responsibility for maintaining archives is clearly established. In addition, in cases of bankruptcy, appropriate regulatory and state legal requirements concerning laboratory records must be followed. In the event of the closure of the laboratory, all records will revert to the control of the corporate headquarters. Should the entire company cease to exist, as much notice as possible will be given to clients and the accrediting bodies who have worked with the laboratory during the previous 5 years of such action.

14.5.2 Records Disposal

Records are removed from the archive and destroyed after 10 years unless otherwise specified by a client or regulatory requirement. On a project specific or program basis, clients may need to be notified prior to record destruction. Records are destroyed in a manner that ensures their confidentiality such as shredding, mutilation or incineration. (Refer to Tables 14-1 and 14-2).

Electronic copies of records must be destroyed by erasure or physically damaging off-line storage media so no records can be read.

If a third party records management company is hired to dispose of records, a "Certificate of Destruction" is required.

SECTION 15. AUDITS

15.1 Internal Audits

Internal audits are performed to verify that laboratory operations comply with the requirements of the lab's quality system and with the external quality programs under which the laboratory operates. Audits are planned and organized by the QA staff. Personnel conducting the audits should be independent of the area being evaluated. Auditors will have sufficient authority, access to work areas, and organizational freedom necessary to observe all activities affecting quality and to report the assessments to laboratory management and, when requested, to corporate management.

Audits are conducted and documented as described in the Eurofins Corporate SOP on performing Internal Auditing, SOP No. CW-Q-S-003. The types and frequency of routine internal audits are described in Table 15-1. Special or ad hoc assessments may be conducted as needed under the direction of the QA staff.

Table 15-1. Types of Internal Audits and Frequency

Description	Performed by	Frequency
Quality Systems Audits	QA Department, QA approved designee, or Corporate QA	All areas of the laboratory annually
Method Audits QA Technical Audits	Joint responsibility: a) QA Manager or designee b) Technical Manager or Designee (Refer to CW-Q-S-003)	QA Technical Audits Frequency: 50% of methods annually
SOP Method Compliance	Joint responsibility: a) QA Manager or designee b) Technical Manager or Designee (Refer to CW-Q-S-003)	SOP Compliance Review Frequency: • Every 2 years
Special	QA Department or Designee	Surveillance or spot checks performed as needed, e.g., to confirm corrective actions from other audits.
Performance Testing	Analysts with QA oversight	Two successful per year for each TNI-field of testing or as dictated by regulatory requirements

15.1.1 Annual Quality Systems Audit

An annual quality systems audit is required to ensure compliance to analytical methods and SOPs, Eurofins's Data Integrity and Ethics Policies, TNI quality systems, client and state requirements, and the effectiveness of the internal controls of the analytical process, including but not limited to data review, quality controls, preventive action and corrective action. The completeness of earlier corrective actions is assessed for effectiveness & sustainability. The audit is divided into sections for each operating or support area of the lab, and each section is

comprehensive for a given area. The area audits may be performed on a rotating schedule throughout the year to ensure adequate coverage of all areas. This schedule may change as situations in the laboratory warrant.

15.1.2 QA Technical Audits

QA technical audits assess data authenticity and analyst integrity. These audits are based on client projects, associated sample delivery groups, and the methods performed. Reported results are compared to raw data to verify the authenticity of results. The validity of calibrations and QC results are compared to data qualifiers, footnotes, and case narratives. Documentation is assessed by examining run logs and records of manual integrations. Manual calculations are checked. Where possible, electronic audit miner programs (e.g., Chrom AuditMiner) are used to identify unusual manipulations of the data deserving closer scrutiny. QA technical audits will include all methods within a two-year period. All analysts should be reviewed over the course of a two year period through at least one QA Technical Audit.

15.1.3 SOP Method Compliance

Compliance of all SOPs with the source methods and compliance of the operational groups with the SOPs will be assessed by the Technical Manager or qualified designee at least every two years. It is also recommended that the work of each newly hired analyst is assessed within 3 months of working independently, (e.g., completion of method IDOC). In addition, as analysts add methods to their capabilities, (new IDOC) reviews of the analyst work products will be performed within 3 months of completing the documented training.

15.1.4 Special Audits

Special audits are conducted on an as needed basis, generally as a follow up to specific issues such as client complaints, corrective actions, PT results, data audits, system audits, validation comments, regulatory audits or suspected ethical improprieties. Special audits are focused on a specific issue, and report format, distribution, and timeframes are designed to address the nature of the issue.

15.1.5 Performance Testing

The laboratory participates semi-annually in performance audits conducted through the analysis of PT samples provided by a third party. The laboratory generally participates in the following types of PT studies: Drinking Water, Non-potable Water, and Soil.

It is Eurofins's policy that PT samples be treated as typical samples in the production process. Furthermore, where PT samples present special or unique problems, in the regular production process they may need to be treated differently, as would any special or unique request submitted by any client. The QA Manager must be consulted and in agreement with any decisions made to treat a PT sample differently due to some special circumstance.

Written investigations for unacceptable PT results are required. In some cases it may be necessary for blind QC samples to be submitted to the laboratory to show a return to control.

15.2 External Audits

External audits are performed when certifying agencies or clients conduct on-site inspections or submit performance testing samples for analysis. It is Eurofins's policy to cooperate fully with regulatory authorities and clients. The laboratory makes every effort to provide the auditors with access to personnel, documentation, and assistance. Laboratory supervisors are responsible for providing corrective actions to the QA Manager who coordinates the response. Audit responses are due in the time allotted by the client or agency performing the audit. When requested, a copy of the audit report and the lab's corrective action plan will be forwarded to Corporate Quality.

The laboratory cooperates with clients and their representatives to monitor the laboratory's performance in relation to work performed for the client. The client may only view data and systems related directly to the client's work. All efforts are made to keep other client information confidential.

15.2.1 Confidential Business Information (CBI) Considerations

During on-site audits, auditors may come into possession of information claimed as business confidential. A business confidentiality claim is defined as "a claim or allegation that business information is entitled to confidential treatment for reasons of business confidentiality or a request for a determination that such information is entitled to such treatment." When information is claimed as business confidential, the laboratory must place on (or attach to) the information at the time it is submitted to the auditor, a cover sheet, stamped or typed legend or other suitable form of notice, employing language such as "trade secret", "proprietary" or "company confidential". Confidential portions of documents otherwise non-confidential must be clearly identified. CBI may be purged of references to client identity by the responsible laboratory official at the time of removal from the laboratory. However, sample identifiers may not be obscured from the information. Additional information regarding CBI can be found in within the 2009/2016 TNI standards.

15.3 Audit Findings

Audit findings are documented using the corrective action process and database (see Section 12). The laboratory's corrective action responses may include action plans that could not be completed within a predefined timeframe. In these instances, a completion date must be set and agreed to by operations management and the QA Manager.

Developing and implementing corrective actions to findings is the responsibility of the Department Manager where the finding originated. Findings that are not corrected by specified due dates are reported monthly to management in the QA monthly report. When requested, a copy of the audit report and the labs corrective action plan will be forwarded to Corporate Quality.

If any audit finding casts doubt on the effectiveness of the operations or on the correctness or validity of the laboratory's test results, the laboratory shall take timely corrective action, and shall notify clients in writing if the investigations show that the laboratory results have been affected. Once corrective action is implemented, a follow-up audit is scheduled to ensure that the problem has been corrected.

Clients must be notified promptly in writing of any event such as the identification of defective measuring or test equipment that casts doubt on the validity of results given in any test report or amendment to a test report. The investigation must begin within 24 hours of discovery of the problem and all efforts are made to notify the client within two weeks after the completion of the investigation.

SECTION 16. MANAGEMENT REVIEWS

16.1 Quality Assurance Report

A comprehensive QA Report shall be prepared each month by the laboratory's QA Department and forwarded to the Laboratory Director, Manager of Project Management, their Quality Director as well as the VP of Operations. All aspects of the QA system are reviewed to evaluate the suitability of policies and procedures. During the course of the year, the Laboratory Director, VP of Operations or Corporate QA may request that additional information be added to the report.

On a monthly basis, Corporate QA compiles information from all the monthly laboratory reports. The Corporate Quality Directors prepare a report that includes a compilation of all metrics and notable information and concerns regarding the QA programs within the laboratories. The report also includes a listing of new regulations that may potentially impact the laboratories. This report is presented to the Senior Management Team and VPs of Operations.

16.2 Annual Management Review

The senior lab management team (Laboratory Director, Technical Director, Department Managers, QA Manager) conducts a review annually of its quality systems and the TALS to ensure its continuing suitability and effectiveness in meeting client and regulatory requirements and to introduce any necessary changes or improvements. It will also provide a platform for defining goals, & objectives and action items that feed into the laboratory planning system. Corporate Operations and Corporate QA personnel is be included in this meeting at the discretion of the Laboratory Director. The TALS review consists of examining any audits, complaints or concerns that have been raised through the year that are related to the TALS. The laboratory will summarize any critical findings that cannot be solved by the lab and report them to Corporate IT.

This management systems review (Corporate SOP No. CW-Q-S-004 and Work Instruction No. CW-Q-WI-003) uses information generated during the preceding year to assess the "big picture" by ensuring that routine actions taken and reviewed on a monthly basis are not components of larger systematic concerns. The monthly review should keep the quality systems current and effective, therefore, the annual review is a formal senior management process to review specific existing documentation. Significant issues from the following documentation are compiled or summarized by the QA Manager prior to the review meeting:

- Matters arising from the previous annual review.
- Prior Monthly QA Reports issues.
- Laboratory QA Metrics.
- Review of report reissue requests.
- Review of client feedback and complaints.
- Issues arising from any prior management or staff meetings.
- Minutes from prior senior lab management meetings. Issues that may be raised from these meetings include:

- Adequacy of staff, equipment and facility resources.
- Adequacy of policies and procedures.
- Future plans for resources and testing capability and capacity.
- The annual internal double blind PT program sample performance (if performed),
- Compliance to the Ethics Policy and Data Integrity Plan. Including any evidence/incidents of inappropriate actions or vulnerabilities related to data Integrity.
- For labs analyzing radioactive samples, also include the following:
 - Radiation health and safety
 - Radioactive hazardous waste management
 - Radioactive materials management
- Evaluation of overall risk, including risks to impartiality, confidentiality, reporting statements of conformity, and nonconforming work.

A report is generated by the QA Manager and management. The report is distributed to the appropriate VP of Operation and the Quality Director. The report includes, but is not limited to:

- The date of the review and the names and titles of participants.
- A reference to the data quality related documents and topics that were reviewed.
- Quality or operational system changes and/or improvements that will be made as a result of the review.
- Provision of required resources
- Implementation plan/schedule

Changes to the quality systems requiring update to the laboratory QA Manual shall be included in the next revision of the QA Manual.

16.3 Potential Integrity Related Managerial Reviews

Potential integrity issues (data or business related) must be handled and reviewed in a confidential manner until such time as a follow-up evaluation, full investigation, or other appropriate actions have been completed and issues clarified. Eurofins's Corporate Internal Investigations SOP shall be followed (SOP No. CW-L-S-002). All investigations that result in finding of inappropriate activity are documented and include any disciplinary actions involved, corrective actions taken, and all appropriate notifications of clients.

Eurofins's President and CEO, Executive VP of Operations, VP of Client & Technical Services, VPs of Operations and Quality Directors receive a monthly report from the VP-QA/EHS summarizing any current data integrity or data recall investigations. The VPs of Operations are also made aware of progress on these issues for their specific labs.

SECTION 17. PERSONNEL

17.1 Overview

The laboratory's management believes that its highly qualified and professional staff is the single most important aspect in assuring a high level of data quality and service. The staff consists of professionals and support personnel as outlined in the organization chart in Figure 4-1.

All personnel must demonstrate competence in the areas where they have responsibility. Any staff that is undergoing training shall have appropriate supervision until they have demonstrated their ability to perform their job function on their own. Staff shall be qualified for their tasks based on appropriate education, training, experience and/or demonstrated skills as required.

The laboratory employs sufficient personnel with the necessary education, training, technical knowledge and experience for their assigned responsibilities.

All personnel are responsible for complying with all QA/QC requirements that pertain to the laboratory and their area of responsibility. Each staff member must have a combination of experience and education to adequately demonstrate a specific knowledge of their particular area of responsibility. Technical staff must also have a general knowledge of lab operations, test methods, QA/QC procedures and records management.

Laboratory management is responsible for formulating goals for lab staff with respect to education, training and skills and ensuring that the laboratory has a policy and procedures for identifying training needs and providing training of personnel. The training shall be relevant to the present and anticipated responsibilities of the lab staff.

The laboratory only uses personnel that are employed by or under contract to, the laboratory. Contracted personnel, when used, must meet competency standards of the laboratory and work in accordance to the laboratory's quality system.

17.2 Education and Experience Requirements for Technical Personnel

The laboratory makes every effort to hire analytical staffs that possess a college degree (AA, BA, BS) in an applied science with some chemistry in the curriculum. Exceptions can be made based upon the individual's experience and ability to learn. Selection of qualified candidates for laboratory employment begins with documentation of minimum education, training, and experience prerequisites needed to perform the prescribed task. Minimum education and training requirements for Eurofins employees are outlined in job descriptions and are generally summarized for analytical staff in the table below.

The laboratory maintains job descriptions for all personnel who manage, perform or verify work affecting the quality of the environmental testing the laboratory performs. Job Descriptions are located on the Eurofins intranet site's Human Resources web-page (Also see Section 4 for position descriptions/responsibilities).

Experience and specialized training are occasionally accepted in lieu of a college degree (basic lab skills such as using a balance, colony counting, aseptic or quantitation techniques, etc., are also considered).

As a general rule for analytical staff:

Specialty	Education	Experience
Extractions, Digestions, some electrode methods (pH, DO, Redox, etc.), or Titrimetric and Gravimetric Analyses	H.S. Diploma	On the job training (OJT)
GFAA, CVAA, FLAA, Single component or short list Chromatography (e.g., Fuels, BTEX-GC, IC	A college degree in an applied science or 2 years of college and at least 1 year of college chemistry	Or 2 years prior analytical experience is required
ICP, ICPMS, Long List or complex chromatography (e.g., Pesticides, PCB, Herbicides, HPLC, etc.), GCMS	A college degree in an applied science or 2 years of college chemistry	or 5 years of prior analytical experience
Spectra Interpretation	A college degree in an applied science or 2 years of college chemistry	And 2 years relevant experience Or 5 years of prior analytical experience
Department Managers – <u>General</u>	Bachelor's Degree in an applied science or engineering with 24 semester hours in chemistry An advanced (MS, PhD.) degree may substitute for one year of experience	And 2 years experience in environmental analysis of representative analytes for which they will oversee
Department Managers – <u>Wet Chem</u> only (no advanced instrumentation)	Associates degree in an applied science or engineering or 2 years of college with 16 semester hours in chemistry	And 2 years relevant experience
Department Managers - <u>Microbiology</u>	Bachelor's degree in applied science with at least 16 semester hours in general microbiology and biology An advanced (MS, PhD.) degree may substitute for one year of experience	And 2 years of relevant experience

When an analyst does not meet these requirements, they can perform a task under the direct supervision of a qualified analyst, peer reviewer or Department Manager, and are considered an analyst in training. The person supervising an analyst in training is accountable for the quality of the analytical data and must review and approve data and associated corrective actions.

17.3 Training

The laboratory is committed to furthering the professional and technical development of employees at all levels.

Orientation to the laboratory's policies and procedures, in-house method training, and employee attendance at outside training courses and conferences all contribute toward employee proficiency. Below are examples of various areas of required employee training:

Required Training	Time Frame	Employee Type
Environmental Health & Safety	Prior to lab work	All
Ethics – New Hires	1 week of hire	All
Ethics – Comprehensive	90 days of hire	All
Data Integrity	30 days of hire	Technical and PMs
Quality Assurance	90 days of hire	All
Ethics – Comprehensive Refresher	Annually	All
Initial Demonstration of Capability (DOC)	Prior to unsupervised method performance	Technical

The laboratory maintains records of relevant authorization/competence, education, professional qualifications, training, skills and experience of technical personnel (including contracted personnel) as well as the date that approval/authorization was given. These records are kept on file at the laboratory. Also refer to "Demonstration of Capability" in Section 19.

The training of technical staff is kept up to date by:

- Each employee must have documentation in their training file that they have read, understood and agreed to follow the most recent version of the laboratory QA Manual and SOPs in their area of responsibility. This documentation is updated as SOPs are updated.
- Documentation from any training courses or workshops on specific equipment, analytical techniques or other relevant topics.
- Documentation of proficiency (refer to Section 19).
- An Ethics Agreement signed by each staff member (renewed each year) and evidence of annual ethics training.
- A Confidentiality Agreement signed by each staff member signed at the time of employment.
- Human Resources maintains documentation and attestation forms on employment status and records; benefit programs; timekeeping/payroll; and employee conduct (e.g., ethics violations). This information is maintained in the employee's secured personnel file.

Evidence of successful training could include such items as:

- Adequate documentation of training within operational areas, including one-on-one technical training for individual technologies, and particularly for people cross-trained.
- Analysts knowledge to refer to QA Manual for quality issues.
- Analysts following SOPs, i.e., practice matches SOPs.
- Analysts regularly communicate to supervisors and QA if SOPs need revision, rather than waiting for auditors to find problems.

Further details of the laboratory's training program are described in the Laboratory's training SOP PS-LAB-014 (Training Program and Documentation).

17.4 Data Integrity and Ethics Training Program

Establishing and maintaining a high ethical standard is an important element of a Quality System. Ethics and data integrity training is integral to the success of Eurofins and is provided for each employee at Eurofins. It is a formal part of the initial employee orientation within 1 week of hire followed by technical data integrity training within 30 days, comprehensive training within 90 days, and an annual refresher for all employees. Senior management at each facility performs the ethics training for their staff.

In order to ensure that all personnel understand the importance Eurofins places on maintaining high ethical standards at all times, Eurofins has established a Corporate Ethics Policy (Policy No. CW-L-P-004) and an Ethics Statement. All initial and annual training is documented by signature on the signed Ethics Statement demonstrating that the employee has participated in the training and understands their obligations related to ethical behavior and data integrity.

Violations of this Ethics Policy will not be tolerated. Employees who violate this policy will be subject to disciplinary actions up to and including termination. Criminal violations may also be referred to the government for prosecution. In addition, such actions could jeopardize Eurofins's ability to do work on government contracts, and for that reason, Eurofins has a Zero Tolerance approach to such violations.

Employees are trained as to the legal and environmental repercussions that result from data misrepresentation. Key topics covered in the presentation include:

- Organizational mission and its relationship to the critical need for honesty and full disclosure in all analytical reporting.
- Ethics Policy
- How and when to report ethical/data integrity issues. Confidential reporting.
- Record keeping.
- Discussion regarding data integrity procedures.
- Specific examples of breaches of ethical behavior (e.g. peak shaving, altering data or computer clocks, improper macros, etc., accepting/offering kickbacks, illegal accounting practices, unfair competition/collusion)
- Internal monitoring. Investigations and data recalls.

- Consequences for infractions including potential for immediate termination, debarment, or criminal prosecution.
- Importance of proper written narration / data qualification by the analyst and project manager with respect to those cases where the data may still be usable but are in one sense or another partially deficient.

Additionally, a data integrity hotline (1-800-736-9407) is maintained by Eurofins and administered by the Corporate Quality Department.

SECTION 18. ACCOMMODATIONS AND ENVIRONMENTAL CONDITIONS

18.1 Overview

The laboratory is a 22,000 ft² secure laboratory facility with controlled access and designed to accommodate an efficient workflow and to provide a safe and comfortable work environment for employees. All visitors sign in and are escorted by laboratory personnel. Access is controlled by various measures.

The laboratory is equipped with structural safety features. Each employee is familiar with the location, use, and capabilities of general and specialized safety features associated with their workplace. The laboratory provides and requires the use of protective equipment including safety glasses, protective clothing, gloves, etc., OSHA and other regulatory agency guidelines regarding required amounts of bench and fume hood space, lighting, ventilation (temperature and humidity controlled), access, and safety equipment are met or exceeded.

Traffic flow through sample preparation and analysis areas is minimized to reduce the likelihood of contamination. Adequate floor space and bench top area is provided to allow unencumbered sample preparation and analysis space. Sufficient space is also provided for storage of reagents and media, glassware, and portable equipment. Ample space is also provided for refrigerated sample storage before analysis and archival storage of samples after analysis. Laboratory HVAC and deionized water systems are designed to minimize potential trace contaminants.

The laboratory is separated into specific areas for sample receiving, sample preparation, volatile organic sample analysis, non-volatile organic sample analysis, inorganic sample analysis, metals sample analysis, microbiological sample analysis, and administrative functions.

18.2 Environment

Laboratory accommodation, test areas, energy sources, and lighting are adequate to facilitate proper performance of tests. The facility is equipped with heating, ventilation, and air conditioning (HVAC) systems appropriate to the needs of environmental testing performed at this laboratory.

The environment in which these activities are undertaken does not invalidate the results or adversely affect the required accuracy of any measurements.

The laboratory provides for the effective monitoring, control and recording of environmental conditions that may affect the results of environmental tests as required by the relevant specifications, methods, and procedures. Such environmental conditions include humidity, voltage, temperature, and vibration levels in the laboratory.

When any of the method or regulatory required environmental conditions change to a point where they may adversely affect test results, analytical testing will be discontinued until the environmental conditions are returned to the required levels.

Environmental conditions of the facility housing the computer network and TALS are regulated to protect against raw data loss.

When the laboratory performs laboratory activities at sites or facilities outside its permanent control, it shall ensure that the requirements related to facilities and environmental conditions of this document are met.

Specific requirements for facility and environmental conditions, as well as periodic monitoring of conditions, are given in the Environmental Health & Safety Manual plus each laboratory's Facility Addendum.

18.3 Work Areas

There is effective separation between neighboring areas when the activities therein are incompatible with each other. Examples include:

- Microbiological culture handling and sample incubation areas.
- Volatile organic chemical handling areas, including sample preparation and waste disposal, and volatile organic chemical analysis areas.

Access to and use of all areas affecting the quality of analytical testing is defined and controlled by secure access to the laboratory building as described below in the Building Security section.

Adequate measures are taken to ensure good housekeeping in the laboratory and to ensure that any contamination does not adversely affect data quality. These measures include regular cleaning to control dirt and dust within the laboratory. Work areas are available to ensure an unencumbered work area. Work areas include:

- Access and entryways to the laboratory.
- Sample receipt areas.
- Sample storage areas.
- Chemical and waste storage areas.
- Data handling and storage areas.
- Sample processing areas.
- Sample analysis areas.

Refer to the following documents and procedures for specific requirements for microbiological laboratory facility requirements.

- Standard Methods, 20th Ed., 9020B, Sec. 2
- TNI V1M5 (2009 and 2016), 1.7.3.7.a

18.4 Floor Plan

A floor plan can be found in Appendix 1.

18.5 Building Security

Building keys and alarm codes are distributed to employees as necessary.

After hours admittance to the building is controlled by use of a numeric keypad lock for which each employee enters a unique code to gain access.

Visitors to the laboratory sign in and out in a visitor's logbook. A visitor is defined as any person who visits the laboratory who is not an employee of the laboratory. In addition to signing into the laboratory, the Environmental Health and Safety Manual contains requirements for visitors and vendors. There are specific safety forms that must be reviewed and signed. Visitors (with the exception of company employees) are escorted by laboratory personnel at all times, or the location of the visitor is noted in the visitor's logbook.

SECTION 19. TEST METHODS AND METHOD VALIDATION

19.1 Overview

The laboratory uses methods that are appropriate to meet our clients' requirements and that are within the scope of the laboratory's capabilities. These include sampling, handling, transport, storage and preparation of samples, and, where appropriate, an estimation of the measurement of uncertainty as well as statistical techniques for analysis of environmental data.

Instructions are available in the laboratory for the operation of equipment as well as for the handling and preparation of samples. All instructions, Standard Operating Procedures (SOPs), reference methods and manuals relevant to the working of the laboratory are readily available to all staff. Deviations from published methods are documented (with justification) in the laboratory's approved SOPs. SOPs are submitted to clients for review at their request. Significant deviations from published methods require client approval and regulatory approval where applicable.

19.2 Standard Operating Procedures (SOPS)

The laboratory maintains SOPs that accurately reflect all phases of the laboratory such as assessing data integrity, corrective actions, handling customer complaints as well as all analytical methods and sampling procedures. The method SOPs are derived from the most recently promulgated/approved, published methods and are specifically adapted to the laboratory facility. Modifications or clarifications to published methods are clearly noted in the SOPs. All SOPs are controlled in the laboratory.

- All SOPs contain a revision number, effective date, and appropriate approval signatures. Controlled copies are available to all staff.
- Procedures for writing an SOP are incorporated by reference to Eurofins's Corporate SOP entitled 'Writing a Standard Operating Procedure', No. CW-Q-S-002 and the laboratory's SOP Process for Creation, Review, Revision and Control of Laboratory Documents.
- SOPs are reviewed at a minimum of every 2 years (annually for Drinking Water and DoD/DOE SOPs), and where necessary, revised to ensure continuing suitability and compliance with applicable requirements.

19.3 Laboratory Methods Manual

For each test method, the laboratory shall have available the published referenced method as well as the laboratory developed SOP.

Note: If more stringent standards or requirements are included in a mandated test method or regulation than those specified in this manual, the laboratory shall demonstrate that such requirements are met. If it is not clear which requirements are more stringent, the standard from the method or regulation is to be followed. Any exceptions or deviations from the referenced methods or regulations are noted in the specific analytical SOP.

The laboratory maintains an SOP Index for both technical and non-technical SOPs. Technical SOPs are maintained to describe a specific test method. Non-technical SOPs are maintained to describe functions and processes not related to a specific test method.

19.4 Selection of Methods

Since numerous methods and analytical techniques are available, continued communication between the client and laboratory is imperative to assure the correct methods are utilized. Once client methodology requirements are established, this and other pertinent information is summarized by the Project Manager. These mechanisms ensure that the proper analytical methods are applied when the samples arrive for log-in. For non-routine analytical services (e.g., special matrices, non-routine compound lists), the method of choice is selected based on client needs and available technology. The methods selected should be capable of measuring the specific parameter of interest, in the concentration range of interest, and with the required precision and accuracy.

19.4.1 Sources of Methods

Routine analytical services are performed using standard EPA-approved methodology. In some cases, modification of standard approved methods may be necessary to provide accurate analyses of particularly complex matrices. When the use of specific methods for sample analysis is mandated through project or regulatory requirements, only those methods shall be used.

When clients do not specify the method to be used or methods are not required, the methods used will be clearly validated and documented in an SOP and available to clients and/or the end user of the data.

The analytical methods used by the laboratory are those currently accepted and approved by the U. S. EPA and the state or territory from which the samples were collected. Reference methods include:

- *Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act; Analysis and Sampling Procedures; 40CFR Part 136 as amended by Method Update Rule; August 28, 2017.*
- *Methods for Chemical Analysis of Water and Wastes, EPA 600 (4-79-020), 1983.*
- *Methods for the Determination of Inorganic Substances in Environmental Samples, EPA-600/R-93/100, August 1993.*
- *Methods for the Determination of Metals in Environmental Samples, EPA/600/4-91/010, June 1991. Supplement I: EPA-600/R-94/111, May 1994.*
- *Methods for the Determination of Organic Compounds in Drinking Water, EPA-600/4-88-039, December 1988, Revised, July 1991, Supplement I, EPA-600-4-90-020, July 1990, Supplement II, EPA-600/R-92-129, August 1992. Supplement III EPA/600/R-95/131 - August 1995 (EPA 500 Series) (EPA 500 Series methods)*
- *NIOSH Manual of Analytical Methods, 4th ed., August 1994.*
- *Statement of Work for Inorganics & Organics Analysis, SOM and ISM, current versions, USEPA Contract Laboratory Program Multi-media, Multi-concentration.*

- Standard Methods for the Examination of Water and Wastewater, 18th/19th /20th/ on-line edition; Eaton, A.D. Clesceri, L.S. Greenberg, A.E. Eds; American Water Works Association, Water Pollution Control Federation, American Public Health Association: Washington, D.C.
- Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), Third Edition, September 1986, Final Update I, July 1992, Final Update IIA, August 1993, Final Update II, September 1994; Final Update IIB, January 1995; Final Update III, December 1996; Final Update IV, January 2008; Final Update V, August 2015.
- Manual for the Certification of Laboratories Analyzing Drinking Water (EPA 815-R-05-004, January 2005).
- Code of Federal Regulations (CFR) 40, Parts 136, 141, 172, 173, 178, 179 and 261
- Method for the Determination of Volatile Petroleum Hydrocarbons (VPH) by Gas Chromatography/Photoionization Detector/Flame Ionization Detector (Gasoline), MA-VPH, revision 2.1, February 2018..
- Method for the Determination of Extractable Petroleum Hydrocarbons (EPH), MA-EPH, revision 1.1, May 2004.
- Method for Determination of Volatile Petroleum Hydrocarbons (Gasoline), IDNR Method OA-1, revision 7/27/93.
- Method for Determination of Extractable Petroleum Products (And Related Low Volatility Organic Compounds), IDNR Method OA-2, revision 7/27/93.
- Method for Determination of Extractable Petroleum Hydrocarbons by GC/FID, TN Extractable Petroleum Hydrocarbons (EPH) Method.
- Total Petroleum Hydrocarbons TNRCC Method 1005, Revision 03; Texas Natural Resource Conservation Commission, June 1, 2001.
- Methods 8020/8015 (Modified), Gasoline Range Organics (GRO), Revision 4.0, Oklahoma Department of Environmental Quality, 02/24/1996.
- Methods 8000/8100 (Modified), Diesel Range Organics (DRO); Revision 4.1; Oklahoma Department of Environmental Quality, 10/22/1997.
- Florida Residual Petroleum Organic Method (FL-PRO), Florida DOH, April 10, 1996.
- Missouri Risk-Based Corrective Action (MRBCA) Process for Petroleum Storage Tanks, Final Draft, January 2004.

The laboratory reviews updated versions to all the aforementioned references for adaptation based upon capabilities, instrumentation, etc., and implements them as appropriate. As such, the laboratory strives to perform only the latest versions of each approved method as regulations allow or require.

Other reference procedures for non-routine analyses may include methods established by specific states (e.g., Underground Storage Tank methods), ASTM or equipment manufacturers. Sample type, source, and the governing regulatory agency requiring the analysis will determine the method utilized.

The laboratory shall inform the client when a method proposed by the client may be inappropriate or out of date. After the client has been informed, and they wish to proceed contrary to the laboratory's recommendation, it will be documented.

19.4.2 Demonstration of Capability

Before the laboratory may institute a new method and begin reporting results, the laboratory shall confirm that it can properly operate the method. In general, this demonstration does not test the performance of the method in real world samples, but in an applicable and available clean matrix sample. If the method is for the testing of analytes that are not conducive to spiking, demonstration of capability may be performed on quality control samples.

A demonstration of capability (DOC, laboratory SOP PS-QAD-021) is performed whenever there is a change in instrument type (e.g., new instrumentation), matrix, method or personnel (e.g., analyst has not performed the test within the last 12 months).

Note: The laboratory shall have a DOC for all analytes included in the methods that the laboratory performs, and proficiency DOCs for each analyst shall include all analytes that the laboratory routinely performs. Addition of non-routine analytes does not require new DOCs for all analysts if those analysts are already qualified for routine analytes tested using identical chemistry and instrument conditions.

The initial demonstration of capability must be thoroughly documented and approved by the Department Manager and QA prior to independently analyzing client samples. All associated documentation must be retained in accordance with the laboratory's archiving procedures.

The laboratory must have an approved SOP, demonstrate satisfactory performance, and conduct an MDL study (when applicable). There may be other requirements as stated within the published method or regulations (e.g., retention time window study).

Note: In some instances, a situation may arise where a client requests that an unusual analyte be reported using a method where this analyte is not normally reported. If the analyte is being reported for regulatory purposes, the method must meet all procedures outlined within this QA Manual (SOP, MDL, and Demonstration of Capability). If the client states that the information is not for regulatory purposes, the result may be reported as long as the following criteria are met:

- The instrument is calibrated for the analyte to be reported using the criteria for the method and ICV/CCV criteria are met (unless an ICV/CCV is not required by the method or criteria are per project DQOs).
- The laboratory's nominal or default reporting limit (RL) is equal to the quantitation limit (QL), must be at or above the lowest non-zero standard in the calibration curve and must be reliably determined. Project RLs are client specified reporting levels which may be higher than the QL. Results reported below the QL must be qualified as estimated values. Also see Section 19.6.1.3, Relationship of Limit of Detection (LOD) to Quantitation Limit (QL).
- The client request is documented and the lab informs the client of its procedure for working with unusual compounds. The final report must be footnoted: *Reporting Limit based on the low standard of the calibration curve.*

19.4.3 Initial Demonstration of Capability (IDOC) Procedures

19.4.3.1 The spiking standard used must be prepared independently from those used in instrument calibration.

19.4.3.2 The analyte(s) shall be diluted in a volume of clean matrix sufficient to prepare four aliquots at the concentration specified by a method or the laboratory SOP.

19.4.3.3 At least four aliquots shall be prepared (including any applicable clean-up procedures) and analyzed according to the test method (either concurrently or over a period of days).

19.4.3.4 Using all of the results, calculate the mean recovery in the appropriate reporting units and the standard deviations for each parameter of interest.

19.4.3.5 When it is not possible to determine the mean and standard deviations, such as for presence, absence and logarithmic values, the laboratory will assess performance against criteria described in the Method SOP.

19.4.3.6 Compare the information obtained above to the corresponding acceptance criteria for precision and accuracy in the test method (if applicable) or in laboratory generated acceptance criteria (LCS or interim criteria) if there is no mandatory criteria established. If any one of the parameters do not meet the acceptance criteria, the performance is unacceptable for that parameter.

19.4.3.7 When one or more of the tested parameters fail at least one of the acceptance criteria, the analyst must proceed according to either option listed below:

- Locate and correct the source of the problem and repeat the test for all parameters of interest beginning with 19.4.3.3 above.
- Beginning with 19.4.3.3 above, repeat the test for all parameters that failed to meet criteria. Repeated failure, however, will confirm a general problem with the measurement system. If this occurs, locate and correct the source of the problem and repeat the test for all compounds of interest beginning with 19.4.3.1 above.

Note: Results of successive LCS analyses can be used to fulfill the DOC requirement. A certification statement (refer to Figure 19-1) shall be used to document the completion of each initial demonstration of capability. A copy of the certification is archived in the analyst's training folder.

Methods on line prior to the effective date of this Section shall be updated to the procedures outlined above as new analysts perform their demonstration of capability. A copy of the new record will replace that which was used for documentation in the past. At a minimum, the precision and accuracy of four mid-level laboratory control samples must have been compared to the laboratory's quality control acceptance limits.

19.4.3.8 For analytes/methods where no LCS is performed the department manager observes the analyst perform the test and evaluates the performance based on the lab SOP for the test. The acceptability criteria for this type of DOC are therefore subjective. By signing the certification statement (Figure 19-1) management certifies and authorizes the individual to perform the test. Eurofins Pensacola tests falling into this category include:

Volatile Solids	PS-WCD-010	PS-WCD-027
Coliforms	PS-WCD-019	
Amenable Cyanide	PS-WCD-036	
Odor	PS-WCD-006	
pH	PS-WCD-001	
Paint Filter	PS-WCD-033	
Self-Heating	PS-EXT-025	

19.5 **Laboratory Developed Methods and Non-Standard Methods**

Any new method developed by the laboratory must be fully defined in an SOP and validated by qualified personnel with adequate resources to perform the method. Method specifications and the relation to client requirements must be clearly conveyed to the client if the method is a non-standard method (not a published or routinely accepted method). The client must also be in agreement to the use of the non-standard method.

19.6 **Validation of Methods**

Validation is the confirmation by examination and the provision of objective evidence that the particular requirements for a specific intended use are fulfilled.

All non-standard methods, laboratory designed/developed methods, standard methods used outside of their scope, and major modifications to published methods must be validated to confirm they are fit for their intended use. The validation will be as extensive as necessary to meet the needs of the given application. The results are documented with the validation procedure used and contain a statement as to the fitness for use.

19.6.1 **Method Validation and Verification Activities for All New Methods**

While method validation can take various courses, the following activities can be required as part of method validation. Method validation records are designated QC records and are archived accordingly.

When changes are made to any validated methods, the influence of such changes shall be documented and, if appropriate, a new validation shall be performed.

19.6.1.1 Determination of Method Selectivity – Method selectivity is the demonstrated ability to discriminate the analyte(s) of interest from other compounds in the specific matrix or matrices from other analytes or interference. In some cases to achieve the required selectivity for an analyte, a confirmation analysis is required as part of the method.

19.6.1.2 Determination of Method Sensitivity – Sensitivity can be both estimated and demonstrated. Whether a study is required to estimate sensitivity depends on the level of method development required when applying a particular measurement system to a specific set of samples. Detection limit studies are conducted as described in Section 19.7 below. Where other protocols for estimations and/or demonstrations of sensitivity are required by regulation or client agreement, these shall be followed.

19.6.1.3 **Relationship of Limit of Detection (LOD) to the Limit of Quantitation (LOQ)**

19.6.1.4 An important characteristic of expression of sensitivity is the distinction between the LOD and the LOQ. The LOD is the minimum level at which the presence of an analyte can be reliably concluded. The LOQ is the minimum concentration of analyte that can be quantitatively determined with acceptable precision and bias, equivalent to the laboratory's routine reporting limit (RL). For most instrumental measurement systems, there is a region where semi-quantitative data is generated around the LOD (both above and below the estimated MDL or LOD) and below the LOQ. In this region, detection of an analyte may be confirmed but quantification of the analyte is unreliable within the accuracy and precision guidelines of the measurement system. When an analyte is detected below the LOQ, and the presence of the analyte is confirmed by meeting the qualitative identification criteria for the analyte, the analyte can be reliably reported, but the amount of the analyte can only be estimated. If data is to be reported in this region, it must be done so with a qualification that denotes the semi-quantitative nature of the result.

19.6.1.5 Determination of Interferences – A determination that the method is free from interferences in a blank matrix is performed.

19.6.1.6 Determination of Range – Where appropriate to the method, the quantitation range is determined by comparison of the response of an analyte in a curve to established or targeted criteria. Generally the upper quantitation limit is defined by highest acceptable calibration concentration. The lower quantitation limit or QL cannot be lower than the lowest non-zero calibration level, and can be constrained by required levels of bias and precision.

19.6.1.7 Determination of Accuracy and Precision – Accuracy and precision studies are generally performed using replicate analyses, with a resulting percent recovery and measure of reproducibility (standard deviation, relative standard deviation) calculated and measured against a set of target criteria.

19.6.1.8 Documentation of Method – The method is formally documented in an SOP. If the method is a minor modification of a standard laboratory method that is already documented in an SOP, an SOP Attachment describing the specific differences in the new method is acceptable in place of a separate SOP.

19.6.1.9 Continued Demonstration of Method Performance – Continued demonstration of method performance is addressed in the SOP. Continued demonstration of method performance is generally accomplished by batch specific QC samples such as LCS, method blanks or PT samples.

19.7 Method Detection Limits (MDL) / Limits of Detection (LOD)

The MDL is the minimum measured quantity of a substance that can be reported with 99% confidence that the concentration is distinguishable from method blank results, consistent with 40CFR Part 136 Appendix B, August, 2017. The MDL is equivalent to the TNI LOD, and is also equivalent to the DoD/DOE Quality Systems Manual (QSM) DL. The working or final MDL is the higher of the MDL value determined from spikes (MDLs) and the MDL value determined from blanks (MDLb). An initial MDL study shall be performed during the method validation process and when the method is altered in a way that can reasonably be expected to change its sensitivity. On-going data are collected during each quarter in which samples are being analyzed. At least once every 13 months the MDLs and MDLb are re-calculated and re-evaluated using data

collected during the preceding period. Details of Eurofins's procedure for conducting MDL studies are given in SOP # CA-Q-S-006).

19.8 Verification of Detection Limits

If it is found during the re-evaluation of detection limit results that more than 5% of the spiked samples do not return positive numeric results that meet all method qualitative identification criteria, then the spiking level shall be increased and the initial MDL study pre-performed at the new spiking concentration.

19.9 Instrument Detection Limits (IDL)

The IDL is sometimes used to assess the reasonableness of the MDL or in some cases required by the analytical method or program requirements. IDLs are most commonly used in metals analyses but may be useful in demonstration of instrument performance in other areas.

IDLs are calculated to determine an instrument's sensitivity independent of any preparation method. IDLs are calculated either using 7 replicate spike analyses, like MDL but without sample preparation, or by the analysis of 10 instrument blanks and calculating 3 x the absolute value of the standard deviation.

19.10 Limit of Quantitation

The LOQ shall be at a concentration equivalent to the lowest calibration standard concentration, with the exception of methods using a single-point calibration, and shall be greater than the MDL. The LOQ is verified by preparing and analyzing spikes at concentrations two times or less than the selected LOQ, employing the complete analytical process.

When the laboratory establishes a quantitation limit, it must be initially verified by the analysis of a low level standard or QC sample at 1-2 times the reporting limit and annually thereafter. The annual requirement is waived for methods that have an annually verified MDL. The laboratory will comply with any regulatory requirements.

19.11 Retention Time Windows

Most organic analyses and some inorganic analyses use chromatography techniques for qualitative and quantitative determinations. For every chromatography analysis or as specified in the reference method, each analyte will have a specific time of elution from the column to the detector. This is known as the analyte's retention time. The variance in the expected time of elution is defined as the retention time window. As the key to analyte identification in chromatography, retention time windows must be established on every column for every analyte used for that method. These records are kept on-file and available for review. Complete details are available in the laboratory SOPs.

19.12 Evaluation of Selectivity

The laboratory evaluates selectivity by following the checks within the applicable analytical methods, which include mass spectral tuning, second column confirmation, ICP interelement interference checks, chromatography retention time windows, sample blanks, spectrochemical,

atomic absorption or fluorescence profiles, co-precipitation evaluations and specific electrode response factors.

19.13 Estimation of Uncertainty of Measurement

19.13.1 Uncertainty is “a parameter associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand” (as defined by the International Vocabulary of Basic and General Terms in Metrology, ISO Geneva, 1993, ISBN 92-67-10175-1). Knowledge of the uncertainty of a measurement provides additional confidence in a result’s validity. Its value accounts for all the factors which could possibly affect the result, such as adequacy of analyte definition, sampling, matrix effects and interferences, climatic conditions, variances in weights, volumes, and standards, analytical procedure, and random variation. Some national accreditation organizations require the use of an “expanded uncertainty” defined as the range within which the value of the measurand is believed to lie within at least a 95% confidence level with the coverage factor $k=2$.

19.13.2 Uncertainty is not error. Error is a single value (i.e., the difference between the true result and the measured result). On environmental samples, the true result is never known. The measurement is the sum of the unknown true value and the unknown error. Unknown error is a combination of systematic error, or bias, and random error. Bias varies predictably, constantly, and independently from the number of measurements. Random error is unpredictable, assumed to be Gaussian in distribution, and reducible by increasing the number of measurements.

19.13.3 The minimum uncertainty associated with results generated by the laboratory can be determined by using the Laboratory Control Sample (LCS) accuracy range for a given analyte. The LCS limits are used to assess the performance of the measurement system since they take into consideration all of the laboratory variables associated with a given test over time (except for variability associated with the sampling and the variability due to matrix effects). The percent recovery of the LCS is compared either to the method-required LCS accuracy limits or to the statistical, historical, in-house LCS accuracy limits.

19.13.4 To calculate the uncertainty for the specific result reported, multiply the result by the decimal of the lower end of the LCS range percent value for the lower end of the uncertainty range, and multiply the result by the decimal of the upper end of the LCS range percent value for the upper end of the uncertainty range. These calculated values represent uncertainties at approximately the 99% confidence level with a coverage factor of $k = 3$. As an example, for a reported result of 1.0 mg/L with an LCS recovery range of 50 to 150%, the estimated uncertainty in the result would be 1.0 +/- 0.5 mg/L.

19.13.5 In the case where a well-recognized test method specifies limits to the values of major sources of uncertainty of measurement (e.g., 524.2, 525, etc.) and specifies the form of presentation of calculated results, no further discussion of uncertainty is required.

19.14 Sample Reanalysis Guidelines

Because there is a certain level of uncertainty with any analytical measurement, a sample re-preparation (where appropriate) and subsequent analysis (hereafter referred to as ‘reanalysis’) may result in either a higher or lower value from an initial sample analysis. There are also

variables that may be present (e.g., sample homogeneity, analyte precipitation over time, etc.) that may affect the results of a reanalysis. Based on the above comments, the laboratory will reanalyze samples at a client's request with the following caveats. **Client specific Contractual Terms & Conditions for reanalysis protocols may supersede the following items.**

- Homogenous samples: If a reanalysis agrees with the original result to within the RPD limits for MS/MSD or Duplicate analyses, or within ± 1 reporting limit for samples $\leq 5x$ the reporting limit, the original analysis will be reported. At the client's request, both results may be reported on the same report but not on two separate reports.
- If the reanalysis does not agree (as defined above) with the original result, then the laboratory will investigate the discrepancy and reanalyze the sample a third time for confirmation if sufficient sample is available.
- Any potential charges related to reanalysis are discussed in the contract terms and conditions or discussed at the time of the request. The client will typically be charged for reanalysis unless it is determined that the lab was in error.
- Due to the potential for increased variability, reanalysis may not be applicable to Non-homogenous, Encore, and Sodium Bisulfate preserved samples. See the Area Supervisor or Laboratory Director if unsure.

19.15 Control of Data

The laboratory has policies and procedures in place to ensure the authenticity, integrity, and accuracy of the analytical data generated by the laboratory.

19.15.1 Computer and Electronic Data Related Requirements

The three basic objectives of our computer security procedures and policies are shown below. The laboratory is currently using the Eurofins TALS, which has been highly customized to meet the needs of the laboratory. It is referred to as the TALS for the remainder of this section. More detailed descriptions of computer systems and associated controls given in the "IT Change Control Procedure Manual" (CW-I-M-001) policies and procedures posted on Eurofins's intranet site, Oasis.

19.15.1.1 Maintain the Database Integrity – Assurance that data is reliable and accurate through data verification (review) procedures, password-protecting access, anti-virus protection, data change requirements, as well as an internal LIMS permissions procedure.

- LIMS Database Integrity is achieved through data input validation, internal user controls, documentation of system failures and corrective actions taken, and data change requirements.
- Spreadsheets and other software developed in-house must be verified with documentation through hand calculations prior to use. Cells containing calculations must be lock-protected and controlled.
- Instrument hardware and software adjustments are safeguarded through maintenance logs, audit trails and controlled access.

19.15.1.2 Ensure Information Availability – Protection against loss of information or service is ensured through scheduled back-ups, stable file server network architecture, secure storage of media, line filter, Uninterruptible Power Supply (UPS), and maintaining older versions of software as revisions are implemented.

19.15.1.3 Maintain Confidentiality – Ensure data confidentiality through physical access controls such as password protection or website access approval when electronically transmitting data.

19.15.2 Data Reduction

The complexity of the data reduction depends on the analytical method and the number of discrete operations involved (e.g., extractions, dilutions, instrument readings and concentrations). The analyst calculates the final results from the raw data or uses appropriate computer programs to assist in the calculation of final reportable values.

For manual data entry, e.g., Wet Chemistry, the data is reduced by the analyst and then verified by the Department Manager or alternate analyst prior to updating the data in the TALS. The spreadsheets, or any other type of applicable documents, are signed by both the analyst and alternate reviewer to confirm the accuracy of the manual entry(s).

Manual integration of peaks will be documented and reviewed and the raw data will be flagged in accordance with the Eurofins Corporate SOP No. CA-Q-S-002, *Acceptable Manual Integration Practices*.

Analytical results are reduced to appropriate concentration units specified by the analytical method, taking into account factors such as dilution, sample weight or volume, etc. Blank correction will be applied only when required by the method or per manufacturer's indication; otherwise, it should not be performed. Calculations are independently verified by appropriate laboratory staff. Calculations and data reduction steps for various methods are summarized in the respective analytical SOPs or program requirements.

19.15.2.1 All raw data must be retained in the worklist folder, computer file (if appropriate), and/or runlog. All criteria pertinent to the method must be recorded. The documentation is recorded at the time observations or calculations are made and must be signed or initialed/dated (month/day/year). It must be easily identifiable who performed which tasks if multiple people were involved.

19.15.2.2 In general, concentration results are reported in milligrams per liter (mg/l) or micrograms per liter (µg/l) for liquids and milligrams per kilogram (mg/kg) or micrograms per kilogram (µg/kg) for solids. For values greater than 10,000 mg/l, results can be reported in percent, i.e., 10,000 mg/l = 1%. Units are defined in each lab SOP.

19.15.2.3 In reporting, the analyst or the instrument output records the raw data result using values of known certainty plus one uncertain digit. If final calculations are performed external to TALS, the results should be entered in TALS with at least three significant figures. In general, results are reported to 2 significant figures on the final report.

19.15.2.4 For those methods that do not have an instrument printout or an instrumental output compatible with the TALS, the raw results and dilution factors are entered directly into the TALS by the analyst, and the software calculates the final result for the analytical report. The TALS has a defined significant figure criterion for each analyte.

19.15.2.5 The laboratory strives to import data directly from instruments or calculation spreadsheets to ensure that the reported data are free from transcription and calculation errors. For those analyses with an instrumental output compatible with the TALS, the raw results and dilution factors are transferred into the TALS electronically after reviewing the quantitation report, and removing unrequested or poor spectrally-matched compounds. Raw data reports, calibration information etc. for non-chrom instruments is retained with the data file. The data file is stored in a monthly folder on the instrument computer; periodically, this file is transferred to the server and automatically backed-up to the data centers in Denver and Houston.

19.15.3 Logbook / Worksheet Use Guidelines

Logbooks and worksheets are filled out 'real time' and have enough information on them to trace the events of the applicable analysis/task. (e.g. calibrations, standards, analyst, sample ID, date, time on short holding time tests, temperatures when applicable, calculations are traceable, etc.)

- Corrections are made following the procedures outlined in Section 12.
- Logbooks are controlled by the QA department. A record is maintained of all logbooks in the lab.
- Unused portions of pages must be "Z"ed out, signed and dated.
- Worksheets are created with the approval of the Department Manager/QA Manager at the facility. The QA Manager controls all worksheets following the procedures in Section 6.

19.15.4 Review / Verification Procedures

Review procedures are outlined in SOPs PS-CSD-007 (Log In Review and Final Job Approval) and SOP PS-LAB-022 (Data Generation, Review, Approval, and Reporting) to ensure that reported data are free from calculation and transcription errors, that QC parameters have been reviewed and evaluated before data is reported. The general review concepts are discussed below, more specific information can be found in the SOPs.

19.15.4.1 Log-In Review - The data review process starts at the sample receipt stage. Sample control personnel review chain-of-custody forms and project instructions from the project management group. This is the basis of the sample information and analytical instructions entered into the TALS. The log-in instructions are reviewed by the personnel entering the information, and a second level review is conducted by the project management staff.

19.15.4.2 First Level Data Review - The next level of data review occurs with the analysts. As data are generated, analysts review their work to ensure that the results meet project and SOP requirements. First level reviews include inspection of all raw data (e.g., instrument output for continuous analyzers, chromatograms, spectra, and manual integrations), evaluation of calibration/calibration verification data in the day's analytical run, evaluation of QC data, and reliability of sample results. The analyst transfers data into the TALS, data qualifiers are added as needed. All first level reviews are documented.

19.15.4.3 Second Level Data Review – All analytical data are subject to review by a second qualified analyst or supervisor. Second level reviews include inspection of all raw data (e.g., instrument output, chromatograms, and spectra) including 100% of data associated with any changes made by the primary analyst, such as manual integrations or reassignment of peaks to different analytes, or elimination of false negative analytes. The second review also includes evaluation of initial calibration/calibration verification data in the day's analytical run, evaluation of QC data, reliability of sample results, qualifiers and NCM narratives. Manual calculations are checked in second level review. All second level reviews are documented.

Issues that deem further review include the following:

- QC data are outside the specified control limits for accuracy and precision
- Reviewed sample data does not match with reported results
- Unusual detection limit changes are observed
- Samples having unusually high results
- Samples exceeding a known regulatory limit
- Raw data indicating some type of contamination or poor technique
- Inconsistent peak integration
- Transcription errors
- Results outside of calibration range

19.15.4.4 Unacceptable analytical results may require reanalysis of the samples. Any problems are brought to the attention of the Laboratory Director, Project Manager, Quality Director/Manager, Technical Manager, or Supervisor for further investigation. Corrective action is initiated whenever necessary.

19.15.4.5 The results are then entered or directly transferred into the computer database and a hard copy (or .pdf) is printed for the client.

19.15.4.6 As a final review prior to the release of the report, the Project Manager reviews the results for appropriateness and completeness. This review and approval ensures that client requirements have been met and that the final report has been properly completed. The process includes, but is not limited to, verifying that the COC is followed, cover letters / narratives are present, flags are appropriate, and project specific requirements are met. The Project Manager may also evaluate the validity of results for different test methods given expected chemical relationships.

19.15.4.7 Any project that requires a data package is subject to a tertiary data review for transcription errors and acceptable quality control requirements. The Project Manager then signs the final report. The accounting personnel also check the report for any clerical or invoicing errors. When complete, the report is sent out to the client.

19.15.4.8 A visual summary of the flow of samples and information through the laboratory, as well as data review and validation, is presented in Figure 19-2.

19.15.5 Manual Integrations

Computerized data systems provide the analyst with the ability to re-integrate raw instrument data in order to optimize the interpretation of the data. Though manual integration of data is an

invaluable tool for resolving variations in instrument performance and some sample matrix problems, when used improperly, this technique would make unacceptable data appear to meet quality control acceptance limits. Improper re-integrations lead to legally indefensible data, a poor reputation, or possible laboratory decertification. Because guidelines for re-integration of data are not provided in the methods and most methods were written prior to widespread implementation of computerized data systems, the laboratory trains all analytical staff on proper manual integration techniques using Eurofins's Corporate SOP (CA-Q-S-002).

19.15.5.1 The analyst must adjust baseline or the area of a peak in some situations, for example when two compounds are not adequately resolved or when a peak shoulder needs to be separated from the peak of interest. The analyst must use professional judgment to determine when manual integrating is required. Analysts are encouraged to ask for assistance from a senior analyst or manager when in doubt.

19.15.5.2 Analysts shall not increase or decrease peak areas for the sole purpose of achieving acceptable QC recoveries that would have otherwise been unacceptable. The intentional recording or reporting of incorrect information (or the intentional omission of correct information) is against company principles and policy and is grounds for immediate termination.

19.15.5.3 Client samples, performance evaluation samples, and quality control samples are all treated equally when determining whether or not a peak area or baseline should be manually adjusted.

19.15.5.4 All manual integrations receive a second level review. Manual integrations must be indicated on an expanded scale "before" and "after" chromatograms such that the integration performed can be easily evaluated during data review. Expanded scale "before" chromatograms are also required for all manual integrations on QC parameters (calibrations, calibration verifications, laboratory control samples, internal standards, surrogates, etc.) unless the laboratory has another documented corporate approved procedure in place that can demonstrate an active process for detection and deterrence of improper integration practices.

Figure 19-1. Example - Demonstration of Capability Documentation



**Environment Testing
TestAmerica**

Eurofins TestAmerica, Pensacola

PS-QA-FM-017, Rev. 1
Effective Date: 12/29/2020
Page 1 of 1

Demonstration of Capability Certification Statement

Date: _____

Department: _____

Employee: _____

SOP(s):	Rev.:	Method (s):	Matrix:

We the undersigned CERTIFY that:

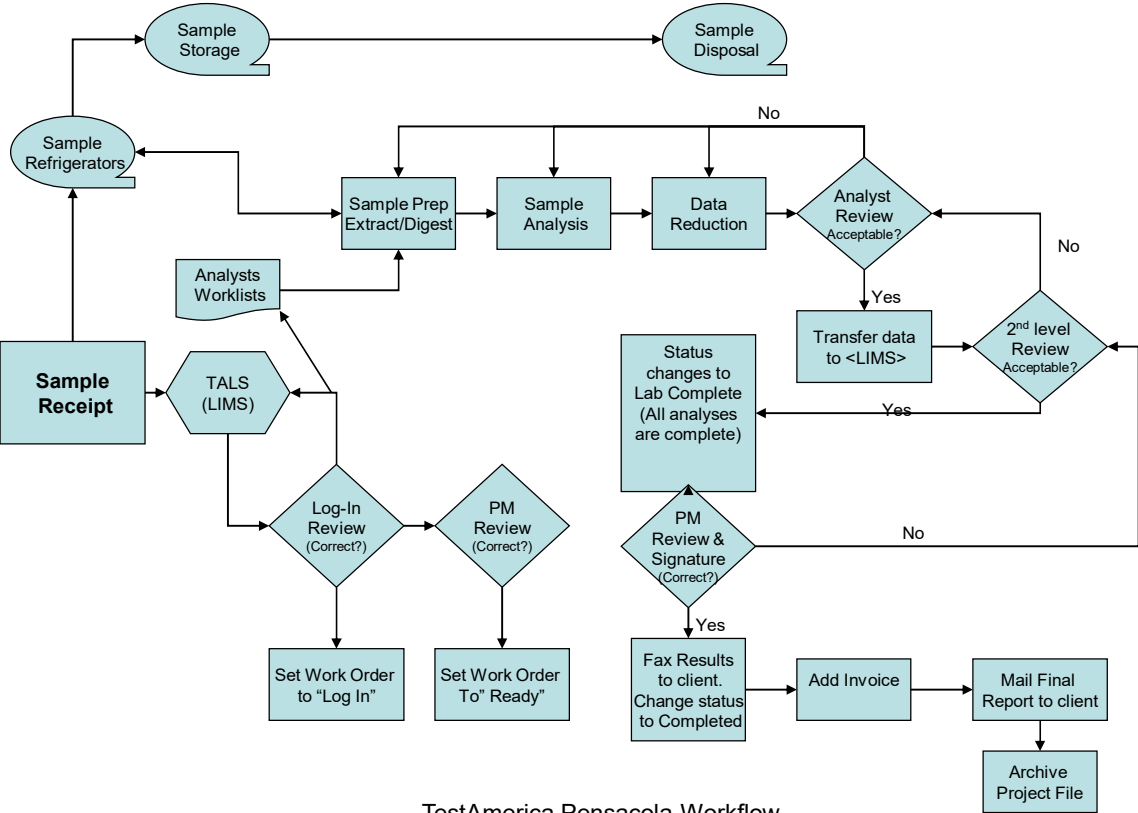
- The employee identified above, using the cited SOP(s) has demonstrated competency in the performance of the tasks outlined therein.
- The supervisor/manager of the department has observed this performance and documents authorization by signing this document.
- The employee has read and understands the SOPs listed above, and agrees to perform the procedures accordingly; or request a revision of the SOP where appropriate.

Employee (print)	Signature	Date
Supervisor/Senior Tech Name (print)	Signature	Date
QA Review Name (Print)	Signature	Date

Company Confidential & Proprietary

Company Confidential & Proprietary

Figure 19-2. Example: Work Flow



TestAmerica Pensacola Workflow

SECTION 20. EQUIPMENT and CALIBRATIONS

20.1 Overview

The laboratory purchases the most technically advanced analytical instrumentation for sample analyses. Instrumentation is purchased on the basis of accuracy, dependability, efficiency and sensitivity. Each laboratory is furnished with all items of sampling, preparation, analytical testing and measurement equipment necessary to correctly perform the tests for which the laboratory has capabilities. Each piece of equipment is capable of achieving the required accuracy and complies with specifications relevant to the method being performed. Before being placed into use, the equipment (including sampling equipment) is calibrated and checked to establish that it meets its intended specification. The calibration routines for analytical instruments establish the range of quantitation. Calibration procedures are specified in laboratory method SOPs. A list of laboratory instrumentation is presented in Table 20-1.

Equipment is only operated by authorized and trained personnel. Manufacturer's instructions for equipment use are readily accessible to all appropriate laboratory personnel.

20.2 Preventive Maintenance

The laboratory follows a well-defined maintenance program to ensure proper equipment operation and to prevent the failure of laboratory equipment or instrumentation during use. This program of preventive maintenance helps to avoid delays due to instrument failure.

Routine preventive maintenance procedures and frequency, such as cleaning and replacements, should be performed according to the procedures outlined in the manufacturer's manual. Qualified personnel must also perform maintenance when there is evidence of degradation of peak resolution, a shift in the calibration curve, loss of sensitivity, or failure to continually meet one of the quality control criteria.

Table 20-2 lists examples of scheduled routine maintenance. It is the responsibility of each Department Manager to ensure that instrument maintenance logs are kept for all equipment in his/her department. Preventative maintenance procedures are also outlined in analytical SOPs or instrument manuals. (Note: for some equipment, the log used to monitor performance is also the maintenance log. Multiple pieces of equipment may share the same log as long as it is clear as to which instrument is associated with an entry.)

Instrument maintenance logs are controlled and are used to document instrument problems, instrument repair and maintenance activities. Maintenance logs shall be kept for all major pieces of equipment. Instrument maintenance logs may also be used to specify instrument parameters.

- Documentation must include all major maintenance activities such as contracted preventive maintenance and service and in-house activities such as the replacement of electrical components, lamps, tubing, valves, columns, detectors, cleaning and adjustments.
- Each entry in the instrument log includes the analyst's initials, the date, a detailed description of the problem (or maintenance needed/scheduled), a detailed explanation of the solution or maintenance performed, and a verification that the equipment is functioning properly (state what was used to determine a return to control. e.g. CCV run on 'date' was acceptable, or

instrument recalibrated on 'date' with acceptable verification, etc.) must also be documented in the instrument records.

- When maintenance or repair is performed by an outside agency, service receipts detailing the service performed can be affixed into the logbooks adjacent to pages describing the maintenance performed. This stapled in page must be signed across the page entered and the logbook so that it is clear that a page is missing if only half a signature is found in the logbook.

If an instrument requires repair (subjected to overloading or mishandling), gives suspect results, or otherwise has shown to be defective or outside of specified limits it shall be taken out of operation and tagged as out-of-service or otherwise isolated until such a time as the repairs have been made and the instrument can be demonstrated as operational by calibration and/or verification or other test to demonstrate acceptable performance. The laboratory shall examine the effect of this defect on previous analyses.

In the event of equipment malfunction that cannot be resolved, service shall be obtained from the instrument vendor manufacturer, or qualified service technician, if such a service can be tendered. If on-site service is unavailable, arrangements shall be made to have the instrument shipped back to the manufacturer for repair. Back up instruments, which have been approved, for the analysis shall perform the analysis normally carried out by the malfunctioning instrument. If the back-up is not available and the analysis cannot be carried out within the needed timeframe, the samples shall be subcontracted.

At a minimum, if an instrument is sent out for service or transferred to another facility, it must be recalibrated and the laboratory MDL verified (using an MDLV) prior to return to lab operations.

20.3 Support Equipment

This section applies to all devices that may not be the actual test instrument, but are necessary to support laboratory operations. These include but are not limited to: balances, ovens, refrigerators, freezers, incubators, water baths, field sampling devices, temperature measuring devices, thermal/pressure sample preparation devices and volumetric dispensing devices if quantitative results are dependent on their accuracy, as in standard preparation and dispensing or dilution into a specified volume. All raw data records associated with the support equipment are retained to document instrument performance.

20.3.1 Weights and Balances

The accuracy of the balances used in the laboratory is checked every working day, before use. All balances are placed on stable counter tops.

Each balance is checked prior to initial serviceable use with at least two certified ASTM type 1 weights spanning its range of use (weights that have been calibrated to ASTM type 1 weights may also be used for daily verification). ASTM type 1 weights used only for calibration of other weights (and no other purpose) are inspected for corrosion, damage or nicks at least annually and if no damage is observed, they are calibrated at least every 5 years by an outside calibration laboratory. Any weights (including ASTM Type 1) used for daily balance checks or other purposes are recalibrated/recertified annually to NIST standards (this may be done internally if laboratory maintains "calibration only" ASTM type 1 weights).

All balances are serviced annually by a qualified service representative, who supplies the laboratory with a certificate that identifies traceability of the calibration to the NIST standards.

All of this information is recorded in logs, and the recalibration/recertification certificates are kept on file. Refer to SOP PS-QAD-016 for further information.

20.3.2 pH, Conductivity, and Turbidity Meters

The pH meters used in the laboratory are accurate to ± 0.1 pH units, and have a scale readability of at least 0.05 pH units. The meters automatically compensate for the temperature, and are calibrated with at least two working range buffer solutions before each use.

Conductivity meters are also calibrated before each use with a known standard to demonstrate the meters do not exceed an error of 1% or one umhos/cm.

Turbidity meters are also calibrated before each use. All of this information is documented in logs.

Consult pH, Conductivity, and Turbidity SOPs for further information.

20.3.3 Thermometers

All thermometers are calibrated on an annual basis with a NIST-traceable thermometer.

- If the temperature measuring device is used over a range of 10°C or less, then a single point verification within the range of use is acceptable;
- If the temperature measuring device is used over a range of greater than 10°C, then the verification must bracket the range of use.

IR thermometers, digital probes and thermocouples are calibrated quarterly. IR Thermometers should be calibrated over the full range of use, including ambient, iced (4°C) and frozen (0°C to -5°C), per the Drinking Water Manual.

The thermocouple NIST thermometer is replaced upon the expiration of the current calibration (unless thermometer has been exposed to temperature extremes or apparent separation of internal liquid) and the new certificate of traceability is kept on file. The NIST thermometer(s) have increments of 1 degree (0.5 degree or less increments are required for drinking water microbiological laboratories), and have ranges applicable to method and certification requirements. The NIST traceable thermometer is used for no other purpose than to calibrate other thermometers.

Monitoring method-specific temperatures, including incubators, heating blocks, water baths, and ovens, is documented on posted recording sheets which are turned in to QA daily or recorded directly in the batch information section in TALs. More information on this subject can be found in the PS-QAD-014 Thermometers and Temperature Control.

20.3.4 Refrigerators/Freezer Units, Water baths, Ovens and Incubators

The temperatures of all refrigerator units and freezers used for sample and standard storage are monitored each working day.

Ovens, water baths and incubators are monitored on days of use.

All of this equipment has a unique identification number, and is assigned a thermometer for monitoring.

Sample storage refrigerator temperatures are kept between $> 0^{\circ}\text{C}$ and $\leq 6^{\circ}\text{C}$.

Specific temperature settings/ranges for other refrigerators, ovens, water baths, and incubators can be found in method specific SOPs.

All of this information is documented in daily thermometer checklists.

20.3.5 Autopipettors, Dilutors, and Syringes

Mechanical volumetric dispensing devices including burettes (except Class A Glassware and glass microliter syringes) are given unique identification numbers and the delivery volumes are verified gravimetrically, at a minimum, on a quarterly basis. and have ranges applicable to method and certification requirements. Glass micro-syringes are considered the same as Class A glassware, however are verified semiannually. If glass micro-syringes are ordered without certificates of acceptance, they are verified by a one point calibration verification prior to use

For those dispensers that are not used for analytical measurements, a label is applied to the device stating that it is not calibrated. Any device not regularly verified can not be used for any quantitative measurements. Refer to laboratory SOP PS-LAB-011 (Pipette, Syringe, Dispenser, and Digital Burette Calibration and Verification).

Micro-syringes are purchased from Hamilton Company. Each syringe is uniquely identified and an initial calibration check is performed prior to use. Calibrations or replacements are performed semiannually thereafter.

20.3.6 Autoclaves

Autoclaves are checked quarterly for length of sterilization cycle and pressure maintained. This information is recorded in the Microbiology QC logbook. The instrument is cleaned on a monthly basis. Each day of use the temperature and pressure are recorded.

20.4 Instrument Calibrations

Calibration of analytical instrumentation is essential to the production of quality data. Strict calibration procedures are followed for each method. These procedures are designed to determine and document the method detection limits, the working range of the analytical instrumentation and any fluctuations that may occur from day to day.

Sufficient raw data records are retained to allow an outside party to reconstruct all facets of the initial calibration. Records contain, but are not limited to, the following: calibration date, method, instrument, analyst(s) initials or signatures, analysis date, analytes, concentration, response, and type of calibration (Avg RF, curve, or other calculations that may be used to reduce instrument responses to concentration.)

Sample results must be quantitated from the initial calibration and may not be quantitated from any continuing instrument calibration verification unless otherwise required by regulation, method or program.

If the initial calibration results are outside of the acceptance criteria, corrective action is performed and any affected samples are reanalyzed if possible. If the reanalysis is not possible, any data associated with an unacceptable initial calibration will be reported with appropriate data qualifiers (refer to Section 12).

Note: Instruments are calibrated initially and as needed after that and at least.

20.4.1 Calibration Standards

Calibration standards are prepared using the procedures indicated in the Reagents and Standards section of the determinative method SOP. If a reference method does not specify the number of calibration standards, a minimum of 3 calibration points will be used.

Standards for instrument calibration are obtained from a variety of sources. All standards are traceable to national or international standards of measurement, or to national or international standard reference materials.

The lowest concentration calibration standard that is analyzed during an initial calibration must be at or below the stated reporting limit for the method based on the final volume of extract (or sample).

The other concentrations define the working range of the instrument/method or correspond to the expected range of concentrations found in actual samples that are also within the working range of the instrument/method. Results of samples not bracketed by initial instrument calibration standards (within calibration range to at least the same number of significant figures used to report the data) must be reported as having less certainty, e.g., defined qualifiers or flags (additional information may be included in the case narrative). The exceptions to these rules. ICP and ICPMS methods which define the working range with periodic linear dynamic range studies, rather than through the range of concentrations of daily calibration standards.

All initial calibrations are verified with a standard obtained from a second source and traceable to a national standard, when available (or vendor certified different lot if a second source is not available). For unique situations, such as air analysis where no other source or lot is available, a standard made by a different analyst at a different time or a different preparation would be considered a second source. This verification occurs immediately after the calibration curve has been analyzed, and before the analysis of any samples.

20.4.1.1 Calibration Verification

The calibration relationship established during the initial calibration must be verified initially and at least daily as specified in the laboratory method SOPs in accordance with the referenced analytical methods and in the 2009 and 2016 TNI Standards. The process of calibration verification applies to both external standard and internal standard calibration techniques, as well as to linear and non-linear calibration models. Initial calibration verification (ICV) is with a standard source secondary (second source standard) to the calibration standards, but continuing calibration verifications (CCV) may use the same source standards as the calibration curve.

Note: The process of calibration verification referred to here is fundamentally different from the approach called "calibration" in some methods. As described in those methods, the calibration factors or response factors calculated during calibration are used to update the calibration factors or response factors used for sample quantitation. This approach, while employed in other EPA programs, amounts to a daily single-point calibration.

All target analytes and surrogates, including those reported as non-detects, must be included in periodic calibration verifications for purposes of retention time confirmation and to demonstrate that calibration verification criteria are being met, i.e., RPD, per 2009 TNI Std. EL-V1M4 Sec. 1.7.2 and 2016 TNI Std. EL-V1M4, Sec. 1.7.1.

All samples must be bracketed by periodic analyses of standards that meet the QC acceptance criteria (e.g., calibration and retention time). The frequency is found in the determinative methods or SOPs.

Note: If an internal standard calibration is being used then bracketing calibration verification standards are not required, only daily verifications are needed. The results from these verification standards must meet the calibration verification criteria and the retention time criteria (if applicable).

Generally, the calibrations must be verified by an ICV analyzed immediately following initial calibration and before sample analysis. The ICV may be used as the first bracketing CCV, if criteria for both are met.

A continuing instrument calibration verification (CCV) is generally analyzed at the beginning of each 12-hour analytical shift during which samples are analyzed. The 12-hour analytical shift begins with the injection of the calibration verification standard (or the MS tuning standard in MS methods). The shift ends after the completion of the analysis of the last sample, QC, or standard that can be injected within 12-hours of the beginning of the shift. For methods that have quantitation by external calibration models, a CCV is analyzed at the end of each analytical sequence. Some methods have more frequent CCV requirements. See specific SOPs. Most inorganic methods require the CCV to be analyzed after every 10 samples or injections, including matrix or batch QC samples.

Note: If an internal standard calibration is being used (e.g., GCMS) then bracketing standards are not required, only daily verifications are needed, except as specified by program or method requirements.

If the results of a CCV are outside the established acceptance criteria and analysis of a second consecutive (and immediate) CCV fails to produce results within acceptance criteria, corrective action shall be performed. Once corrective actions have been completed and documented, the laboratory shall demonstrate acceptable instrument / method performance by analyzing two consecutive CCVs, or a new initial instrument calibration shall be performed.

Sample analyses and reporting of data may not occur or continue until the analytical system is calibrated or calibration verified. However, data associated with an unacceptable calibration verification may be fully useable reported based upon discussion and approval of the client under the following special conditions:

- a). when the acceptance criteria for the CCV are exceeded high (i.e., high bias) and the associated samples within the batch are non-detects, then those non-detects may be reported ~~with a footnote or~~ case narrative comment explaining the high bias. Otherwise the samples affected by the unacceptable CCV shall be re-analyzed after a new calibration curve has been established, evaluated and accepted; or
- b). when the acceptance criteria for the CCV are exceeded low (i.e., low bias), those sample results may be reported if they exceed a maximum regulatory limit/decision level. Otherwise the samples affected by the unacceptable CCV shall be re-analyzed after a new calibration curve has been established, evaluated and accepted.

Samples reported by the 2 conditions identified above will be appropriately flagged.

20.4.1.2 Verification of Linear and Non-Linear Calibrations

Calibration verification for calibrations involves the calculation of the percent drift or the percent difference of the instrument response between the initial calibration and each subsequent analysis of the verification standard. (These calculations are available in the laboratory method SOPs.) Verification standards are evaluated based on the % Difference from the average CF or RF of the initial calibration or based on % Drift or % Recovery if a linear or quadratic curve is used.

Regardless of whether a linear or non-linear calibration model is used, if initial verification criterion is not met, then no sample analyses may take place until the calibration has been verified or a new initial calibration is performed that meets the specifications listed in the method SOPs. If the calibration cannot be verified after the analysis of a single verification standard, then adjust the instrument operating conditions and/or perform instrument maintenance, and analyze another aliquot of the verification standard. If the calibration cannot be verified with the second standard, then a new initial calibration is performed.

- When the acceptance criteria for the calibration verification are exceeded high, i.e., high bias, and there are associated samples that are non-detects, then those non-detects may be reported. Otherwise, the samples affected by the unacceptable calibration verification shall be reanalyzed after a new calibration curve has been established, evaluated and accepted.
- When the acceptance criteria for the calibration verification are exceeded low, i.e., low bias, those sample results may be reported if they exceed a maximum regulatory limit/decision level. Otherwise, the samples affected by the unacceptable verification shall be reanalyzed

after a new calibration curve has been established, evaluated and accepted. Alternatively, a reporting limit standard may be analyzed to demonstrate that the laboratory can still support non-detects at their reporting limit.

20.5 Tentatively Identified Compounds (TICs) – GC/MS Analysis

For samples containing components not associated with the calibration standards, a library search may be made for the purpose of tentative identification. The necessity to perform this type of identification will be determined by the purpose of the analyses being conducted. For example, the RCRA permit or waste delisting requirements may require the reporting of non-target analytes. Only after visual comparison of sample spectra with the nearest library searches may the analyst assign a tentative identification. Data system library search routines should not use normalization routines that would misrepresent the library or unknown spectra when compared to each other. Further details are given in policy memorandum CA-Q-QM-001, Policy on Tentatively Identified Compounds (TICs) – GC/MS Analysis.

Note: If the TIC compound is not part of the client target analyte list but is calibrated by the laboratory and is both qualitatively and/or quantitatively identifiable, it should not be reported as a TIC. If the compound is reported on the same form as true TICs, it should be qualified and/or narrated that the reported compound is qualitatively and quantitatively (if verification in control) reported compared to a known standard that is in control (where applicable).

20.6 GC/MS Tuning

Prior to any GC/MS analytical sequence, including calibration, the instrument parameters for the tune and subsequent sample analyses within that sequence must be set.

Prior to tuning/auto-tuning the mass spectrometer, the parameters may be adjusted within the specifications set by the manufacturer or the analytical method. These generally do not need any adjustment but it may be required based on the current instrument performance. If the tune verification does not pass it may be necessary to clean the source or perform additional maintenance. Any maintenance is documented in the maintenance log.

Table 20-1. Instrumentation List

Equipment/ Instrument	Manufacturer	Model Number	Serial Number	Year Put into Service	Condition When Received
Centrifuge	IEC	HN-SII	235519029		
Refrigerator	Fisher Scientific	ISOTEMP 97-938-1	119139101100601	2010	New
Extraction System	Gerhardt	SoxTherm 6 Place	4041166		New
Controller	Gehardt	Multistat	4041164	2005	New
Evaporator	Horizon	SPEEDVAP III	10-0773		
Evaporator	Horizon	SPEEDVAP III	04-2016		
Water Bath	Biotage	TURBOVAP II	TV1202N16934		
Water Bath	Caliper Life Sciences	TURBOVAP II	TV1031N16014		
Water Bath	Caliper Life Sciences	TURBOVAP II			
Water Bath	Caliper Life Sciences	TURBOVAP II	TV1030N15999		

Equipment/ Instrument	Manufacturer	Model Number	Serial Number	Year Put into Service	Condition When Received
Water Bath	Caliper Life Sciences	TURBOVAP II	TV1030N15994		
Meter	Thermo Electronics Corp	Orion 310	017542	2005	New
Oven	Quincy Lab	30GC	G3-011442		
Oven	Blue M Electric Co.	OV-12A	OV1-10209		
Refrigerator	True Mfg., Co.	T-23	695730	1999	Used
Balance	Denver	S-602	23350123		
Balance	Denver	P-214	P214118007		
Balance	Mettler	PJ 3600	H78985	1999	Used
Balance	Sartorius	B3100S	40030076		
Balance	Denver	S-602	23350126	1994	New
Water Bath	Sheldon	1245PC	10011600		
Hot Plate/Stirrer	Corning	PC-310			
Hot Plate/Stirrer	Corning	PC-310			
Hot Plate/Stirrer	Corning	PC-310			
Hot Plate/Stirrer	Corning	PC-310			
Hot Plate/Stirrer	Corning	PC-310			
Hot Plate/Stirrer	Corning	PC-310			
Hot Plate/Stirrer	Corning	PC-310			
Hot Plate/Stirrer	Corning	PC-310			
Bath	Koehler	K23371-00000	R2039046I		
Shaker Table	Eberbach				
Shaker Table	Eberbach				
Shaker Table	Scilogex	SK-330-Pro	SC1000251		
Heating Mantles	Electrothermal Unimantle	UM1000 EX1			
Microwave Ext. System	Milestone	Ethos Ex	133829		
Microwave Ext. System	Milestone	Ethos Ex	133827		
Tumbler	Lars Lande Mfg Inc.				
Tumbler	Lars Lande Mfg Inc.				
Tumbler					
Tumbler					
Sonic Disruptor	Sonics & Materials	VC600-2	16598F		
Meter	Orion	250A	1038	1991	New
Meter	Orion	250A	302	1996	New
Water Level Indicator	Solinist		19018	1996	New
Meter	YSI	30	99F0005	1999	New
Meter	YSI	55	99J0723	1999	New
Probe	Slope Indicator		7580	1994	New
Pump	Master Flex			1991	
Sampler	America Signa		06891-081	1990	
Sampler	America Signa		08855-162	1998	
Air Pack	Scott		01316-0001	1995	
Generator	Honda	EZ5000	AKM0515	1999	
Water Analyzer	Micropurge	MP20DT	MP20DT-1252	2003	New
Water Analyzer	Micropurge	MP10	MP20DT-1241	2003	New
Water Analyzer	Micropurge	MP-SPK-4P	MP10-1493	2003	New
Water Analyzer	Micropurge	MP-SPK-4P	MP10-1494	2003	New

Equipment/ Instrument	Manufacturer	Model Number	Serial Number	Year Put into Service	Condition When Received
Level Meter, 150 FT	Micropurge	MOCEL MP30	MP30-1244	2003	New
Level Meter, 300 FT	Micropurge	MOCEL MP30	MP30-1231	2003	New
Micropurge Generator	Micropurge	MP40	11020006	2003	New
Micropurge Generator	Micropurge	MP40	11020019	2003	New
Autotitrator	Mantech	PC-1040-00	MS-0K4-216		
Autotitrator Rinse	Mantech	PC-1000-400	MS-0A5-229		
Autotitrator Rinse	Mantech	PC-1000-408	MS-0C3-555		
COD Reactor	Bioscience, Inc.	100 003	COD-B0261		New
COD Reactor	Bioscience, Inc.	100 003	COD-B0194	2009	New
Flashpoint Detector	Pensky-Martin	APM-7	23241		
Flow Injection Analyzer	Lachat	QuikChem 8000	110200001305		
Reagent Pump	Lachat	15M1135	1530880		
Autosampler	Lachat	ASX-520	100200001931		
Flow Injection Analyzer	Lachat	QuikChem 8000	100200001166		
Reagent Pump	Lachat	15M1135	0611501-1		
Autosampler	Lachat	ASX-520	110100002082		
Water Analyzer	Thermo Scientific	Konelab 9027500	S3319254	2003	New
Distillation Unit	Wilmaad-LabGlass	Midi-Stil			
Block Digester	Lachat	BD-40			
Block Digester	Lachat	BD-40			
UV Spectrophotometer	Genesys	10S Vis	2D9P301001	2014	
Spectrophotometer	Hach	DR 2000	940900031406	1994	New
Spectrophotometer	Hach	DR 2800	1343165		
Turbidimeter	Hach	2100P	001100026944		
Turbidimeter	LaMotte	2020	3357-2502	1999	New
TOC Analyzer	Shimadzu	TOC-V-CPN	H51404435039	2006	New
Autosampler	Shimadzu	ASI-V	H52104301752	2006	New
TOC Analyzer	Shimadzu	TOC-V-CPH	H51314800321AG		New
Incubator	VWR	285PC	100394	1993	
Incubator	VWR	1545	1104103	2004	New
Incubator	Fisher Scientific	Thermo 3721	317564-1394	2010	New
Oven	Fisher-Scientific	650G	904N0067	2016	New
Oven	Quincy Lab	30GC	G3-10355	2015	New
Oven	Quincy Lab	40E	A43-00305	2016	New
Meter	Fisher	Traceable	B12135	1999	Used
Meter	YSI	3100-115V	13D 100733		
Stirrer	Fisher Scientific	11-500-75H	771940790583		
Stirrer	Tremolyme	Cimarec2	1069970592419		
Meter	YSI	5100	06G 2334		
Meter Rinse	Mantech	PC-1000-416	MS-0G6-146		
Meter Rinse	Mantech	PC-1000-408	MS-0H6-296		
Meter	YSI	5100	067 1605		
Meter Rinse	Mantech	PC-1000-416	MS-0M6-150		
Meter Rinse	Mantech	PC-1000-408	MS-0H1-140		
Hot Plate/Stirrer	Fisher	Thermix 120MR	101		
Shaker Table	Eberbach			1990	

Equipment/ Instrument	Manufacturer	Model Number	Serial Number	Year Put into Service	Condition When Received
Refrigerator	Marvel	61RF	M/121691041		
Refrigerator	True Mfg., Co.	T-72 - AK9441A	1047770		
Sterilizer	tuttnauer Brinkman	3545M	2911989		
Balance	Denver	P-602	P602016005	2006	New
Hot Plate/Stirrer	Corning	PC-310			
Stirrer	Thermolyne	Cimarec2	638901000000		
Balance	Denver	P-214	P214066013		
Balance	America Weigh Scales	PN-210B	40050012		
Incubator	True Mfg., Co.	T-49	690734		
Incubator	Frigidaire	LFH2067DW3	WB73860178		
Incubator	Frigidaire	626-2	45163700		
Incubator	Frigidaire	11-680-626-4	B0751345		
Incubator	Northland	UF30K-5020	0F8675A1		
Autotitrator	Mantech	PC-1040-00	MS-OK4-216		
Stirrer	Thermolyne	Cimarec2	640910908645		
Distillation Unit	Lachat	MicroDist	160600002282		
Water Analyzer	Thermo Scientific	Konelab 20i	P2018827		
Hot Plate/Stirrer	VWR Scientific 325	33918-250	0504		
Stirrer	American Dade	58252-1	004416		
Stirrer	Corning	PC-320			
Stirrer	Thermolyne	M-16715	268		
Hot Plate/Stirrer	Corning	PC-310			
Oven	Quincy Lab	40GC	697030698		
Refrigerator	Thermo Fischer Scientific	3721-BOD	317564-1394		
Bomb Calorimeter	Parr Instruments	1341EB	6331		
Motor Assembly	Parr Instruments	A50M	186		
Ignition Unit	Parr Instruments	2901EB	1291		
Bomb Calorimeter	Parr Instruments	1341	5453		
Motor Assembly	Parr Instruments	A50MEB	0106		
Ignition Unit	Parr Instruments	2901	0386		
Autosampler	Shimadzu	ASI-V			
Meter	Accumet	AB15+	AB92322755	2006	New
Meter	Accumet	AB150	AB92343741		
Distillation Unit	BSL Midi-Vap	MCV100-3	MCVK95271(BSL)	1995	New
Hydra II AA	Leeman Lab, Inc.	112-01000-1	63646	2009	New
Hydra AF Gold Plus	Leeman Lab, Inc.	112-00067-1	62787		New
Hydra AF Gold Plus	Leeman Lab, Inc.	112-00067-1	62825	2004	New
ICP Mass Spectrometer	Agilent	7700X	JP11050866	2013	Used
ICP Spectrometer	Thermo Scientific	6500 Duo	20101710	2010	New
Chiller	Thermo Scientific	ThermoFlex900	0127903301151218		
Balance	Ohaus	E4000D	1851		
Balance	Sartorius	H160	39120117		
Block Digestor	CPI International	Mod Block	0002240ID	2000	New
Hotblock	Environmental Express	SC154	3483CEC1683		
Hotblock	Environmental Express	SC100			
Hotblock	Environmental	SC154			

Equipment/ Instrument	Manufacturer	Model Number	Serial Number	Year Put into Service	Condition When Received
	Express				
Hotblock	Environmental Express	SC154			
Hotblock	Environmental Express	SC154			
Hotblock	Environmental Express	SC154			
Hotblock	Environmental Express	SC154			
Water System	Millipore	Milli-Q	07509C	1987	New
Water System	Modulab	Modu Pure	90-020	1991	New
Water Bath	Baxter Scientific Products	2976-22	0890-0513		
Balance	Sartorius	GD503	24850510		
Balance	A&D Company	GR300	14212090		
IR Thermometer	Fluke	561	36020079WS	2018	New
IR Thermometer	Fluke	561	38960047WS	2018	New
Moisture Analyzer	Mettler Toledo	HB43-S	1128420387	2007	New
Moisture Analyzer	Mettler Toledo	HB43-S	1128470718	2007	New
Moisture Analyzer	Mettler Toledo	HB43	1126423540	2006	New
Freezer	Frigidaire	LFFH21F7HWJ	WB32735526	2011	New
Refrigerator	Russell	AA38-195B	D950317-156		
Refrigerator	Russell	AA38-195B	D950317-157		
Refrigerator	Russell	AA38-195B	D950317-158		
Refrigerator	True Mfg., Co.	GDM-49 - AK9434A	1-2790186		
Refrigerator	True Mfg., Co.	GDM-49 - AK9434A	1-2816018		
Refrigerator	Sanyo	SR-360X	950533031		
Refrigerator	Bally	3678W	DX30004-01		
Refrigerator	Kolpak	Polar-Pak	24850510		Used
Centrifuge	IEC	HN-SII	235520449	1990	New
Gas Chromatograph/	Agilent	6890N	CN10531042	2012	Used
Mass Spectrometer/	Agilent	5975	US52430633	2012	Used
Autosampler	Agilent	7683B	CN51624719	2012	Used
Gas Chromatograph/	Agilent	6890N	CN10544189	2006	New
Mass Spectrometer/	Agilent	5975	US54421743	2006	New
Autosampler	Agilent	7683B	CN73044834	2006	New
Gas Chromatograph	Agilent	7890A	CN10730016	2007	New
Mass Spectrometer	Agilent	5975C	US73236855	2007	New
Autosampler	Agilent	7863	CN54737450	2007	New
Gas Chromatograph/	Hewlett Packard	6890	US00025928	2014	Used
Mass Spectrometer/	Hewlett Packard	5973	US82311460	2014	Used
Autosampler	Agilent	7683	US90303095	2014	Used
Gas Chromatograph/	Agilent	7890A	CN10231066	2013	Used
Mass Spectrometer/	Agilent	5975C	US10223403	2013	Used
Autosampler	Agilent	7693	CN10210026	2013	Used
Gas Chromatograph/	Agilent	6890N	CN10450103	2013	Used
Mass Spectrometer/	Agilent	5973	US10442208	2013	Used
Autosampler	Agilent	7683	CN41728707	2013	Used
Gas Chromatograph/	Agilent	7890	CN10221047	2013	Used
Mass Spectrometer/	Agilent	5975C	US10213429	2013	Used

Equipment/ Instrument	Manufacturer	Model Number	Serial Number	Year Put into Service	Condition When Received
Autosampler	Agilent	7693	CN10210018	2013	Used
Gas Chromatograph/	Agilent	6890N	US10204018	2013	Used
Mass Spectrometer/	Agilent	5973N	US44621198	2013	Used
Autosampler	Agilent	7683	CN34827238	2013	Used
Balance	Sartorius	A200S	37060105		
Refrigerator	True Mfg., Co.	T-72	741733		
Freezer	Fisher Scientific	ISOTEMP 97-925-1	0119138801100601	2010	New
Refrigerator	True Mfg., Co.	T-72	857438		
Gas Chromatograph	Agilent	7890A	CN10241008	2013	
Autosampler	Agilent	7693	CN10200056		
FID detector	Agilent	DB-WAX			
FID detector	Restek	RTX-624			
Gas Chromatograph	Perkin-Elmer	Claris 680	680S12040301	2015	
Autosampler	Perkin-Elmer	built-in	n/a		
FID detector	Restek	RTX-1			
Gas Chromatograph	Hewlett Packard	5890 Series II	3133A37901	2005	
Autosampler	Gerstel	MPS2L	161139		
FID detector	Restek	RTX-1			
Gas Chromatograph	Agilent	6890N	US10350015	2005	
Autosampler	Hewlett Packard	7683	CN45331787		
FID detector	Phenomenex	Zebron ZB-5			
FID detector	Phenomenex	Zebron ZB-5			
Gas Chromatograph	Agilent	6890	CN10422014	2013	
Autosampler	Agilent	7683	US90704050		
ECD detector	Agilent	DB-35MS			
ECD detector	Agilent	DB-XLB			
Gas Chromatograph	Agilent	6890N	CN10422015	2005	
Autosampler	Hewlett Packard	7673	CN73545251		
ECD detector	Agilent	DB-35MS			
ECD detector	Agilent	DB-XLB			
Gas Chromatograph	Agilent	6890N	CN10416081	2013	
Autosampler	Gerstel	MPS2L	161138		
ECD detector	Agilent	DB-35MS			
ECD detector	Agilent	DB-XLB			
Gas Chromatograph	Hewlett Packard	5890 Series II	CN10544109	2005	New
Autosampler	Agilent	7683	CN41728708		
ECD detector	Agilent	DB-35MS			
ECD detector	Agilent	DB-XLB			
Gas Chromatograph	Perkin-Elmer	Claris 600	665N9020903	2009	
Autosampler	Perkin-Elmer	built-in	n/a		
FID detector	Phenomenex	Zebron ZB-1			
Gas Chromatograph	Agilent	6890N	CN10421070	2013	
Autosampler	Agilent	7694E	IT81U08005		
FID detector	Restek	Rt-Alumina			
Gas Chromatograph	Hewlett Packard	6890	US00004256	2014	New
Autosampler	Hewlett Packard	6890	US00001201		
FID detector	Phenomenex	Zebron ZB-1			
Gas Chromatograph	Hewlett Packard	6890	US00033752	2016	
Autosampler	Agilent	7683	US00707417		

Equipment/ Instrument	Manufacturer	Model Number	Serial Number	Year Put into Service	Condition When Received
ECD detector	Agilent	DB-35MS			
ECD detector	Agilent	DB-XLB			
Gas Chromatograph	Hewlett Packard	5890 Series II	2859A25253	2005	
Autosampler	Gerstel	MPS2L	161031		
ECD detector	Agilent	DB-35MS			
ECD detector	Agilent	DB-XLB			
Ion Chromatograph					
Balance	Mettler	PM 600	000782		
Centrifuge	Clay Adams	0144-4	173020		
Refrigerator	Black & Decker	BCF27	BS00Y1E0100BKA46885	2014	New
Refrigerator	Fisher Scientific	ISOTEMP 97-938-1	119139101100601	2010	New
Refrigerator	Frigidaire	FRT18L4JWK	BA23327416		
Oven	VWR Scientific	1305U	U405295		
Freezer	Sears Roebuck	564.9205010	900500255		
Freezer	Frigidaire	FFU12C2AWO	WB21518072		
Freezer	Frigidaire	FRT18L4JWK	BA23327416		
Centrifuge	Thermo Electron	5696	792130220		
Shaker	Scientific Industries	G-560	2-372799		
Shaker Table	Thermolyne	M49235	4929110576696		
Ultrasonic Cleaner	Branson	1210	1210R-MT		
Ultrasonic Cleaner	Mellter Electronics	4.6 Dom	791413767		
Ultrasonic Cleaner	Branson	B-2200R-1	B126772		
Gas Chromatograph	Hewlett Packard	6890	US00029055	2013	
Mass Spectrometer	Hewlett Packard	5973	US91922657		
Concentrator	EST	Archon	13489		
Autosampler	Tekmar Dohrmann	3100	00276003		
Gas Chromatograph	Hewlett Packard	6890N	CN10731011	2013	
Mass Spectrometer	Hewlett Packard	5975C	US71236406		
Concentrator	EST	Encon	EV248041510		
Autosampler	EST	Cent WS	CENTS5155050610		
Gas Chromatograph	Agilent	6890N	CN10731011	2013	
Mass Spectrometer	Agilent	5975C	US71236406		
Concentrator	Tekmar Dohrmann	XPT	US03335003		
Autosampler	EST	Archon	13575		
Gas Chromatograph	Agilent	6890N	US10234135	2002	New
Mass Spectrometer	Agilent	5973N	US21863754		
Concentrator	EST	Encon	258032403		
Autosampler	EST	Archon	13796		
Gas Chromatograph	Agilent	6890N	CN10312010	2003	New
Mass Spectrometer	Agilent	5973N	US03940598		
Concentrator	EST	Encon	260032703E		
Autosampler	EST	Archon	13901		
Gas Chromatograph	Agilent	7890A	CN10814121	2008	New
Mass Spectrometer	Agilent	5975C	US80838926		
Concentrator	Teledyne Tekmar	Stratum	US08120001		
Autosampler	EST	Archon	15252		
Gas Chromatograph	Hewlett Packard	6890	US00004268	2006	Used
Mass Spectrometer	Hewlett Packard	5972	3609A03471		
Concentrator	Teledyne Tekmar	XPT	US06018002		

Equipment/ Instrument	Manufacturer	Model Number	Serial Number	Year Put into Service	Condition When Received
Autosampler	EST	Archon	13524		
Gas Chromatograph	Agilent	7890A	CN11081019	2011	New
Mass Spectrometer	Agilent	5985C	US11073805		
Concentrator	ESI Analytical	Encon	IV339122210		
Autosampler	EST	Cent WS	CENTS210121510		
Gas Chromatograph/	Hewlett Packard	6890	US00028392	1997	New
Mass Spectrometer/	Hewlett Packard	5973	US91922656		
Concentrator	EST	Encon	344022704		
Autosampler	EST	Archon	13898		
Refrigerator	True Mfg., Co.	GDM-49 - AK9434A	757529		
Freezer	Fisher Scientific	ISOTEMP 97-925-1	0119148701100602	2010	New
Freezer	Fisher Scientific	ISOTEMP 97-925-1	0168527901110712	2010	New
Freezer	Holiday	WUF12	00143507HX9208		
VOC Monitor	RAE Systems	MiniRae Lite	590-000368	2008	New
Gas Chromatograph	Hewlett Packard	5890 Series II	3033A32686	1992	New
Purge & Trap	Tekmar	LSC2000	91003014		
Autosampler	Tekmar	ALS 2016	92204003		
FID detector	Restek	RTX-502.2			
PID detector	Restek	RTX-502.2			
Gas Chromatograph	Hewlett Packard	5890 Series II	2921A23344	1989	New
Purge & Trap	Tekmar Dohrmann	3100	00276004		
Autosampler	EST	EST8100PT	14082		
FID detector	Sigma-Aldrich	VOCOL			
PID detector	Sigma-Aldrich	VOCOL			
Gas Chromatograph	Hewlett Packard	6890	US10250142	1991	New
Purge & Trap	EST	Encon	342022004		
Autosampler	EST	Archon	13392		
FID detector	Agilent	DB-VRX			
PID detector	Agilent	DB-VRX			
Gas Chromatograph	Hewlett Packard	5890 Series II	2950A27554	1989	New
Purge & Trap	Tekmar Dohrmann	3100	US01249004		
Autosampler	EST	Archon	15242		
FID detector	Agilent	DB-VRX			
PID detector	Agilent	DB-VRX			
Gas Chromatograph	Hewlett Packard	6890	US10349101	2004	New
Purge & Trap	Tekmar Dohrmann	XPT	US03344002		
Autosampler	EST	Archon	13410		
FID detector	Agilent	DB-VRX			
PID detector	Agilent	DB-VRX			
Gas Chromatograph	Hewlett Packard	5890 Series II	33033A32687	1991	New
Purge & Trap	Tekmar Dohrmann	3100	00272005		
Autosampler	Tekmar	ALS 2016	92031018		
FID detector	Restek	RTX-502.2			
PID detector	Restek	RTX-502.2			
Refrigerator	True Mfg., Co.	T-72	732212		
Balance	Sartorius	LC6200	40050019		
Balance	A&D Company	FX-2000i	15611529		
Refrigerator	General Electric	TX4DNTBWH	LM088424		
Refrigerator	True Mfg., Co.	T-72	1048159		

Equipment/ Instrument	Manufacturer	Model Number	Serial Number	Year Put into Service	Condition When Received
Freezer	Frigidaire	LFFU1424DW15	WB11442168		
Balance	Ohaus	V71P6T	8337410002		
Balance	Mettler Toledo	ML203E	B320034651		

Table 20-2. Schedule of Routine Maintenance

Instrument	Procedure	Frequency
Leeman Mercury Analyzer	Check tubing for wear Fill rinse tank with 10% HCl Insert clean drying tube filled with Magnesium Perchlorate Fill reductant bottle with 10% Stannous Chloride	Daily Daily Daily Daily
ICP	Check pump tubing Check liquid argon supply Check fluid level in waste container Check filters Clean or replace filters Check torch Check sample spray chamber for debris Clean and align nebulizer Check entrance slit for debris Change printer ribbon Replace pump tubing	Daily Daily Daily Weekly As required Daily Monthly Monthly Monthly As required As required
UV-Vis Spectrophotometer	Clean ambient flow cell Precision check/alignment of flow cell Wavelength verification check	As required As required Semi-annually
Auto Analyzers	Clean sampler Check all tubing Clean inside of colorimeter Clean pump well and pump rollers Clean wash fluid receptacle Oil rollers/chains/side rails Clean optics and cells	Daily Daily Daily Quarterly Weekly Weekly Quarterly
Hewlett Packard GC/MS	Ion gauge tube degassing Pump oil-level check Pump oil changing Analyzer bake-out Analyzer cleaning Resolution adjustment COMPUTER SYSTEM AND PRINTER: Air filter cleaning Change data system air filter Printer head carriage lubrication Paper sprocket cleaning Drive belt lubrication	As required Monthly Annually As required As required As required As required As required As required As required As required
Gas Chromatograph	Compare standard response to previous day or since last initial calibration Check carrier gas flow rate in column Check temp. of detector, inlet, column oven Septum replacement Check system for gas leaks with SNOOP	Daily Daily via use of known compound retention Daily As required W/cylinder change as required

Instrument	Procedure	Frequency
	Check for loose/frayed wires and insulation ½" Bake injector/column Change/remove sections of guard column Replace connectors/liners Change/replace column(s)	Monthly As Required As Required As Required As Required
Electron Capture Detector (ECD)	Detector wipe test (Ni-63) Detector cleaning	Semi-annually As required
Flame Ionization Detector (FID)	Detector cleaning	As required
Photoionization Detector (PID)	Change O-rings Clean lamp window	As required As required
HPLC	Change guard columns Change lamps Change pump seals Replace tubing Change fuses in power supply Filter all samples Change autosampler rotor/stator	As required As required Semi-annually or as required As required As required Daily As required
Balances	Class "S" traceable weight check Clean pan and check if level Field service	Daily, when used Daily At least Annually
Conductivity Meter	0.01 M KCl calibration Conductivity cell cleaning	Daily As required
Total Organic Carbon Analyzer	Check gas flow Check fluid level (IC reservoirs) Replace "O" rings Check needle Replace scrubbers (halogen and CO2) Replace catalyst Vendor repair	As required Daily Daily Each use Yearly As required As required
Turbidimeter	Check light bulb	Daily, when used
Deionized/Distilled Water	Conductivity Point Sources Daily conductivity check Check deionizer light Monitor for VOA's System cleaning Replace cartridge & large mixed bed resins	Water Quality Daily Daily As required As required
Drying Ovens	Temperature monitoring Temperature adjustments	Daily As required
Refrigerators/Freezers	Temperature monitoring Temperature adjustment Defrosting/cleaning	Daily As required As required
Vacuum Pumps/ Air Compressor	Drained Belts checked Lubricated	Weekly Monthly Semi-annually
pH/Specific Ion Meter	Calibration/check slope Clean electrode	Daily As required
BOD Incubator	Temperature monitoring Coil and incubator cleaning	Daily Monthly
Centrifuge	Check brushes and bearings	Every 6 months or as needed

Instrument	Procedure	Frequency
Water baths	Temperature monitoring Water replaced	Daily Monthly or as needed

SECTION 21. MEASUREMENT TRACEABILITY

21.1 Overview

Traceability of measurements shall be assured using a system of documentation, calibration, and analysis of reference standards. Laboratory equipment that are peripheral to analysis and whose calibration is not necessarily documented in a test method analysis or by analysis of a reference standard shall be subject to ongoing certifications of accuracy. At a minimum, these must include procedures for checking specifications of ancillary equipment: balances, thermometers, temperature, Deionized (DI) and Reverse Osmosis (RO) water systems, automatic pipettes and other volumetric measuring devices. (Refer to Section 20.3). With the exception of Class A Glassware and glass microliter syringes, quarterly accuracy checks are performed for all mechanical volumetric devices. Micro syringes are verified at least semi-annually or disposed of after 6 months of use. Wherever possible, subsidiary or peripheral equipment is checked against standard equipment or standards that are traceable to national or international standards. Class A Glassware and glass microliter syringes should be routinely inspected for chips, acid etching or deformity (e.g., bent needle). If the Class A glassware or syringe is suspect, the accuracy of the glassware will be assessed prior to use.

21.2 NIST-Traceable Weights and Thermometers

Reference standards of measurement shall be used for calibration only and for no other purpose, unless it can be shown that their performance as reference standards would not be invalidated.

For NIST-traceable weights and thermometers, the laboratory requires that all calibrations be conducted by a calibration laboratory accredited by A2LA, NVLAP (National Voluntary Laboratory Accreditation Program), or another accreditation organization that is a signatory to a MRA (Mutual Recognition Arrangement) of one or more of the following cooperations – ILAC (International Laboratory Accreditation Cooperation) or APLAC (Asia-Pacific Laboratory Accreditation Cooperation). A calibration certificate and scope of accreditation is kept on file at the laboratory.

Calibration laboratory's policy for achieving measurement traceability is defined and includes the subsequent elements of uncertainty.

The uncertainty calculations of the calibration laboratory are supported by uncertainty budgets and are represented by expanded uncertainties typically using a coverage factor of $k=2$ to approximate the 95% confidence level. This explanation accompanies the measurement result and the associated uncertainty.

The tolerance uncertainty ratio (TUR) is calculated using the expanded uncertainty of the measurement, not the collective uncertainty of the measurement standards. A statement to this effect accompanies the TUR along with the coverage factor and confidence level.

The calibration report or certificate submitted to Eurofins Pensacola contains, in a well-designed format, a traceability statement, the conditions under which the calibrations were made in the context of any potential influence, a compliance statement with an identified metrological specification and the pertinent clauses, a clearly identified record of the quantities and functional test results before and after re-calibration, and no recommendation on the calibration interval. Opinions and interpretations of results are presented along with the basis upon which they were

made and identified as such. The report may be submitted by facsimile or other electronic means as long as the requirements of the International Standard are achieved. If significant amendments are made to a calibration certificate, a supplemental certificate for the serial-number-specified piece of equipment is so identified. When a new certificate is offered, it uniquely identifies and references the one it replaces. All calibration reports are filed in the QA Office.

The calibration laboratory supports in-house calibration systems: documented procedures for in-house calibrations, evidence by a report, certificate, or sticker, for an appropriate amount of time; training records of calibration personnel; certificates from accreditation services demonstrating traceability to national or international standards of measurement; procedures for evaluating measurement uncertainty; timely and documented recalibration of reference standards. When subcontracting to a calibration laboratory, Eurofins Pensacola does not use a firm who subcontracts the work.

An external certified service engineer services laboratory balances on an annual basis. This service is documented on each balance with a signed and dated certification sticker. Balance calibrations are checked each day of use. All mercury thermometers are calibrated annually against a traceable reference thermometer. Temperature readings of ovens, refrigerators, and incubators are checked on each day of use.

21.3 Reference Standards / Materials

Reference standards/materials, where commercially available, are traceable to certified reference materials. Commercially prepared reference standards, to the extent available, are purchased from vendors that are accredited to ISO Guide 34 and ISO/IEC Guide 17025. All reference standards from commercial vendors shall be accompanied with a certificate that includes at least the following information:

- Manufacturer
- Analytes or parameters calibrated
- Identification or lot number
- Calibration method
- Concentration with associated uncertainties
- Purity

If a standard cannot be purchased from a vendor that supplies a Certificate of Analysis, the purity of the standard is documented by analysis. The receipt of all reference standards must be documented. Reference standards are labeled with a unique Standard Identification Number and expiration date. All documentation received with the reference standard is retained as a QC record and references the Standard Identification Number.

All reference, primary and working standards/materials, whether commercially purchased or laboratory prepared, must be checked regularly to ensure that the variability of the standard or material from the true value does not exceed method requirements. The accuracy of calibration standards is checked by comparison with a standard from a second source. In cases where a second standard manufacturer is not available, a vendor certified different lot is acceptable for use as a second source. For unique situations, such as air analysis where no other source or lot is available, a standard made by a different analyst would be considered a second source.

The appropriate Quality Control (QC) criteria for specific standards are defined in laboratory SOPs. In most cases, the analysis of an Initial Calibration Verification (ICV) or LCS (where there is no sample preparation) is used as the second source confirmation. These checks are generally performed as an integral part of the analysis method (e.g. calibration checks, laboratory control samples).

All standards and materials must be stored and handled according to method or manufacturer's requirements in order to prevent contamination or deterioration. Refer to the Corporate Environmental Health & Safety Manual or laboratory SOPs. For safety requirements, please refer to method SOPs and the laboratory Environmental Health and Safety Manual.

Standards and reference materials shall not be used after their expiration dates unless their reliability is verified by the laboratory and their use is approved by the Quality Assurance Manager. The laboratory must have documented contingency procedures for re-verifying expired standards.

21.4 Documentation and Labeling of Standards, Reagents, and Reference Materials

Reagents must be at a minimum the purity required in the test method. The date of reagent receipt and the expiration date are documented. The lots for most of the common solvents and acids are tested for acceptability prior to company-wide purchase, as per Eurofins's Corporate SOP (CA-Q-S-001), Solvent and Acid Lot Testing and Approval.

All manufacturer or vendor supplied Certificate of Analysis or Purity must be retained, stored appropriately, and readily available for use and inspection. These records are maintained by the analytical departments in the TALS. Records must be kept of the date of receipt and date of expiration of standards, reagents and reference materials. In addition, records of preparation of laboratory standards, reagents, and reference materials must be retained, stored appropriately, and be readily available for use and inspection. For detailed information on documentation and labeling, please refer to method specific SOPs.

Commercial materials purchased for preparation of calibration solutions, spike solutions, etc., are usually accompanied with an assay certificate or the purity is noted on the label. If the assay purity is 96% or better, the weight provided by the vendor may be used without correction. If the assay purity is less than 96% a correction will be made to concentrations applied to solutions prepared from the stock commercial material. Blended gas standard cylinders use a nominal concentration if the certified value is within +/-15%, otherwise the certified values is used for the canister concentration.

21.4.1 All standards, reagents, and reference materials must be labeled in an unambiguous manner. Standards are logged into the laboratory's TALS, and are assigned a unique identification number. The following information is typically recorded in the electronic database within the TALS.

- Standard ID
- Description of Standard
- Department
- Preparer's name

- Final volume and number of vials prepared
- Solvent type and lot number
- Preparation Date
- Expiration Date
- Standard source type (stock or daughter)
- Standard type (spike, surrogate, other)
- Parent standard ID (if applicable)
- Parent Standard Analyte Concentration (if applicable)
- Parent Standard Amount used (if applicable)
- Component Analytes
- Final concentration of each analyte
- Comment box (text field)

Records are maintained electronically for standard and reference material preparation. These records show the traceability to purchased stocks or neat compounds. These records also include method of preparation, date of preparation, expiration date and preparer's name or initials. Preparation procedures are provided in the Method SOPs.

21.4.2 All standards, reagents, and reference materials must be clearly labeled with a minimum of the following information:

- Expiration Date (include prep date for reagents)
- Standard ID (from TALS)
- Special Health/Safety warnings if applicable

Records must also be maintained of the date of receipt for commercially purchased items or date of preparation for laboratory prepared items. Special Health/Safety warnings must also be available to the analyst. This information is maintained as follows:

- Date received is written on the chemical container and also documented on the receipt
- Date of preparation is documented in LIMS and on the container label
- Health and Safety warnings are contained in the method SOPs

21.4.3 In addition, the following information may be helpful:

- Date opened (for multi-use containers, if applicable)
- Description of standard (if different from manufacturer's label or if standard was prepared in the laboratory)
- Recommended Storage Conditions
- Concentration (if applicable)
- Initials of analyst preparing standard or opening container

All containers of prepared reagents must include an expiration date and an ID number to trace back to preparation.

Procedures for preparation of reagents can be found in the Method SOPs.

Standard ID numbers must be traceable through associated logbooks, worksheets and preparation/analytical batch records.

All reagents and standards must be stored in accordance to the following priority: 1) with the manufacturer's recommendations; 2) with requirements in the specific analytical methods as specified in the laboratory SOP.

SECTION 22. SAMPLING

22.1 Overview

The laboratory does not provide sampling services. The laboratory's responsibility in the sample collection process lies in supplying the sampler with the necessary coolers, reagent water, sample containers, preservatives, sample labels, custody seals, COC forms, ice, and packing materials required to properly preserve, pack, and ship samples to the laboratory.

22.2 Sampling Containers

The laboratory offers clean sampling containers for use by clients. These containers are obtained from reputable container manufacturers and meet EPA specifications as required. Certificates of cleanliness for bottles and preservatives are provided by the supplier and are maintained at the laboratory. Alternatively, the certificates may be maintained by the supplier and available to the laboratory on-line.

22.2.1 Preservatives

Upon request, preservatives are provided to the client in pre-cleaned sampling containers. In some cases containers may be purchased pre-preserved from the container supplier. Whether prepared by the laboratory or bought pre-preserved, the grades of the preservatives are at a minimum:

- Hydrochloric Acid – Reagent ACS (Certified VOA Free) or equivalent
- Methanol – Purge and Trap grade
- Nitric Acid – Instra-Analyzed or equivalent
- Sodium Bisulfate – ACS Grade or equivalent
- Sodium Hydroxide – Instra-Analyzed or equivalent
- Sulfuric Acid – Instra-Analyzed or equivalent
- Sodium Thiosulfate – ACS Grade or equivalent

22.3 Definition of Holding Time

The date and time of sampling documented on the COC form establishes the day and time zero. As a general rule, when the maximum allowable holding time is expressed in days (e.g., 14 days, 28 days), the holding time is based on calendar day measured. Holding times expressed in hours (e.g., 6 hours, 24 hours, etc.) are measured from date and time zero. Holding times for analysis include any necessary reanalysis. However, there are some programs that determine holding time compliance based on the date and specific time of analysis compared to the time of sampling regardless of how long the holding time is.

22.4 Sampling Containers, Preservation Requirements, Holding Times

The preservation and holding time criteria specified in the laboratory SOPs are derived from the source documents for the methods. If method required holding times or preservation requirements are not met, the reports will be qualified using a flag, footnote or case narrative. As soon as possible or "ASAP" is an EPA designation for tests for which rapid analysis is advised, but for which neither EPA nor the laboratory have a basis for a holding time.

22.5 Sample Aliquots / Subsampling

Taking a representative sub-sample from a container is necessary to ensure that the analytical results are representative of the sample collected in the field. The size of the sample container, the quantity of sample fitted within the container, and the homogeneity of the sample need consideration when sub-sampling for sample preparation. It is the laboratory's responsibility to take a representative subsample or aliquot of the sample provided for analysis.

Analysts should handle each sample as if it is potentially dangerous. At a minimum, safety glasses, gloves, and lab coats must be worn when preparing aliquots for analysis.

Guidelines on taking sample aliquots and subsampling are located SOP PS-LAB-003, Sample Homogenization and Subsampling.

SECTION 23. HANDLING OF SAMPLES

Sample management procedures at the laboratory ensure that sample integrity and custody are maintained and documented from sampling/receipt through disposal.

23.1 Chain of Custody (COC)

The COC form is the written documented history of any sample and is initiated when bottles are sent to the field, or at the time of sampling. This form is completed by the sampling personnel and accompanies the samples to the laboratory where it is received and stored under the laboratory's custody. The purpose of the COC form is to provide a legal written record of the handling of samples from the time of collection until they are received at the laboratory. It also serves as the primary written request for analyses from the client to the laboratory. The COC form acts as a purchase order for analytical services when no other contractual agreement is in effect. An example of a COC form may be found in Figure 23-1.

23.1.1 Field Documentation

The information the sampler needs to provide at the time of sampling on the container label is:

- Sample identification
- Date and time
- Preservative

During the sampling process, the COC form is completed and must be legible (see Figure 23-1). This form includes information such as:

- Client name, address, phone number and fax number (if available)
- Project name and/or number
- The sample identification
- Date, time and location of sampling
- Sample collectors name
- The matrix description
- The container description
- The total number of each type of container
- Preservatives used
- Analysis requested
- Requested turnaround time (TAT)
- Any special instructions
- Purchase Order number or billing information (e.g. quote number) if available
- The date and time that each person received or relinquished the sample(s), including their signed name.

When the sampling personnel deliver the samples directly to Eurofins personnel, the samples are stored in a cooler with ice, as applicable, and remain solely in the possession of the client's field technician until the samples are delivered to the laboratory personnel. The sample collector must assure that each container is in his/her physical possession or in his/her view at all times, or stored in such a place and manner to preclude tampering. The field technician relinquishes the samples in writing on the COC form to the sample control personnel at the

laboratory or to a Eurofins courier. When sampling personnel deliver the samples through a common carrier (Fed-Ex, UPS), the CoC relinquished date/time is completed by the field personnel and samples are released to the carrier. Samples are only considered to be received by the laboratory when personnel at the fixed laboratory facility have physical contact with the samples.

Note: Independent couriers are not required to sign the COC form. The COC is usually kept in the sealed sample cooler. The receipt from the courier is stored in log-in by date; it lists all receipts each date.

23.1.2 Legal / Evidentiary Chain-of-Custody

If samples are identified for legal/evidentiary purposes on the COC, login will complete the custody seal retain the shipping record with the COC, and initiate an internal COC for laboratory use by analysts and a sample disposal record.

23.2 Sample Receipt

Samples are received at the laboratory by designated sample receiving personnel and a unique laboratory project identification number is assigned. Each sample container shall be assigned a unique sample identification number that is cross-referenced to the client identification number such that traceability of test samples is unambiguous and documented. Each sample container is affixed with a durable sample identification label. Sample acceptance, receipt, tracking and storage procedures are summarized in the following sections.

23.2.1 Laboratory Receipt

When samples arrive at the laboratory, sample receiving personnel inspect the coolers and samples. The integrity of each sample must be determined by comparing sample labels or tags with the COC and by visual checks of the container for possible damage. Any non-conformance, irregularity, or compromised sample receipt must be documented on TALs sample receipt checklist, in the NCM module of TALs, and brought to the immediate attention of the client. The COC, shipping documents, documentation of any non-conformance, irregularity, or compromised sample receipt, record of client contact, and resulting instructions become part of the project record. (See SOP PS-SCD-007)

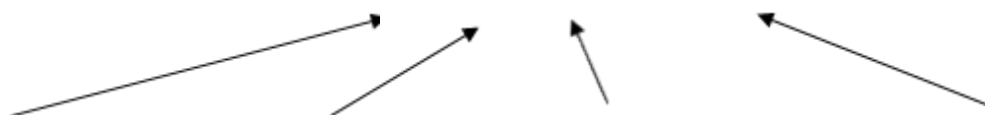
23.2.1.1 Unique Sample Identification

Note: Example TALS IDs are from TALS.

All samples that are processed through the laboratory receive a unique sample identification to ensure that there can be no confusion regarding the identity of such samples at anytime. This system includes identification for all samples, subsamples and subsequent extracts and/or digestates.

The laboratory assigns a unique identification (e.g., Sample ID) code to each sample container received at the laboratory. This Primary ID is made up of the following information (consisting of 4 components):

Example: 400 - 9608 - A - 1



Location ID Number	Login ID (3-digit # for your lab)	Container Code/Occurrence	Sample

The above example states the Eurofins Laboratory Location ID (Location Pensacola), the Login ID (9608) which is unique to a particular client/job occurrence, the container code (A) indicating the first container and Sample Number (1).

If the primary container goes through a prep step that creates a “new” container, then the new container is considered secondary and gets another ID. An example of this being a client sample in a 1-Liter amber bottle is sent through a Liquid/Liquid Extraction and an extraction vial is created from this step. The vial would be a SECONDARY container. The secondary ID has 5 components.

Example: 400 - 9608 - A - 1 - **A** ← **Secondary Container Occurrence**

Example: 220-9608-A-1-A, would indicate the PRIMARY container listed above that went through a step that created the 1st occurrence of a Secondary container.

With this system, a client sample can literally be tracked throughout the laboratory in every step from receipt to disposal.

23.3 Sample Acceptance Policy

The laboratory has sample acceptance criteria (Figure 23-2) that outline the circumstances under which samples shall be accepted. These include:

- a COC filled out completely;
- samples must be properly labeled;
- proper sample containers with adequate volume for the analysis (Sampling Guide) and necessary QC;
- samples must be preserved according to the requirements of the requested analytical method (Sampling Guide);
- sample holding times must be adhered to (Sampling Guide);
- the project manager will be notified if any sample is received in damaged condition.

When samples do not meet these criteria variations from policy are documented and communicated to the client for further instruction.

23.3.1 After inspecting the samples, the sample receiving personnel sign and date the COC form, make any necessary notes of the samples' conditions and store them in appropriate refrigerators or storage locations.

23.3.2 Any deviations from these checks that question the suitability of the sample for analysis, or incomplete documentation as to the tests required will be resolved by consultation with the client. If the sample acceptance policy criteria are not met, the laboratory shall either:

- Retain all correspondence and/or records of communications with the client regarding the disposition of rejected samples [The project manager may be able to make decisions on samples with prior knowledge from the client, but documentation of acceptable scenarios must be provided and acknowledge by the client, and records of these decisions must be documented], or
- Fully document any decision to proceed with sample analysis that does not meet sample acceptance criteria.

Note: North Carolina requires that they be notified when samples are processed that do not meet sample acceptance criteria.

Once sample acceptance is verified, the samples are logged into the TALS according SOP PS-SCD-007 (Procedure for Receiving Samples and Logging Samples into the LIMS).

23.4 Sample Storage

In order to avoid deterioration, contamination or damage to a sample during storage and handling, from the time of receipt until all analyses are complete, samples are stored in refrigerators, freezers or protected locations suitable for the sample matrix. Preserved samples submitted for metals analysis may be stored at ambient temperature. In addition, samples to be analyzed for volatile organic parameters are stored in separate refrigerators designated for volatile organic parameters only. Samples are never to be stored with reagents, standards or materials that may create contamination.

To ensure the integrity of the samples during storage, refrigerator blanks are maintained in the volatile sample refrigerators and analyzed every two weeks.

Analysts and technicians retrieve the sample container allocated to their analysis from the designated refrigerator and place them on carts, analyze the sample, and return the remaining sample or empty container to the refrigerator from which it originally came. All unused portions of samples, including empty sample containers, are returned to the secure sample control area. [This is one lab's example – please insert your procedure.] All samples are kept in the refrigerators for two to four weeks after analysis, which meets or exceeds most sample holding times. After two to four weeks the samples are moved to dry room temperature, sample archive area where they are stored for an additional four weeks before they are disposed of. This eight week holding period allows samples to be checked if a discrepancy or question arises. Special arrangements may be made to store samples for longer periods of time. This extended holding period allows additional metal analyses to be performed on the archived sample and assists clients in dealing with legal matters or regulatory issues.

Access to the laboratory is controlled such that sample storage need not be locked at all times unless a project specifically demands it. Samples are accessible to laboratory personnel only. Visitors to the laboratory are prohibited from entering the refrigerator and laboratory areas unless accompanied by an employee of Eurofins.

23.5 Hazardous Samples and Foreign Soils

To minimize exposure to personnel and to avoid potential accidents, hazardous and foreign soil samples are stored in an isolated area designated for hazardous waste only. For any sample that is known to be hazardous at the time of receipt or, if after completion of analysis the result

exceeds the acceptable regulatory levels, a Hazardous Sample Notice must be completed by the analyst. This form may be completed by Sample Control, Project Managers, or analysts and must be attached to the report. The sample itself is clearly marked with a red stamp, stamped on the sample label reading "HAZARDOUS" or "FOREIGN SOIL" and placed in a colored and/or marked bag to easily identify the sample. The date, log number, lab sample number, and the result or brief description of the hazard are all written on the Hazardous & Foreign Soil Sample Notice. A copy of the form must be included with the original COC and Work Order and the original must be given to the Sample Control Custodian. Analysts will notify Sample Control of any sample determined to be hazardous after completion of analysis by completing a Hazardous Sample Notice. All hazardous samples are either returned to the client or disposed of appropriately through a hazardous waste disposal firm that lab-packs all hazardous samples and removes them from the laboratory. Foreign soils are labeled with a blue dot upon receipt. All foreign soils are taken to the area designated for foreign soils upon completion of testing. Foreign soil samples are sent out for incineration by a USDA-approved waste disposal facility.

See SOP PS-LAB-015 Waste Disposal for a complete description of waste disposal practices at Eurofins Pensacola.

23.6 Sample Shipping

In the event that the laboratory needs to ship samples, the samples are placed in a cooler with enough ice to ensure the samples remain just above freezing and at or below 6.0°C during transit. The samples are carefully surrounded by packing material to avoid breakage (yet maintain appropriate temperature). A trip blank is enclosed for those samples requiring water/solid volatile organic analyses (see Note). The chain-of-custody form is signed by the sample control technician and attached to the shipping paperwork. Samples are generally shipped overnight express or hand-delivered by a Eurofins courier to maintain sample integrity. All personnel involved with shipping and receiving samples must be trained to maintain the proper chain-of-custody documentation and to keep the samples intact and on ice. The Environmental, Health and Safety Manual contains additional shipping requirements.

Note: If a client does not request trip blank analysis on the COC or other paperwork, the laboratory will not analyze the trip blanks that were supplied. However, in the interest of good client service, the laboratory will advise the client at the time of sample receipt that it was noted that they did not request analysis of the trip blank; and that the laboratory is providing the notification to verify that they are not inadvertently omitting a key part of regulatory compliance testing.

23.7 Sample Disposal

Samples should be retained for a minimum of 30 days after the project report is sent, however, provisions may be made for earlier disposal of samples once the holding time is exceeded. Some samples are required to be held for longer periods based on regulatory or client requirements (e.g., 60 days after project report is sent). The laboratory must follow the longer sample retention requirements where required by regulation or client agreement. Several possibilities for sample disposal exist: the sample may be consumed completely during analysis, the sample may be returned to the customer or location of sampling for disposal, or the sample may be disposed of in accordance with the laboratory's waste disposal procedures (SOP PS-LAB-015 Waste Disposal). All procedures in the laboratory Environmental Health and Safety Manual are followed during disposal. Samples are normally maintained in the laboratory no longer than two months from receipt unless otherwise requested. Unused portions of samples

found or suspected to be hazardous according to state or federal guidelines may be returned to the client upon completion of the analytical work.

If a sample is part of a known litigation, the affected legal authority, sample data user, and/or submitter of the sample must participate in the decision about the sample's disposal. All documentation and correspondence concerning the disposal decision process must be kept on file. Pertinent information includes the date of disposal, nature of disposal (such as sample depletion, hazardous waste facility disposal, return to client), names of individuals who conducted the arrangements and physically completed the task. The laboratory will remove or deface sample labels prior to disposal unless this is accomplished through the disposal method (e.g., samples are incinerated). A Waste Disposal Record should be completed.

Figure 23-1. Example: Chain of Custody (COC)

[illegible]

Figure 23-2. Example: Sample Acceptance Criteria

Question	Answer	Failure Reason
▶ Radioactivity wasn't checked or is $\leq$ background as measured by a survey meter.	NA	
The cooler's custody seal, if present, is intact.	Yes	
Sample custody seals, if present, are intact.	NA	
The cooler or samples do not appear to have been compromised or tampered with.	Yes	
Samples were received on ice.	Yes	
Cooler Temperature is acceptable.	Yes	
Cooler Temperature is recorded.	Yes	2.5°C IR-7
COC is present.	Yes	
COC is filled out in ink and legible.	Yes	
COC is filled out with all pertinent information.	Yes	
Is the Field Sampler's name present on COC?	Yes	
There are no discrepancies between the containers received and the COC.	Yes	
Samples are received within Holding Time (excluding tests with immediate HTs)	Yes	
Sample containers have legible labels.	Yes	
Containers are not broken or leaking.	Yes	
Sample collection date/times are provided.	Yes	
Appropriate sample containers are used.	Yes	
Sample bottles are completely filled.	Yes	
Sample Preservation Verified.	Yes	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	Yes	
Containers requiring zero headspace have no headspace or bubble is $<6\text{mm}$ (1/4").	NA	
Multiphasic samples are not present.	Yes	
Samples do not require splitting or compositing.	Yes	
Residual Chlorine Checked.	NA	

All incoming work will be evaluated against the criteria listed below. Where applicable, data from any samples that do not meet the criteria listed below will be noted on the laboratory report defining the nature and substance of the variation. In addition the client will be notified either by telephone, fax or e-mail ASAP after the receipt of the samples.

Per State and/or Federal Regulation, the client is responsible to ensure that samples are shipped in accordance with DOT/IATA requirements, and that radioactive materials may only be delivered to licensed facilities. Any samples containing (or suspected to contain) Source, Byproduct, or Special Nuclear Material as defined by 10 CFR should be delivered directly to facilities licensed to handle such radioactive material. Natural material or ores containing naturally occurring radionuclides may be delivered to any Eurofins facility or courier as long as the activity concentration of the material does not exceed 270 pCi/g alpha or 2700 pCi/g beta (49 CFR Part 173).

- 1) Samples must arrive with labels intact with a Chain of Custody filled out completely. The following information must be recorded.

- *Client name, address, phone number and fax number (if available)*
 - *Project name and/or number*
 - *The sample identification*
 - *Date, time and location of sampling*
 - *The collectors name*
 - *The matrix description*
 - *The container description*
 - *The total number of each type of container*
 - *Preservatives used*
 - *Analysis requested*
 - *Requested turnaround time (TAT)*
 - *Any special instructions*
 - *Purchase Order number or billing information (e.g. quote number) if available*
 - *The date and time that each person received or relinquished the sample(s), including their signed name.*
 - *The date and time of receipt must be recorded between the last person to relinquish the samples and the person who receives the samples in the lab, and they must be exactly the same.*
 - *Information must be legible*
- 2) Samples must be properly labeled.
- Use durable labels (labels provided by Eurofins are preferred)
 - Include a unique identification number
 - Include sampling date and time & sampler ID
 - Include preservative used.
 - Use indelible ink
 - Information must be legible
- 3) Proper sample containers with adequate volume for the analysis and necessary QC are required for each analysis requested. See Lab Sampling Guide.
- 4) Samples must be preserved according to the requirements of the requested analytical method (See Sampling Guide).
- 5) Most analytical methods require chilling samples to 4° C (other than water samples for metals analysis). For these methods, the criteria are met if the samples are chilled to below 6° C and above freezing (0°C). For methods with other temperature criteria (e.g. some bacteriological methods require $\leq 10^{\circ}\text{C}$), the samples must arrive within $\pm 2^{\circ}\text{C}$ of the required temperature or within the method specified range.
- 5i.) Samples that are delivered to the laboratory on the same day they are collected may not meet the requirements of Section 5. In these cases, the samples shall be considered acceptable if the samples were received on ice.
- 5ii.) If sample analysis is begun within fifteen (15) minutes of collection, thermal preservation is not required.
- 5iii.) Thermal preservation is not required in the field if the laboratory receives and refrigerates the sample within fifteen (15) minutes of collection.
- Chemical preservation (pH) will be verified prior to analysis and documented, either in sample control or at the analyst's level. The project manager will be notified immediately if there is a

discrepancy. If analyses will still be performed, all affected results will be flagged to indicate improper preservation.

- FOR WATER SAMPLES TESTED FOR CYANIDE (by Standard Methods or EPA 335)
 - In the Field: Samples are to be tested for Sulfide using lead acetate paper prior to the addition of Sodium Hydroxide (NaOH). If sulfide is present, the sample must be treated with Cadmium Chloride and filtered prior to the addition of NaOH.
 - If the sulfide test and treatment is not performed in the field, the lab will test the samples for sulfide using lead acetate paper at the time of receipt and if sulfide is present in the sample, the client will be notified and given the option of retaking the sample and treating in the field per the method requirements or the laboratory can analyze the samples as delivered and qualify the results in the final report.
 - It is the responsibility of the client to notify the laboratory if thiosulfate, sulfite, or thiocyanate are known or suspected to be present in the sample. This notification may be on the chain of custody. The samples may need to be subcontracted to a laboratory that performs a UV digestion. If the lab does not perform the UV digestion on samples that contain these compounds, the results must be qualified in the final report.
 - The laboratory must test the sample for oxidizing agents (e.g. Chlorine) prior to analysis and treat according to the methods prior to distillation. (ascorbic acid or sodium arsenite are the preferred choice).

6) Sample Holding Times

- Eurofins will make every effort to analyze samples within the regulatory holding time. Samples must be received in the laboratory with enough time to perform the sample analysis. Except for short holding time samples (< 48hr HT) sample must be received with at least 48 hrs (2 working days) remaining on the holding time for us to ensure analysis.
 - Analyses that are designated as “field” analyses (Odor, pH, Dissolved Oxygen, Disinfectant Residual; a.k.a. Residual Chlorine, and Redox Potential) should be analyzed ASAP by the field sampler prior to delivering to the lab (within 15 minutes). However, if the analyses are to be performed in the laboratory, Eurofins will make every effort to analyze the samples within 24 hours from receipt of the samples in the testing laboratory. Samples for “field” analyses received after 4:00 pm on Friday or on the weekend will be analyzed no later than the next business day after receipt (Monday unless a holiday). Samples will remain refrigerated and sealed until the time of analysis. The actual times of all “field” sample analyses are noted on the “Short Hold Time Detail Report” in the final report. Samples analyzed in the laboratory will be qualified on the final report with an ‘H’ to indicate holding time exceedance.
- 7) All samples submitted for Volatile Organic analyses must have a Trip Blank submitted at the same time. Eurofins will supply a blank with the bottle order.
- 8) The project manager will be notified if any sample is received in damaged condition. Eurofins will request that a sample be resubmitted for analysis.
- 9) Recommendations for packing samples for shipment.
- Pack samples in Ice rather than “Blue” ice packs.

- Soil samples should be placed in plastic zip-lock bags. The containers often have dirt around the top and do not seal very well and are prone to intrusion from the water from melted ice.
- Water samples would be best if wrapped with bubble-wrap or paper (newspaper, or paper towels work) and then placed in plastic zip-lock bags.
- Fill extra cooler space with bubble wrap.

SECTION 24. ASSURING THE QUALITY OF TEST RESULTS

24.1 Overview

In order to assure our clients of the validity of their data, the laboratory continuously evaluates the quality of the analytical process. The analytical process is controlled not only by instrument calibration as discussed in Section 20, but also by routine process quality control measurements (e.g. Blanks, Laboratory Control Samples (LCS), Matrix Spikes (MS), duplicates (DUP), surrogates, Internal Standards (IS)). These quality control checks are performed as required by the method or regulations to assess precision and accuracy. Quality control samples are to be treated in the exact same manner as the associated field samples being tested. In addition to the routine process quality control samples, Proficiency Testing (PT) Samples (concentrations unknown to laboratory) are analyzed to help ensure laboratory performance.

24.2 Controls

Sample preparation or pre-treatment is commonly required before analysis. Typical preparation steps include homogenization, grinding, solvent extraction, sonication, acid digestion, distillation, reflux, evaporation, drying and ashing. During these pre-treatment steps, samples are arranged into discreet manageable groups referred to as preparation (prep) batches. Prep batches provide a means to control variability in sample treatment. Control samples are added to each prep batch to monitor method performance and are processed through the entire analytical procedure with investigative/field samples.

24.3 Negative Controls

Table 24-1. Example – Negative Controls

Control Type	Details
Method Blank (MB)	are used to assess preparation and analysis for possible contamination during the preparation and processing steps. The specific frequency of use for method blanks during the analytical sequence is defined in the specific standard operating procedure for each analysis. Generally it is 1 for each batch of samples; not to exceed 20 environmental samples. The method blank is prepared from a clean matrix similar to that of the associated samples that is free from target analytes (e.g., Reagent water, Ottawa sand, glass beads, etc.) and is processed along with and under the same conditions as the associated samples. The method blank goes through all of the steps of the process (including as necessary: filtration, clean-ups, etc.). Reanalyze or qualify associated sample results when the concentration of a targeted analyte in the blank is at or above the reporting limit as established by the method or by regulation, AND is greater than 1/10 of the amount measured in the sample.
Calibration Blanks	are prepared and analyzed along with calibration standards where applicable. They are prepared using the same reagents that are used to prepare the standards. In some analyses the calibration blank may be included in the calibration curve.
Instrument Blanks	are blank reagents or reagent water that may be processed during an analytical sequence in order to assess contamination in the analytical system. In general, instrument blanks are used to differentiate between contamination caused by the analytical system and that caused by the sample handling or sample prep process. Instrument blanks may also be inserted throughout the analytical sequence to minimize the effect of carryover from samples with high analyte content.

Table 24-1. Example – Negative Controls

Control Type	Details
Trip Blank ¹	are required to be submitted by the client with each shipment of samples requiring aqueous and solid volatiles analyses (or as specified in the client's project plan). Additionally, trip blanks may be prepared and analyzed for volatile analysis of air samples, when required by the client. A trip blank may be purchased (certified clean) or is prepared by the laboratory by filling a clean container with pure deionized water that has been purged to remove any volatile compounds. Appropriate preservatives are also added to the container. The trip blank is sent with the bottle order and is intended to reflect the environment that the containers are subjected to throughout shipping and handling and help identify possible sources if contamination is found. The field sampler returns the trip blank in the cooler with the field samples.
Field Blanks ¹	are sometimes used for specific projects by the field samplers. A field blank prepared in the field by filling a clean container with pure reagent water and appropriate preservative, if any, for the specific sampling activity being undertaken. (EPA OSWER)
Equipment Blanks ¹	are also sometimes created in the field for specific projects. An equipment blank is a sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures. (TNI)
Holding Blanks	also referred to as refrigerator or freezer blanks, are used to monitor the sample storage units for volatile organic compounds during the storage of VOA samples in the laboratory

¹ When known, these field QC samples should not be selected for matrix QC as it does not provide information on the behavior of the target compounds in the field samples. Usually, the client sample ID will provide information to identify the field blanks with labels such as "FB", "EB", or "TB."

Evaluation criteria and corrective action for these controls are defined in the specific standard operating procedure for each analysis.

24.3.1 Negative Controls for Microbiological Methods – Microbiological Methods utilize a variety of negative controls throughout the process to ensure that false positive results are not obtained. These controls are critical to the validity of the microbiological analyses. Some of these negative controls are:

Table 24-2. Negative Controls for Microbiology

Control Type	Details
Sterility Checks (Media)	are analyzed for each lot of pre-prepared media, ready-to-use media and for each batch of medium prepared by the laboratory.
Filtration Blanks	blanks are run at the beginning and end for each sterilized filtration unit used in a filtration series. For pre-sterilized single use funnels a sterility check is performed on at least one funnel per lot.
Sterility checks (Sample Containers)	are performed on at least one container per lot of purchased, pre-sterilized containers. If containers are prepared and sterilized by the laboratory, one container per sterilization batch is checked. Container sterility checks are performed using non-selective growth media.
Sterility Checks (Dilution Water)	are performed on each batch of dilution water prepared by the laboratory and on each batch of pre-prepared dilution water. All checks are performed using non-selective growth media.
Sterility Checks (Filters)	are also performed on at least one filter from each new lot of membrane filters using non-selective growth media.

Negative culture controls demonstrate that a media does not support the growth of non-target organisms and ensures that there is not an atypical positive reaction from the target organisms. Prior to the first use of the media, each lot of pre-prepared selective media or batch of laboratory

prepared selective media is analyzed with at least one known negative culture control as appropriate to the method.

24.4 Positive Controls

Control samples (e.g., QC indicators) are analyzed with each batch of samples to evaluate data based upon (1) Method Performance (Laboratory Control Sample (LCS) or Blank Spike (BS)), which entails both the preparation and measurement steps; and (2) Matrix Effects (Matrix Spike (MS) (Matrix spikes are not applicable to air) or Sample Duplicate (MD, DUP), which evaluates field sampling accuracy, precision, representativeness, interferences, and the effect of the matrix on the method performed. Each regulatory program and each method within those programs specify the control samples that are prepared and/or analyzed with a specific batch

Note that frequency of control samples vary with specific regulatory, methodology and project specific criteria. Complete details on method control samples are as listed in each analytical SOP.

24.4.1 Method Performance Control - Laboratory Control Sample (LCS)

The LCS measures the accuracy of the method in a blank matrix and assesses method performance independent of potential field sample matrix affects in a laboratory batch.

The LCS is prepared from a clean matrix similar to that of the associated samples that is free from target analytes (for example: Reagent water, Ottawa sand, glass beads, etc.) and is processed along with and under the same conditions as the associated samples. The LCS is spiked with verified known amounts of analytes or is made of a material containing known and verified amounts of analytes, taken through all preparation and analysis steps along with the field samples. Where there is no preparation taken for an analysis (such as in aqueous volatiles), or when all samples and standards undergo the same preparation and analysis process (such as Phosphorus), a calibration verification standard is reported as the LCS. In some instances where there is no practical clean solid matrix available, aqueous LCS's may be processed for solid matrices; final results may be calculated as mg/kg or ug/kg, assuming 100% solids and a weight equivalent to the aliquot used for the corresponding field samples, to facilitate comparison with the field samples.

Certified pre-made reference material purchased from a NIST/A2LA accredited vendor may also be used for the LCS when the material represents the sample matrix or the analyte is not easily spiked (e.g. solid matrix LCS for metals, TDS, etc.).

The specific frequency of use for LCS during the analytical sequence is defined in the specific standard operating procedure for each analysis. It is generally 1 for each batch of samples; not to exceed 20 environmental samples.

If the mandated or requested test method, or project requirements, do not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample (and Matrix Spike) where applicable (e.g. no spike of pH). However, in cases where the components interfere with accurate assessment (such as simultaneously spiking chlordane, Toxaphene and PCBs in Method 608), the test method has an extremely long list of components or components are incompatible, at a minimum, a representative number of the listed components (see below) shall be used to control the test method. The selected components of each spiking mix shall represent all chemistries, elution patterns and

masses, permit specified analytes and other client requested components. However, the laboratory shall ensure that all reported components are used in the spike mixture within a two-year time period.

- For methods that have 1-10 target analytes, spike all components.
- For methods that include 11-20 target analytes, spike at least 10 or 80%, whichever is greater.
- For methods with more than 20 target analytes, spike at least 16 components.
- Exception: Due to analyte incompatibility in pesticides, Toxaphene and Chlordane are only spiked at client request based on specific project needs.
- Exception: Due to analyte incompatibility between the various PCB aroclors, aroclors 1016 and 1260 are used for spiking as they cover the range of all of the aroclors. Specific aroclors may be used by request on a project specific basis.

24.4.2 Positive Controls for Microbiological Methods *[Remove this section if not doing micro analyses]*

- Each lot of pre-prepared media (including chromofluorogenic reagent) and each batch of laboratory prepared media is tested with a pure culture of known positive reaction.
- In addition, every analytical batch also contains a pure culture of known positive reaction.
- A pure culture of known negative reaction is also tested with each analytical batch to ensure specificity of the procedure.

24.5 Sample Matrix Controls

Table 24-3. Sample Matrix Control

Control Type	Details	
Matrix Spikes (MS)	Use	used to assess the effect sample matrix of the spiked sample has on the precision and accuracy of the results generated by the method used;
	Typical Frequency ¹	At a minimum, with each matrix-specific batch of samples processed, an MS is carried through the complete analytical procedure. Unless specified by the client, samples used for spiking are randomly selected and rotated between different client projects. If the mandated or requested test method does not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample and Matrix Spike. Refer to the method SOP for complete details
	Description	essentially a sample fortified with a known amount of the test analyte(s).
Surrogate	Use	Measures method performance to sample matrix (organics only).
	Typical Frequency ¹	Are added to all samples, standards, and blanks, for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. The recovery of the surrogates is compared to the acceptance limits for the specific method. Poor surrogate recovery may indicate a problem with sample composition and shall be reported, with data qualifiers, to the client whose sample produced poor recovery.
	Description	Are similar to matrix spikes except the analytes are compounds with properties that mimic the analyte of interest and are unlikely to be found in environment samples.

Table 24-3. Sample Matrix Control

Control Type	Details	
Duplicates ²	Use	For a measure of analytical precision, with each matrix-specific batch of samples processed, a matrix duplicate (MD or DUP) sample, matrix spike duplicate (MSD), or LCS duplicate (LCSD) is carried through the complete analytical procedure.
	Typical Frequency ¹	Duplicate samples are usually analyzed with methods that do not require matrix spike analysis.
	Description	Performed by analyzing two aliquots of the same field sample independently or an additional LCS.
Internal Standards	Use	Are spiked into all environmental and quality control samples (including the initial calibration standards) to monitor the qualitative aspect of organic and some inorganic analytical measurements.
	Typical Frequency ¹	All organic and ICP methods as required by the analytical method.
	Description	Used to correct for matrix effects and to help troubleshoot variability in analytical response and are assessed after data acquisition. Possible sources of poor internal standard response are sample matrix, poor analytical technique or instrument performance.

¹ See the specific analytical SOP for type and frequency of sample matrix control samples.

² LCSD's are normally not performed except when regulatory agencies or client specifications require them. The recoveries for the spiked duplicate samples must meet the same laboratory established recovery limits as the accuracy QC samples. If an LCSD is analyzed both the LCS and LCSD must meet the same recovery criteria and be included in the final report. The precision measurement is reported as "Relative Percent Difference" (RPD). Poor precision between duplicates (except LCS/LCSD) may indicate non-homogeneous matrix or sampling.

24.6 Acceptance Criteria (Control Limits)

As mandated by the test method and regulation, each individual analyte in the LCS, MS, or Surrogate Spike is evaluated against the control limits published in the test method. Where there are no established acceptance criteria, the laboratory calculates in-house control limits with the use of control charts or, in some cases, utilizes client project specific control limits. When this occurs, the regulatory or project limits will supersede the laboratory's in-house limits.

Note: For methods, analytes and matrices with very limited data (e.g., unusual matrices not analyzed often), interim limits are established using available data or by analogy to similar methods or matrices.

Once control limits have been established, they are verified, reviewed, and updated if necessary on an annual basis unless the method requires more frequent updating. Control limits are established per method (as opposed to per instrument) regardless of the number of instruments utilized.

Laboratory generated % Recovery acceptance (control) limits are generally established by taking ± 3 Standard Deviations (99% confidence level) from the average recovery of a minimum of 20-30 data points (more points are preferred).

- Regardless of the calculated limit, the limit should be no tighter than the Calibration Verification (ICV/CCV). (Unless the analytical method specifies a tighter limit).
- In-house limits cannot be any wider than those mandated in a regulated analytical method. Client or contract required control limits are evaluated against the laboratory's statistically derived control limits to determine if the data quality objectives (DQOs) can be achieved. If

laboratory control limits are not consistent with DQOs, then alternatives must be considered, such as method improvements or use of an alternate analytical method.

- The lowest acceptable recovery limit will be 10% (the analyte must be detectable and identifiable). Exception: The lowest acceptable recovery limit for Benzidine will be 5% and the analyte must be detectable and identifiable.
- The maximum acceptable recovery limit will be 150%.
- The maximum acceptable RPD limit will be 35% for waters and 40% for soils. The minimum RPD limit is 10%.
- If either the high or low end of the control limit changes by $\leq 5\%$ from previous, the control chart is visually inspected and, using professional judgment, they may be left unchanged if there is no affect on laboratory ability to meet the existing limits.

24.6.1 The lab must be able to generate a current listing of their control limits and track when the updates are performed. In addition, the laboratory must be able to recreate historical control limits.

A Quality Control Limit Summary contains tables that summarize the precision and accuracy acceptability limits for analyses performed in Pensacola. This summary includes an effective date, is updated each time new limits are generated and is located on the QA drive. Unless otherwise noted, limits within these tables are laboratory generated. The analysts are instructed to use the current limits in the laboratory (dated and approved by the Technical Manager and QA Manager) and entered into the Laboratory Information Management System (TALS). The Quality Assurance department maintains an archive of all limits used within the laboratory.

24.6.2 A LCS that is within the acceptance criteria establishes that the analytical system is in control and is used to validate the process. Samples that are analyzed with an LCS with recoveries outside of the acceptance limits may be determined as out of control and should be reanalyzed if possible. If reanalysis is not possible, then the results for all affected analytes for samples within the same batch must be qualified when reported. The internal corrective action process (see Section 12) is also initiated if an LCS exceeds the acceptance limits. Sample results may be qualified and reported without reanalysis if:

- The analyte results are below the reporting limit and the LCS is above the upper control limit.
- If the analytical results are above the relevant regulatory limit and the LCS is below the lower control limit.

Or, for TNI and DoD/DOE work, there are an allowable number of Marginal Exceedances (ME):

<11 analytes	0 marginal exceedances are allowed.
11 – 30 Analytes	1 marginal exceedance is allowed
31-50 Analytes	2 marginal exceedances are allowed
51-70 Analytes	3 marginal exceedances are allowed
71-90 Analytes	4 marginal exceedances are allowed

> 90 Analytes	5 marginal exceedances are allowed

- Marginal exceedances are recovery exceedances between 3 SD and 4 SD from the mean recovery limit (TNI).
- Marginal exceedances must be random. If the same analyte exceeds the LCS control limit repeatedly, it is an indication of a systematic problem. The source of the error must be located and corrective action taken. To determine if a marginal exceedance is random, the analyst reviews the 2 most recent batches containing an LCS result for the method analyte combination in question. If the analyte did not exceed the control limits in either of the 2 preceding batches, then the exceedance is considered to be random. If the analyte failed in either of the 2 preceding batches the failure is not random and random marginal exceedance does not apply.
- Analytes designated as "Poor-Performers" in the various methods and/or method SOPs are not included in the evaluation of marginal exceedances.

Though marginal exceedances may be allowed, the data must still be qualified to indicate it is outside of the normal limits.

24.6.3 If the MS/MSDs do not meet acceptance limits, the MS/MSD and the associated spiked sample is reported with a qualifier for those analytes that do not meet limits. If obvious preparation errors are suspected, or if requested by the client, unacceptable MS/MSDs are reprocessed and reanalyzed to prove matrix interference. A more detailed discussion of acceptance criteria and corrective action can be found in the lab's method SOPs and in Section 12.

24.6.4 If a surrogate standard falls outside the acceptance limits, and if there is not obvious chromatographic matrix interference, reanalyze the sample to confirm a possible matrix effect. If the recoveries confirm or there was obvious chromatographic interference, results are reported from the original analysis and a qualifier is added. If the reanalysis meets surrogate recovery criteria, the second run is reported (or both are reported if requested by the client). Under certain circumstances, where all of the samples are from the same location and share similar chromatography, the reanalysis may be performed on a single sample rather than all of the samples and if the surrogate meets the recovery criteria in the reanalysis, all of the affected samples would require reanalysis.

24.7 Additional Procedures to Assure Quality Control

The laboratory has written and approved method SOPs to assure the accuracy of the test method including calibration (see Section 20), use of certified reference materials (see Section 21) and use of PT samples (see Section 15).

A discussion regarding MDLs, Limit of Detection (LOD) and Limit of Quantitation (LOQ) can be found in Section 19.

- Use of formulae to reduce data is discussed in the method SOPs and in Section 20.
- Selection of appropriate reagents and standards is included in Section 9 and 21.
- A discussion on selectivity of the test is included in Section 5.

- Constant and consistent test conditions are discussed in Section 18.
- The laboratories sample acceptance policy is included in Section 23.

SECTION 25. REPORTING RESULTS

25.1 Overview

The results of each test are reported accurately, clearly, unambiguously, and objectively in accordance with State and Federal regulations as well as client requirements. Analytical results are issued in a format that is intended to satisfy customer and laboratory accreditation requirements as well as provide the end user with the information needed to properly evaluate the results. Where there is conflict between client requests and laboratory ethics or regulatory requirements, the laboratory's ethical and legal requirements are paramount, and the laboratory will work with the client during project set up to develop an acceptable solution. Refer to Section 7.

A variety of report formats are available to meet specific needs.

In cases where a client asks for simplified reports, there must be a written request from the client. There still must be enough information that would show any analyses that were out of conformance (QC out of limits) and there should be a reference to a full report that is made available to the client. Review of reported data is included in Section 19.

25.2 Test Reports

Analytical results are reported in a format that is satisfactory to the client and meets all requirements of applicable accrediting authorities and agencies. A variety of report formats are available to meet specific needs. The report is printed on laboratory letterhead, reviewed, and signed by the appropriate project manager. At a minimum, the standard laboratory report shall contain the following information:

25.2.1 A report title (e.g., Analytical Report)

25.2.2 The cover page shall include the laboratory name, address and telephone number.

25.2.3 A unique identification of the report (e.g., Eurofins Job ID #) and on each page an identification in order to ensure the page is recognized as part of the report and a clear identification of the end.

Note: Page numbers of report are represented as page # of ##. Where the first number is the page number and the second is the total number of pages.

25.2.4 A copy of the chain of custody (COC).

- Any COCs involved with Subcontracting are included.

25.2.5 The name and address of client and a project name/number, if applicable.

25.2.6 Client project manager or other contact

25.2.7 Description and unambiguous identification of the tested sample(s) including the client identification code.

25.2.8 Date of receipt of sample, date and time of collection, and date(s) of test preparation and performance, and time of preparation or analysis if the required holding time for either activity is less than or equal to 72 hours.

25.2.9 Date reported or date of revision, if applicable.

25.2.10 Method of analysis including method code (EPA, Standard Methods, etc.).

25.2.11 Practical quantitation limits or reporting limit.

25.2.12 Method detection limits (if requested)

25.2.13 Definition of Data qualifiers and reporting acronyms (e.g. ND).

25.2.14 Sample results.

25.2.15 QC data consisting of method blank, surrogate, LCS, and MS/MSD recoveries and control limits.

25.2.16 Condition of samples at receipt including temperature. This may be accomplished in a narrative or by attaching sample login sheets (Refer to Sec. 25.2.4 – Item 3 regarding additional addenda).

25.2.17 A statement expressing the validity of the results, that the source methodology was followed and all results were reviewed for error.

25.2.18 A statement to the effect that the results relate only to the items tested and the sample as received by the laboratory, except when information is provided by the client. When data is provided by the client there shall be a clear identification of it, and a disclaimer shall be put in the report when the client supplied data can affect the validity of the test.

25.2.19 A statement that the report shall not be reproduced except in full, without prior express written approval by the laboratory coordinator.

25.2.20 A signature and title of the person(s) accepting responsibility for the content of the report and date of issue. Authorized signatories are qualified Project Managers appointed by the Manager of Project Managers.

25.2.21 When TNI accreditation is required, the lab shall certify that the test results meet all requirements of TNI or provide reasons and/or justification if they do not.

25.2.22 The laboratory includes a cover letter.

25.2.23 Where applicable, a narrative to the report that explains the issue(s) and corrective action(s) taken in the event that a specific accreditation or certification requirement was not met.

25.2.24 When soil samples are analyzed, a specific identification as to whether soils are reported on a “wet weight” or “dry weight” basis.

25.2.25 Appropriate laboratory certification number for the state of origin of the sample, if applicable.

25.2.26 If only part of the report is provided to the client (client requests some results before all of it is complete), it must be clearly indicated on the report (e.g., partial report, or how your lab identifies it). A complete report must be sent once all of the work has been completed.

25.2.27 Any non-Eurofins subcontracted analysis results are provided as a separate report on the official letterhead of the subcontractor. All Eurofins subcontracting is clearly identified on the report as to which laboratory performed a specific analysis.

25.2.28 A Certification Summary Report, where required, will document that, unless otherwise noted, all analytes tested and reported by the laboratory were covered by the noted certifications.

Note: Refer to the Corporate SOP on Electronic Reporting and Signature Policy (No. CA-I-P-002) for details on internally applying electronic signatures of approval.

25.2.29 Where the laboratory is responsible for the sampling stage, in addition to the requirements listed above, reports containing the results of sampling shall include the following, where necessary for the interpretation of test results:

- the date of sampling;
- unambiguous identification of the material sampled;
- the location of sampling plan and procedures, and deviations, addition to or exclusions from the sample procedures;
- a reference to the sampling plan and procedure, and deviations, additions to or exclusions from the sample procedures;
- details of any environmental conditions during sampling that affect the interpretation of test results;
- information required to evaluate measurement uncertainty for subsequent testing

25.3 Reporting Level or Report Type

The laboratory offers four levels of quality control reporting. Each level, in addition to its own specific requirements, contains all the information provided in the preceding level. The packages provide the following information in addition to the information described above:

- Level 1 is a report with all of the elements outlined in Section 25.2 above, excluding 25.2.15 (QC data).
- Level II is a Level I report plus summary information, including results for the method blank reported to the laboratory MDL, percent recovery for laboratory control samples and matrix spike samples, and the RPD values for all MSD and sample duplicate analyses.
- Level III contains all the information supplied in Level II, but presented on the CLP-like summary forms, and relevant calibration information. A Level II report is not included, unless specifically requested. No raw data is provided.
- Level IV is the same as Level III with the addition of all raw supporting data.

In addition to the various levels of QC packaging, the laboratory also provides reports in diskette deliverable form. Initial reports may be provided to clients by facsimile. Procedures used to ensure client confidentiality are outlined in Section 25.6.

25.3.1 Electronic Data Deliverables (EDDs)

EDDs are routinely offered as part of Eurofins's services in addition to the test report as described in Section 25.2. When NELAP accreditation is required and both a test report and EDD are provided to the client, the official version of the test report will be the combined information of the report and the EDD. Eurofins Pensacola offers a variety of EDD formats including Environmental Restoration Information Management System (ERPIMS), Staged Electronic Data Deliverable (SEDD) Environmental Quality Information System (EQUIS), Electronic Deliverable Format (EDF), Excel and custom.

EDD specifications are submitted to the IT department by the PM for review and undergo the contract review process. Once the facility has committed to providing data in a specific electronic format, the coding of the format may need to be performed. This coding is documented and validated. The validation of the code is retained by the IT staff coding the EDD.

EDDs shall be subject to a review to ensure their accuracy and completeness. If EDD generation is automated, review may be reduced to periodic screening if the laboratory can demonstrate that it can routinely generate that EDD without errors. Any revisions to the EDD format must be reviewed until it is demonstrated that it can routinely be generated without errors. If the EDD can be reproduced accurately and if all subsequent EDDs can be produced error-free, each EDD does not necessarily require a review.

25.4 Supplemental Information for Test

The lab identifies any unacceptable QC analyses or any other unusual circumstances or observations such as environmental conditions and any non-standard conditions that may have affected the quality of a result. This is typically in the form of a footnote or a qualifier and/or a narrative explaining the discrepancy in the front of the report.

Numeric results with values outside of the calibration range, either high or low are qualified as estimated.

Where quality system requirements are not met, a statement of compliance/non-compliance with requirements and/or specifications is required, including identification of test results derived from any sample that did not meet TNI sample acceptance requirements such as improper container, holding time, or temperature.

Where applicable, a statement on the estimated uncertainty of measurements; information on uncertainty is needed when a client's instructions so require.

When, as requested by the client and agreed to by Eurofins, the report includes a statement of conformity to specification or standard (see Special Services, Section 7.4), the report shall clearly identify:

- to which results the statement applies,

- which specifications, standard or parts thereof are met or not, and
- the decision rule that was applied (unless the decision rule is inherent in the requested specification or standard, taking into account the level of risk (such as false accept and false reject and statistical assumptions) associated with the decision rule.

Opinions and Interpretations - The test report contains objective information, and generally does not contain subjective information such as opinions and interpretations. If such information is required by the client, the Laboratory Director will determine if a response can be prepared. If so, the Laboratory Director will designate the appropriate member of the management team to prepare a response. The response will be fully documented, and reviewed by the Laboratory Director, before release to the client. There may be additional fees charged to the client at this time, as this is a non-routine function of the laboratory.

Note: Review of data deliverable packages for submittal to regulatory authorities requires responses to non-conforming data concerning potential impact on data quality. This necessitates a limited scope of interpretation, and this work is performed by the QA Department. This is the only form of “interpretation” of data that is routinely performed by the laboratory.

When opinions or interpretations are included in the report, the laboratory provides an explanation as to the basis upon which the opinions and interpretations have been made. Opinions and interpretations are clearly noted as such and where applicable, a comment should be added suggesting that the client verify the opinion or interpretation with their regulator.

25.5 Environmental Testing Obtained From Subcontractors

If the laboratory is not able to provide the client the requested analysis, the samples would be subcontracted following the procedures outlined in the Corporate SOP on Subcontracting (SOP No. CW-L-S-004).

Data reported from analyses performed by a subcontractor laboratory are clearly identified as such on the analytical report provided to the client. Results from a subcontract laboratory outside of Eurofins are reported to the client on the subcontract laboratory's original report stationary and the report includes any accompanying documentation.

25.6 Client Confidentiality

Eurofins is responsible for maintaining in confidence all client information obtained or created. In situations involving the transmission of environmental test results by telephone, facsimile or other electronic means, client confidentiality must be maintained.

Eurofins will not intentionally divulge to any person (other than the client or any other person designated by the client in writing) any information regarding the services provided by Eurofins or any information disclosed to Eurofins by the client. Furthermore, information known to be potentially endangering to national security or an entity's proprietary rights will not be released.

Information about the client obtained from sources other than the client (e.g., complainant, regulators) shall be confidential between client and the laboratory. The source of this information shall be confidential to the laboratory and shall not be shared with the client, unless agreed by the source.

Note: This shall not apply to the extent that the information is required to be disclosed by Eurofins under the compulsion of legal process. Eurofins will, to the extent feasible, provide reasonable notice to the client before disclosing the information.

Note: Authorized representatives of an accrediting authority are permitted to make copies of any analyses or records relevant to the accreditation process, and copies may be removed from the laboratory for purposes of assessment.

25.6.1 Report deliverable formats are discussed with each new client. If a client requests that reports be faxed or e-mailed, the reports are to meet all requirements of this document, including cover letter.

25.7 Format of Reports

The format of reports is designed to accommodate each type of environmental test carried out and to minimize the possibility of misunderstanding or misuse.

25.8 Amendments to Test Reports

Corrections, additions, or deletions to reports are only made when justification arises through supplemental documentation. Justification is documented using the laboratory's corrective action system (refer to Section 12).

The revised report is retained on the Archive data server, as is the original report. The revised report is stored in the Archive data server under the sample number with the revision number. The revised report will have the word "revised" or next to the date rather than the word "reported".

When the report is re-issued, a notation of "report re-issue" is placed on the cover/signature page of the report *or at the top of the narrative page* with a brief explanation of reason for the re-issue and a reference back to the last final report generated.

25.9 Policies on Client Requests for Amendments

25.9.1 Policy on Data Omissions or Reporting Limit Increases

Fundamentally, our policy is simply to not omit previously reported results (including data qualifiers) or to not raise reporting limits and report sample results as ND. This policy has few exceptions. Exceptions are:

- Laboratory error.
- Sample identification is indeterminate (confusion between COC and sample labels).
- An incorrect analysis (not analyte) was requested (e.g., COC lists 8315 but client wanted 8310). A written request for the change is required.
- Incorrect limits reported based on regulatory requirements.
- The requested change has absolutely no possible impact on the interpretation of the analytical results and there is no possibility of the change being interpreted as misrepresentation by anyone inside or outside of our company.

25.9.2 Multiple Reports

Eurofins does not issue multiple reports for the same work order where there is different information on each report (this does not refer to copies of the same report) unless required to meet regulatory needs and approved by QA.

Appendix 2. Glossary/Acronyms (EL-V1M2 Sec. 3.1)

Glossary:

Acceptance Criteria: Specified limits placed on characteristics of an item, process, or service defined in requirement documents. (ASQC)

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.

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. (QAMS)

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. (TNI)

Anomaly: A condition or event, other than a deficiency, that may affect the quality of the data, whether in the laboratory’s control or not.

Assessment: The evaluation process used to measure or establish the performance, effectiveness, and conformance of an organization and/or its systems to defined criteria (to the standards and requirements of laboratory accreditation). (TNI)

Audit: A systematic and independent examination of facilities, equipment, personnel, training, procedures, record-keeping, data validation, data management, and reporting aspects of a system to determine whether QA/QC and technical activities are being conducted as planned and whether these activities will effectively achieve quality objectives. (TNI)

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 (1) to twenty (20) environmental samples of the same quality systems 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 twenty-four (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 quality system matrices and can exceed twenty (20) samples. (TNI)

Bias: The systematic or persistent distortion of a measurement process, which causes errors in one direction (i.e., the expected sample measurement is different from the sample’s true value). (TNI)

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. (ASQC)

Calibration: A set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards. (TNI)

- 1) In calibration of support equipment the values realized by standards are established through the use of reference standards that are traceable to the International System of Units (SI).
- 2) In calibration according to methods, the values realized by standards are typically established through the use of Reference Materials that are either purchased by the laboratory with a certificate of analysis or purity, or prepared by the laboratory using support equipment that has been calibrated or verified to meet specifications.

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

Calibration Standard: A substance or reference material used to calibrate an instrument (QAMS)

Certified Reference Material (CRM): A reference material accompanied by a certificate, having a value, measurement uncertainty, and stated metrological traceability chain to a national metrology institute. (TNI)

Chain of Custody (COC) Form: Record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and types of containers; the mode of collection; the collector; time of collection; preservation; and requested analyses. (TNI)

Compromised Samples: Those samples which are improperly sampled, insufficiently documented (chain of custody and other sample records and/or labels), improperly preserved, collected in improper containers, or exceeding holding times when delivered to a laboratory. Under normal conditions, compromised samples are not analyzed. If emergency situation require analysis, the results must be appropriately qualified.

Confidential Business Information (CBI): Information that an organization designates as having the potential of providing a competitor with inappropriate insight into its management, operation or products. TNI and its representatives agree to safeguard identified CBI and to maintain all information identified as such in full confidentiality.

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. (TNI)

Conformance: An affirmative indication or judgment that a product or service has met the requirements of the relevant specifications, contract, or regulation; also the state of meeting the requirements. (ANSI/ASQC E4-1994)

Correction: Actions necessary to correct or repair analysis specific non-conformances. The acceptance criteria for method specific QC and protocols as well as the associated corrective actions. The analyst will most frequently be the one to identify the need for this action as a result of calibration checks and QC sample analysis. No significant action is taken to change behavior, process or procedure.

Corrective Action: The action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence. (ISO 8402)

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 the number of data items by arithmetic or statistical calculations, standard curves, and concentration factors, and collation into a more useable form. (TNI)

Deficiency: An unauthorized deviation from acceptable procedures or practices, or a defect in an item (ASQC), whether in the laboratory's control or not.

Demonstration of Capability: A procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision. (TNI)

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. (ASQC)

Duplicate Analyses: The analyses or measurements of the variable of interest performed identically on two subsamples 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. (EPA-QAD)

Equipment Blank: Sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures.

External Standard Calibration: Calibrations for methods that do not utilize internal standards to compensate for changes in instrument conditions.

Field Blank: Blank prepared in the field by filling a clean container with pure de-ionized water and appropriate preservative, if any, for the specific sampling activity being undertaken (EPA OSWER)

Field of Accreditation: Those matrix, technology/method, and analyte combinations for which the accreditation body offers accreditation.

Holding Times: The maximum time that samples may be held prior to analyses and still be considered valid or not compromised. (40 CFR Part 136)

Internal Standard: A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical test method. (TNI)

Internal Standard Calibration: Calibrations for methods that utilize internal standards to compensate for changes in instrument conditions.

Instrument Blank: A clean sample (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination. (EPA-QAD)

Instrument Detection Limit (IDL): The minimum amount of a substance that can be measured with a specified degree of confidence that the amount is greater than zero using a specific instrument. The IDL is associated with the instrumental portion of a specific method only, and sample preparation steps are not considered in its derivation. The IDL is a statistical estimation at a specified confidence interval of the concentration at which the relative uncertainty is $\pm 100\%$. The IDL represents a range where qualitative detection occurs on a specific instrument. Quantitative results are not produced in this range.

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 or a material containing known and verified amounts of analytes, taken through all preparation and analysis steps of the procedure unless otherwise noted in a reference method. 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.

An LCS shall be prepared at a minimum of 1 per batch of 20 or less samples per matrix type per sample extraction or preparation method except for analytes for which spiking solutions are not available such as total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, temperature, dissolved oxygen or turbidity. The results of these samples shall be used to determine batch acceptance.

Least Squares Regression (1st Order Curve): The least squares regression is a mathematical calculation of a straight line over two axes. The y axis represents the instrument response (or Response ratio) of a standard or sample and the x axis represents the concentration. The regression calculation will generate a correlation coefficient (r) that is a measure of the "goodness of fit" of the regression line to the data. A value of 1.00 indicates a perfect fit. In order to be used for quantitative purposes, r must be greater than or equal to 0.99 for organics and 0.995 for inorganics.

Limit(s) of Detection (LOD) [a.k.a., Method Detection Limit (MDL)]: The MDL is the minimum measured quantity of a substance that can be reported with 99% confidence that the concentration is distinguishable from method blank results, consistent with 40CFR Part 136 Appendix B, August, 2017.

Limit(s) of Quantitation (LOQ) [a.k.a., Reporting Limit]: The minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. (TNI)

(QS) 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 or Saline/Estuarine. Includes surface water, groundwater effluents, and TCLP or other extracts.

Drinking Water: Any aqueous sample that has been designated as 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: 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 & Emissions: 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 sorbant tube, impinger solution, filter, or other device. (TNI)

Matrix Spike (spiked sample or fortified sample): A sample prepared, taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a referenced method, by adding a known amount of target analyte to a specified amount of sample for which an independent test result 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 replicate matrix spike prepared 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 and 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: See Limit of Detection (LOD).

Negative Control: Measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results.

Non-conformance: An indication, judgment, or state of not having met the requirements of the relevant specifications, contract, or regulation.

Observation: A record of phenomena that (1) may assist in evaluation of the sample data; (2) may be of importance to the project manager and/or the client, and yet not at the time of the observation have any known effect on quality.

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.

Positive Control: Measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects.

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. (TNI)

Preservation: Any conditions under which a sample must be kept in order to maintain chemical and/or biological integrity prior to analysis. (TNI)

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. (TNI)

Proficiency Testing Program: The aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results and the collective demographics and results summary of all participating laboratories. (TNI)

Proficiency Test Sample (PT): A sample, the composition of which is unknown to the laboratory and is provided to test whether the laboratory can produce analytical results within specified acceptance criteria. (TNI)

Quality Assurance: An integrated system of management activities involving planning, implementation, assessment, reporting and quality improvement to ensure that a process, item or service is of the type of quality needed and expected by the client. (TNI)

Quality Assurance [Project] Plan (QAPP): A formal document describing the detailed quality control procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved. (EAP-QAD)

Quality Control: The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality; also the system of activities and checks used to ensure that measurement systems are maintained within prescribed limits, providing protection against "out of control" conditions and ensuring that the results are of acceptable quality. (TNI)

Quality Control Sample: A sample used to assess the performance of all or a portion of the measurement system. One of any number of samples, such as Certified Reference Materials, a quality system matrix fortified by spiking, or actual samples fortified by spiking, intended to demonstrate that a measurement system or activity is in control. (TNI)

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. (TNI)

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 activities. (TNI)

Raw Data: The documentation generated during sampling and analysis. This documentation includes, but is not limited to, field notes, electronic data, magnetic tapes, untabulated sample results, QC sample results, print outs of chromatograms, instrument outputs, and handwritten records. (TNI)

Record Retention: The systematic collection, indexing and storing of documented information under secure conditions.

Reference Material: Material or substance one or more properties of which are sufficiently homogeneous and well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials. (TNI)

Reference Standard: Standard used for the calibration of working measurement standards in a given organization or a given location. (TNI)

Sampling: Activity related to obtaining a representative sample of the object of conformity assessment, according to a procedure.

Second Order Polynomial Curve (Quadratic): The 2nd order curves are a mathematical calculation of a slightly curved line over two axis. The y axis represents the instrument response (or Response ratio) of a standard or sample and the x axis represents the concentration. The 2nd order regression will generate a coefficient of determination (COD or r^2) that is a measure of the "goodness of fit" of the quadratic curvature the data. A value of 1.00 indicates a perfect fit. In order to be used for quantitative purposes, r^2 must be greater than or equal to 0.99.

Selectivity: The ability to analyze, distinguish, and determine a specific analyte or parameter from another component that may be a potential interferent or that may behave similarly to the target analyte or parameter within the measurement system. (TNI)

Sensitivity: The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest. (TNI)

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 standard setting and meets the approval requirements of standard adoption organizations procedures and policies. (TNI)

Standard Operating Procedures (SOPs): A written document which details the method for an operation, analysis, or action, with thoroughly prescribed techniques and steps. SOPs are officially approved as the methods for performing certain routine or repetitive tasks. (TNI)

Storage Blank: A blank matrix stored with field samples of a similar matrix (volatiles only) that measures storage contribution to any source of contamination.

Surrogate: A substance with properties that mimic the analyte of interest. It is unlikely to be found in environment samples and is added to them for quality control purposes.

Surrogate compounds must be added to all samples, standards, and blanks, for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. Poor surrogate recovery may indicate a problem with sample composition and shall be reported to the client whose sample produced poor recovery. (QAMS)

Systems Audit (also Technical Systems Audit): A thorough, systematic, qualitative on-site assessment of the facilities, equipment, personnel, training, procedures, record keeping, data validation, data management, and reporting aspects of a total measurement system. (EPA-QAD)

Technical Manager: A member of the staff of an environmental laboratory who exercises actual day-to-day supervision of laboratory operations for the appropriate fields of accreditation and reporting of results

Technology: A specific arrangement of analytical instruments, detection systems, and/or preparation techniques.

Traceability: The ability to trace the history, application, or location of an entity by means of recorded identifications. In a calibration sense, traceability relates measuring equipment to national or international standards, primary standards, basic physical constants or properties, or reference materials. In a data collection sense, it relates calculations and data generated throughout the project back to the requirements for the quality of the project. (TNI)

Trip Blank: A blank matrix placed in a sealed container at the laboratory that is shipped, held unopened in the field, and returned to the laboratory in the shipping container with the field samples.

Uncertainty: A parameter associated with the result of a measurement that characterizes the dispersion of the value that could reasonably be attributed to the measured value.

Acronyms:

CAR – Corrective Action Report
CCV – Continuing Calibration Verification
CF – Calibration Factor
CFR – Code of Federal Regulations
COC – Chain of Custody
DOC – Demonstration of Capability
DQO – Data Quality Objectives
DUP - Duplicate

EHS – Environment, Health and Safety
EPA – Environmental Protection Agency
GC - Gas Chromatography
GC/MS - Gas Chromatography/Mass Spectrometry
HPLC - High Performance Liquid Chromatography
ICP - Inductively Coupled Plasma Atomic Emission Spectroscopy
ICP/MS – ICP/Mass Spectrometry
ICV – Initial Calibration Verification
IDL – Instrument Detection Limit
IH – Industrial Hygiene
IS – Internal Standard
LCS – Laboratory Control Sample
LCSD – Laboratory Control Sample Duplicate
LIMS – Laboratory Information Management System
LOD – Limit of Detection
LOQ – Limit of Quantitation
MDL – Method Detection Limit
MDLCK – MDL Check Standard
MDLV – MDL Verification Check Standard
MRL – Method Reporting Limit Check Standard
MS – Matrix Spike
MSD – Matrix Spike Duplicate
SDS - Safety Data Sheet
NELAP - National Environmental Laboratory Accreditation Program
PT – Performance Testing
TNI – The NELAC Institute
QAM – Quality Assurance Manual
QA/QC – Quality Assurance / Quality Control
QAPP – Quality Assurance Project Plan
RF – Response Factor
RPD – Relative Percent Difference
RSD – Relative Standard Deviation
SD – Standard Deviation
SOP – Standard Operating Procedure
TAT – Turn-Around-Time
VOA – Volatiles
VOC – Volatile Organic Compound

Appendix 3. Laboratory Certifications, Accreditations, Validations

Eurofins Pensacola maintains accreditations, certifications, and approvals with numerous state and national entities. Programs vary but may include on-site audits, reciprocal agreements with another entity, performance testing evaluations, review of the QA Manual, Standard Operating Procedures, Method Detection Limits, training records, etc. At the time of this QA Manual revision, the laboratory has accreditation/ certification/licensing with the following organizations:

Laboratory	Authority	Program	Lab Cert Id
Eurofins TestAmerica, Pensacola	Alabama	State Program	40150
Eurofins TestAmerica, Pensacola	ANAB	ISO/IEC 17025	L2471
Eurofins TestAmerica, Pensacola	Arizona	State Program	AZ0710
Eurofins TestAmerica, Pensacola	Arkansas DEQ	State Program	88-0689
Eurofins TestAmerica, Pensacola	California	State Program	2510
Eurofins TestAmerica, Pensacola	Florida	NELAP	E81010
Eurofins TestAmerica, Pensacola	Georgia	State Program	E81010 (FL)
Eurofins TestAmerica, Pensacola	Illinois	NELAP	200041
Eurofins TestAmerica, Pensacola	Iowa	State Program	367
Eurofins TestAmerica, Pensacola	Kansas	NELAP	E-10253
Eurofins TestAmerica, Pensacola	Kentucky (UST)	State Program	53
Eurofins TestAmerica, Pensacola	Kentucky (WW)	State Program	98030
Eurofins TestAmerica, Pensacola	Louisiana	NELAP	30976
Eurofins TestAmerica, Pensacola	Louisiana (DW)	NELAP	LA017
Eurofins TestAmerica, Pensacola	Maryland	State Program	233
Eurofins TestAmerica, Pensacola	Massachusetts	State Program	M-FL094
Eurofins TestAmerica, Pensacola	Michigan	State Program	9912
Eurofins TestAmerica, Pensacola	New Jersey	NELAP	FL006
Eurofins TestAmerica, Pensacola	North Carolina (WW/SW)	State Program	314
Eurofins TestAmerica, Pensacola	Oklahoma	State Program	9810
Eurofins TestAmerica, Pensacola	Pennsylvania	NELAP	68-00467
Eurofins TestAmerica, Pensacola	Rhode Island	State Program	LAO00307
Eurofins TestAmerica, Pensacola	South Carolina	State Program	96026
Eurofins TestAmerica, Pensacola	Tennessee	State Program	TN02907
Eurofins TestAmerica, Pensacola	Texas	NELAP	T104704286-18-15
Eurofins TestAmerica, Pensacola	US Fish & Wildlife	Federal	LE058448-0
Eurofins TestAmerica, Pensacola	USDA	Federal	P330-18-00148
Eurofins TestAmerica, Pensacola	Virginia	NELAP	460166
Eurofins TestAmerica, Pensacola	Washington	State Program	C915
Eurofins TestAmerica, Pensacola	West Virginia DEP	State Program	136

The certificates and accredited parameter lists are available for each State/Program at www.Eurofinsinc.com under Analytical Services Search – Certifications.

APPENDIX F – FIELD FORMS

DEP-SOP-001/01
FM 1000 Field Planning and Mobilization
Form FD 9000-22
Field Sample Collection Equipment Checklist

Date: _____

Project/Site: _____

① 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

② 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

③ Sample Transportation Supplies

- ☐ Ice chests
- ☐ Wet ice
- ☐ Sealing tape
- ☐ Shipping labels
- ☐ Shipping forms
- ☐ Bubble wrap
- ☐ Plastic bags
- ☐ Vermiculite
- ☐ Custody seals

④ 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

⑤ REFERENCE MATERIALS

- ☐ Site maps and directions
- ☐ QAPP
- ☐ Sampling plan
- ☐ SOPs
- ☐ Itinerary
- ☐ Float plan
- ☐ Contingency plan

⑥ 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

⑦ FIELD MEASUREMENT EQUIPMENT

- ☐ Lint-free tissues
- ☐ Flow-through cells
- ☐ pH meter
 - ☐ 4, 7 & 10 buffers
- ☐ Conductivity meter
 - ☐ Solution at expected conductivity
- ☐ DO meter
- ☐ Tubidimeter
 - ☐ Gel or Formazin standards
- ☐ Residual chlorine
 - ☐ Secondary or primary standards
- ☐ Secchi disk
- ☐ MultiProbe

⑧ 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

⑨ 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

DEP-SOP-001/01
FM 1000 Field Planning and Mobilization
Form FD 9000-22
Field Sample Collection Equipment Checklist

Date: _____

Project/Site: _____

①①VEHICLES

- ☐ Truck
 - ☐ Fuel
- ☐ Boat
 - ☐ Fuel
 - ☐ Motor
 - ☐ Paddles/oars
 - ☐ Safety vests

①①MISCELLANEOUS SUPPLIES

- ☐ Hip boots
- ☐ Chest waders
- ☐ Rain gear
- ☐ Tool kit
- ☐ Extra batteries
- ☐ Stopwatch

BORING LOG

Page 1 of _____

Boring/Well Number:			Permit Number:			FDEP Facility Identification Number:					
Site Name:			Borehole Start Date:		Borehole Start Time:		☐ AM	☐ PM			
			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 Borehole DTW (in feet from soil moisture content):		Measured Well DTW (in feet after water recharges in well):		OVA (list model and check type):					
						☐ FID ☐ PID					
Disposition of Drill Cuttings [check method(s)]: ☐ Drum ☐ Spread ☐ Backfill ☐ Stockpile ☐ Other											
<i>(describe if other or multiple items are checked):</i>											
Borehole Completion (check one): ☐ Well ☐ Grout ☐ Bentonite ☐ Backfill ☐ Other (describe)											
Sample Type	Sample Depth Interval (feet)	Sample Recovery (inches)	SPT Blows (per six 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 Groundwater Samples (list sample number and depth or temporary screen interval)
							1				
							2				
							3				
							4				
							5				
							6				
							7				
							8				
							9				
							10				
							11				
							12				

Sample Type Codes: **PH** = Post Hole; **HA** = Hand Auger; **SS** = Split Spoon; **ST** = Shelby Tube; **DP** = Direct Push; **SC** = Sonic Core; **DC** = Drill Cuttings
 Moisture Content Codes: **D** = Dry; **M** = Moist; **W** = Wet; **S** = Saturated

BORING LOG

Page 2 of _____

Boring/Well Number:		FDEP Facility Identification Number:			Site Name:		Borehole Start Date:				
							End Date:				
Sample Type	Sample Depth Interval (feet)	Sample Recovery (inches)	SPT Blows (per six 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 Groundwater Samples (list sample number and depth or temporary screen interval)
							13				
							14				
							15				
							16				
							17				
							18				
							19				
							20				
							21				
							22				
							23				
							24				
							25				
							26				
							27				
							28				
							29				
							30				

Sample Type Codes: **PH** = Post Hole; **HA** = Hand Auger; **SS** = Split Spoon; **ST** = Shelby Tube; **DP** = Direct Push; **SC** = Sonic Core; **DC** = Drill Cuttings

Moisture Content Codes: **D** = Dry; **M** = Moist; **W** = Wet; **S** = Saturated

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): ☐ On-Site ☐ Right-of-Way ☐ Off-Site Private Property ☐ Above Grade (AG) ☐ Flush-to-Grade		Well Purpose: ☐ Perched Monitoring ☐ Shallow (Water-Table) Monitoring ☐ Intermediate or Deep Monitoring ☐ Remediation or Other (describe)		Well Install Method:
If AG, list feet of riser above land surface:				Surface Casing Install Method:
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:	☐ Flush-Threaded ☐ Other (describe)		Riser Length: _____ feet from _____ feet to _____ feet
Screen Diameter and Material:	Screen Slot Size:		Screen Length: _____ feet from _____ feet to _____ feet	
1 st Surface Casing Material: also check: ☐ Permanent ☐ Temporary	1 st Surface Casing I.D. (inches):		1 st Surface Casing Length: _____ feet from _____ 0 _____ feet to _____ feet	
2 nd Surface Casing Material: also check: ☐ Permanent ☐ Temporary	2 nd Surface Casing I.D. (inches):		2 nd Surface Casing Length: _____ feet from _____ 0 _____ feet to _____ feet	
3 rd Surface Casing Material: also check: ☐ Permanent ☐ Temporary	3 rd Surface Casing I.D. (inches):		3 rd Surface Casing Length: _____ feet from _____ 0 _____ feet to _____ feet	
Filter Pack Material and Size:	Prepacked Filter Around Screen (check one): ☐ Yes ☐ 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): ☐ Surge/Pump ☐ Pump ☐ Compressed Air ☐ Other (describe)	
Development Pump Type (check): ☐ Centrifugal ☐ Peristaltic ☐ Submersible ☐ Other (describe)		Depth to Groundwater (before developing in feet):	
Pumping Rate (gallons per minute):	Maximum Drawdown of Groundwater During Development (feet):		Well Purged Dry (check one): ☐ Yes ☐ No
Pumping Condition (check one): ☐ Continuous ☐ Intermittent	Total Development Water Removed (gallons):	Development Duration (minutes):	Development Water Drummed (check one): ☐ Yes ☐ No
Water Appearance (color and odor) At Start of Development:		Water Appearance (color and odor) At End of Development:	

WELL CONSTRUCTION OR DEVELOPMENT REMARKS

OVA Field Data Sheet

Site: _____
OVA Model: _____

Project No. _____
Sampler: _____

Designation:[illegible]

Designation: _____

[illegible]

Designation: _____

[illegible]

Designation:

[illegible]

Designation:

[illegible]

Designation:

[illegible]

Top of Casing Sheet for Three-Wire Surveying

Site:**Date:**

Surveyors:

Project No:

Page: of

3-Wire Reading	Backsight (BS)	Height of Instrument (HI) (BS + Elev)	3-Wire Reading	Foresight (FS)	Elevation HI - FS	Recorded Elevation	Comments

Form FD 9000-24
GROUNDWATER SAMPLING LOG

SITE NAME:		SITE LOCATION:	
WELL NO:	SAMPLE ID:		DATE:

PURGING DATA

WELL DIAMETER (inches):		TUBING DIAMETER (inches):		WELL SCREEN INTERVAL DEPTH: feet to feet		STATIC DEPTH TO WATER (feet):		PURGE PUMP TYPE OR BAILER:			
WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH - STATIC DEPTH TO WATER) X WELL CAPACITY (only fill out if applicable) = (feet – feet) X gallons/foot = gallons											
EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = PUMP VOLUME + (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME (only fill out if applicable) = gallons + (gallons/foot X feet) + gallons = gallons											
INITIAL PUMP OR TUBING DEPTH IN WELL (feet):			FINAL PUMP OR TUBING DEPTH IN WELL (feet):			PURGING INITIATED AT:		PURGING ENDED AT:		TOTAL VOLUME PURGED (gallons):	
TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet)	pH (standard units)	TEMP. (°C)	COND. (circle units) <u>μmhos/cm</u> <u>or μS/cm</u>	DISSOLVED OXYGEN (circle units) mg/L <u>or</u> % saturation	TURBIDITY (NTUs)	COLOR (describe)	ODOR (describe)
WELL CAPACITY (Gallons Per Foot): 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 TUBING INSIDE DIA. CAPACITY (Gal./Ft.): 1/8" = 0.0006; 3/16" = 0.0014; 1/4" = 0.0026; 5/16" = 0.004; 3/8" = 0.006; 1/2" = 0.010; 5/8" = 0.016											
PURGING EQUIPMENT CODES: B = Bailer; BP = Bladder Pump; ESP = Electric Submersible Pump; PP = Peristaltic Pump; O = Other (Specify)											

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION:				SAMPLER(S) SIGNATURE(S):			SAMPLING INITIATED AT:		SAMPLING ENDED AT:	
PUMP OR TUBING DEPTH IN WELL (feet):				TUBING MATERIAL CODE:			FIELD-FILTERED: Y N Filtration Equipment Type:		FILTER SIZE: ____ µm	
FIELD DECONTAMINATION: PUMP Y N TUBING Y N (replaced)							DUPLICATE: Y N			
SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD		SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH				
REMARKS:										
MATERIAL CODES: AG = Amber Glass; CG = Clear Glass; PE = Polyethylene; PP = Polypropylene; S = Silicone; T = Teflon; O = Other (Specify)										
SAMPLING EQUIPMENT CODES: APP = After Peristaltic Pump; B = Bailer; BP = Bladder Pump; ESP = Electric Submersible Pump; RFPP = Reverse Flow Peristaltic Pump; SM = Straw Method (Tubing Gravity Drain); O = Other (Specify)										

NOTES: 1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.

2. STABILIZATION CRITERIA FOR RANGE OF VARIATION OF LAST THREE CONSECUTIVE READINGS (SEE FS 2212, SECTION 3)

pH: ± 0.2 units **Temperature:** ± 0.2 °C **Specific Conductance:** $\pm 5\%$ **Dissolved Oxygen:** all readings $\leq 20\%$ saturation (see Table FS 2200-2); optionally, ± 0.2 mg/L or $\pm 10\%$ (whichever is greater) **Turbidity:** all readings < 20 NTU; optionally ± 5 NTU or $\pm 10\%$ (whichever is greater)

Revision Date: February 12, 2009

FIELD INSTRUMENT CALIBRATION RECORDS - CALIBRATION LOG - PRP

Project Site/FacID: _____

Calibrated by (Print)/Affiliation: _____

Boldly "X" this box if there is qualified data on this page.

Temperature (Quarterly)	Date of Last Temp Verification: _____	See log book: _____

DISSOLVED OXYGEN (DO) (REFERENCE: DEP SOP FT 1500)										Acceptance Criteria +/-0.3 mg DO/L		
Meter/Instrument Name and Unique ID: _____												
CAL	ICV	CCV	Initials	Date	Time	Standard (DO %)	Temp °C	DO Saturation mg/L (100%)**	Response DO (%)	Response mg DO/L	Deviation mg DO/L	Pass or Fail
CAL	ICV	CCV	_____	_____	_____	100%	_____	_____	_____	_____	_____	P F
CAL	ICV	CCV	_____	_____	_____	100%	_____	_____	_____	_____	_____	P F
CAL	ICV	CCV	_____	_____	_____	100%	_____	_____	_____	_____	_____	P F
CAL	ICV	CCV	_____	_____	_____	100%	_____	_____	_____	_____	_____	P F
CAL	ICV	CCV	_____	_____	_____	100%	_____	_____	_____	_____	_____	P F
CAL	ICV	CCV	_____	_____	_____	100%	_____	_____	_____	_____	_____	P F

** See Table FS 2200-2 and/or Table FT 1500-1 for Dissolved Oxygen 100% Saturation (mg/L) corresponding to Temperature.

SPECIFIC CONDUCTANCE (REFERENCE: DEP SOP FT 1200)										Acceptance Criteria +/-5% the standard		
Meter/Instrument Name and Unique ID: _____												
CAL	ICV	CCV	Initials	Date	Time	Standard (µmho/cm)	Exp. Date	Lot #	Response (µmho/cm)	Deviation (%)	Pass or Fail	
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P F	
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P F	
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P F	
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P F	
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P F	
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P F	
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P F	
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P F	
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P F	

OXIDATION-REDUCTION POTENTIAL (ORP)										Acceptance Criteria +/-10 mV		
REFERENCE: EPA Region 4, Operating Procedure, Field Measurement of Oxidation-Reduction Potential (ORP)												
Meter/Instrument Name and Unique ID: _____												
CAL	ICV	CCV	Initials	Date	Time	Standard (mV)	Exp. Date	Lot #	Response (mV)	Deviation (mV)	Pass or Fail	
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P F	
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P F	
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P F	
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P F	
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P F	
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P F	

Perform ICVs and CCVs only in "READ/RUN" mode.

CAL - Calibration; ICV - Initial Calibration Verification; and, CCV - Continuing Calibration Verification.

Deviation (%) = 100-{(Response/Standard)*100}

FIELD INSTRUMENT CALIBRATION RECORDS - CALIBRATION LOG - PRP

Project Site/FacID: _____

Calibrated by (Print)/Affiliation: _____

Boldly "X" this box if there is qualified data on this page.

TURBIDITY (REFERENCE: DEP SOP FT 1600)

Meter/Instrument Name and Unique ID: _____

Std=0.1-10 NTU +/-10%						Std=11-40 NTU +/-8%		Std=41-100 NTU +/-6.5%		Std>100 NTU +/-5%		
CAL	ICV	CCV	Initials	Date	Time	Standard (NTU)	Exp. Date	Lot #	Response (NTU)	Deviation (%)	Pass or Fail	
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F

pH (REFERENCE: DEP SOP FT 1100)

Acceptance Criteria +/-0.2 SU

Meter/Instrument Name and Unique ID: _____

CAL	ICV	CCV	Initials	Date	Time	Standard (SU)	Exp. Date	Lot #	Response (SU)	Deviation (SU)	Pass or Fail	
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F
CAL	ICV	CCV	_____	_____	_____	_____	_____	_____	_____	_____	P	F

Perform ICVs and CCVs only in "READ/RUN" mode.

CAL - Calibration; ICV - Initial Calibration Verification; and, CCV - Continuing Calibration Verification.

Deviation (%) = 100-{|(Response/Standard)*100|}

Project Site/FacID: _____	<i>Boldly "X" this box if there is qualified data on this page.</i>
Calibrated by (Print)/Affiliation: _____	

Acceptance Criteria +/-5% the standard

Meter/Instrument Name and Unique ID:

[illegible]

Notes (e.g. corrective actions, etc):

Version Date: November 2021

FIELD INSTRUMENT CALIBRATION RECORDS - CALIBRATION LOG - PRP

THIS FORM MAY BE USED FOR NON-TYPICAL PARAMETERS.

THIS FORM SHALL **NOT** BE USED FOR TYPICAL PARAMETERS (i.e. pH, DO, ORP, OVA, Turbidity, Conductance, etc.).

Project Site/FacID:

Calibrated by (Print)/Affiliation:

Boldly "X" this box if there is qualified data on this page.

[illegible]

Notes (e.g. corrective actions, etc):

Perform only in Calibrate Mode:	CAL - Calibrate
Perform only in Read/Run Mode:	ICV - Initial Calibration Verification
Perform only in Read/Run Mode:	CCV - Continuing Calibration Verification
Deviation (%) = 100-{(Response/Standard)*100}	

DEP-SOP-001/01
FM 1000 Field Planning and Mobilization
Form FD 9000-23
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 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

DEP-SOP-001/01
FM 1000 Field Planning and Mobilization
Form FD 9000-23
Field Sample Collection Equipment Checklist

Date: _____

Project/Site: _____

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

**APPENDIX G – FIELD INVESTIGATION STANDARD OPERATING
PROCEDURES**

FDEP SOP 001/01

FDEP Designation	File Name	Description
Field Title Page	fieldtitle.pdf (80 kB)	Title Page, Field
FA 1000	fa1000.pdf (400 kB)	Administrative
FC 1000	fc1000.pdf (280 kB)	Field Decontamination
FD 1000	fd1000.pdf (380 kB)	Documentation
FM 1000	fm1000.pdf (240 kB)	Field Mobilization
FQ 1000	fq1000.pdf (90 kB)	Quality Control
FS 1000	fs1000.pdf (612 kB)	General Sampling
FS 2000	fs2000.pdf (297 kB)	General Water Sampling
FS 2100	fs2100.pdf (107 kB)	Surface Water Sampling
FS 2200	fs2200.pdf (486 kB)	Groundwater Sampling
FS 2300	fs2300.pdf (65 kB)	Drinking Water Sampling
FS 2400	fs2400.pdf (217 kB)	Wastewater Sampling
FS 3000	fs3000.pdf (159 kB)	Soil Sampling
FS 4000	fs4000.pdf (89 kB)	Sediment Sampling
FS 5000	fs5000.pdf (241 kB)	Waste Sampling
FS 6000	fs6000.pdf (709 kB)	Tissue Sampling
FS 7000	fs7000.pdf (442 kB)	Biological Communities
FS 8100	fs8100.pdf (50 kB)	Contaminated Surfaces Sampling
FS 8200	fs8200.pdf (258 kB)	Clean Sampling for Trace Metals
FT 1000	ft1000.pdf (98 kB)	Field Testing General
FT 1100	ft1100.pdf (72 kB)	Field pH
FT 1200	ft1200.pdf (149 kB)	Field Specific Conductance
FT 1300	ft1300.pdf (74 kB)	Field Salinity
FT 1400	ft1400.pdf (65 kB)	Field Temperature
FT 1500	ft1500.pdf (109 kB)	Field Dissolved Oxygen
FT 1600	ft1600.pdf (88 kB)	Field Turbidity
FT 1700	ft1700.pdf (76 kB)	Field Light Penetration
FT 1800	ft1800.pdf (89 kB)	Field Flowmeters
FT 1900	ft1900.pdf (46 kB)	Field Continuous Monitoring
FT 2000	ft2000.pdf (232 kB)	Field Residual Chlorine
FT 2100	ft2100.pdf (232 kB)	Oxygen Reduction Potential
FT 2200	ft2200.pdf (232 kB)	Field Measurement of Sulfite
FT 2300	ft2300.pdf (232 kB)	Field Measurement of Sediment Oxygen Demand
FT 2400	ft2400.pdf (232 kB)	Field Measurement of Explosive Gases
LQ 1000	lq1000.pdf (127 kB)	Laboratory Quality Control
LT 7000	lt7000.pdf (732 kB)	Biological Indices

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: ± 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: ± 0.2 mg/L or 10%, whichever is greater
- Turbidity: ± 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 ± 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 ≤ 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.

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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.

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- 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.

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- 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.

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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 ≤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.

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- 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.

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- 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.

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- 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.

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- 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

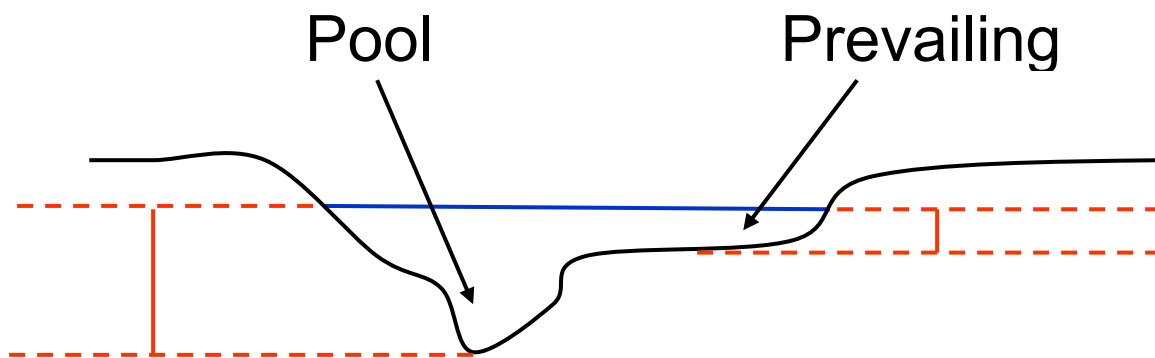
FT-3000 Training for Stream Habitat Assessment Checklist

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.

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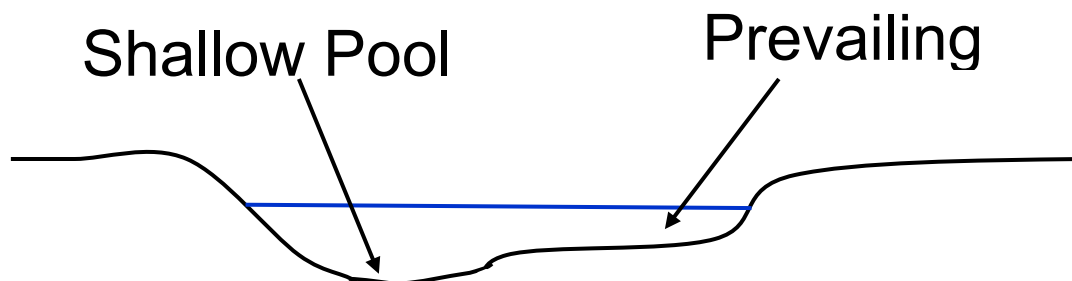
- b. Follow the criteria given on the data sheet within each category to determine the appropriate score for that category.
- c. Score the **Substrate Diversity** by evaluating the number of different kinds of productive substrates present. Refer to the Stream/River Habitat Sketch Sheet (FD 9000-4) and 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

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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.



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.

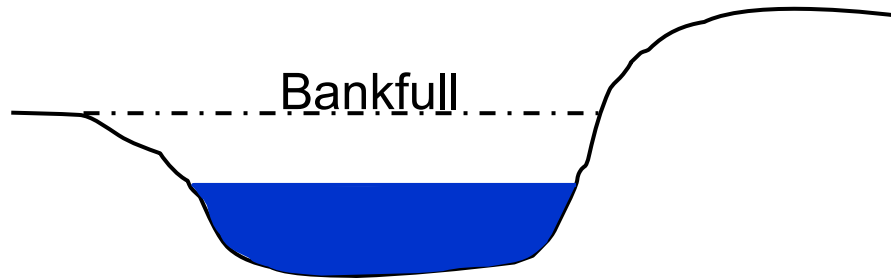
- ii. Second, check for deposition of sand or silt on visible habitats. While a light dusting of sand or silt is normal, excessively thick coatings will reduce habitability of the substrate. Sand smothering on visible habitats is indicated if sand is present on a substrate in an amount greater than a 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

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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.

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 sections II. and III. 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”.

- 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.

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- 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.

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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.

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- 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.

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- 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.

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- 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.

The diagram shows a cross-section of a stream bed. A solid black line represents the stream bed profile, which has a deep, narrow depression on the left and a shallower, wider area on the right. A horizontal blue line is drawn across the stream, representing the prevailing depth. An arrow labeled 'Pool' points to the deep depression. Another arrow labeled 'Prevailing' points to the blue line. Two horizontal dashed red lines are drawn above and below the blue line, and a vertical red line segment connects them on the left side, indicating a depth measurement.

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.

The diagram shows a cross-section of a stream bed. A solid black line represents the stream bed profile, which has a deep, narrow depression on the left and a shallower, wider area on the right. A horizontal blue line is drawn across the stream, representing the prevailing depth. An arrow labeled 'Shallow Pool' points to the deep depression. Another arrow labeled 'Prevailing' points to the blue line. The blue line is positioned higher than in the first diagram, indicating a shallower prevailing depth.

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:

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- 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.

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 sections II. and III. 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".

- 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

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- 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

Acceptance criteria	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.
Accuracy	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.
Analyte	Any measured quantity reported in final units of concentration.
Analyte group	A categorical grouping of analytes based on shared sample collection procedure and equipment construction restrictions. See Tables FA 1000-2 and FA 1000-3.
Analyte-free water	Water free of all positive or negative analytical interferences in which all analytes of interest are below method detection limits.
Audit	A systematic check to determine the quality of the operation of a function, procedure or activity.
Best management practices (BMPs)	Procedures designed to mitigate against adverse environmental consequences associated with human activities.
Bioaccumulation	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.
Bioconcentration	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.
Biological tissue	Includes tissues of plant or animal origin. The most common of these are shellfish, finfish and aquatic plants.
Biomagnification	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.
Blank	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.
Blind sample	A quality control sample of known composition whose analytical characteristics are unknown to an audited analyst or organization.
Calibration	The process by which the correlation between instrument response and actual value of a measured analyte or parameter is determined.

Glossary

Calibration curve	A curve that plots the concentration of known analyte standards against the instrument response to the analyte. Also known as a standard curve.
Calibration standard	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.
Calibration verification	Analyzing a standard as a sample to confirm that the test instrument remains calibrated.
Chemical waste	Liquid or solid chemicals that are no longer industrially useful.
Chronological bracket	Verifying calibration before and after the measurement of environmental samples.
Comparability	Expresses the statistical confidence with which one data set can be compared to another.
Confidence level	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.
Continuing calibration standard	A standard analyzed during a measurement process to verify the accuracy of a calibration curve or other instrument calibration.
Continuing calibration verification	Analysis of a standard as if it were a sample to check the status of the test instrument calibration.
Creel census	An assessment of the fish consumption by human populations based on a statistical survey of fish landings by sport and subsistence catches.
Data quality	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.
Data quality objectives	A set of specifications established for an intended use of a set of data.
Data validation	An audit in which data are evaluated according to predetermined validation criteria established as data quality objectives.
Detection limit	The smallest amount of an analyte that can be measured with a stated probability of significance.
D-frame dip net	Pole with a No.30 mesh bag attached to a "D-shaped" frame used for the collection of aquatic invertebrates.
Drinking water	Includes finished (treated) or raw source water designated as potable water. Drinking water sources may originate from surface or ground water.

Glossary

Environmental sample	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
Equipment blank	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.
External	Refers to operations, personnel, documents and protocols from a party that is separate from or outside the specified organization.
Field blanks	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.
Field spike	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.
Frotus	A double rake-head with a line attached and used for collecting submerged aquatic vegetation.
Groundwater	Includes all waters found below ground in confined or unconfined aquifers.
Hester-Dendy artificial substrate (HD)	Artificial substrate of known surface area used for the collection of invertebrates over a known amount of time.
Hydrophobic	A hydrophobic or lipophilic chemical having low water solubility and correspondingly high solubility in lipids or nonpolar solvents.
Initial Calibration Verification (ICV)	Calibration verification immediately following initial calibration.
Instrument detection limit	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.
Intensive study	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.
Interference	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.
Internal	Refers to operations, personnel, documents and protocols within the specified organization.

Glossary

Internal standard	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.
Legal or evidentiary chain of custody	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.
Method blank	A blank of an appropriate analyte-free matrix that is processed (digested, extracted, etc.) and analyzed with a specified sample set.
Method detection limit	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.
Parameter	For the purposes of the DEP SOPs, any measured quantity not reported in units of concentration.
Parent sample	A sample from which aliquots or subsamples are taken for processing or testing purposes.
Performance audit	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.
Performance evaluation samples	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.
Periphytometer	Artificial substrate of known surface area used for collection of algae (specifically periphyton) over a known amount of time.
Periphyton	Aquatic algae attached to natural or artificial substrates.
Practical quantitation limit	The smallest concentration of an analyte that can be reported with an associated precision. DEP defines a practical quantitation limit as: $PQL = 4 \times MDL$.
Precision	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

Project audit	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.
Quality assurance	The system of management activities and quality control procedures implemented to produce and evaluate data according to preestablished data quality objectives.
Quality assurance plans	An orderly assembly of detailed and specific procedures that delineates how data of known and accepted quality are produced.
Quality assurance project plans	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.
Quality control	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.
Quality control check sample	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.
Quality control check standards	Certified and traceable standard solutions or purified materials from a source other than routine calibration standards used to check the accuracy of a calibration.
Quality control checks	Standards or known samples from an independent source that are analyzed at a specified frequency.
Quantitative Bracket	Standards used for calibration or calibration verification that encompass the range of environmental samples.
Reagent blank	An aliquot of analyte-free water or solvent that is analyzed with a sample set.
Reagent spike	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.
Reagent water	A sample of water that conforms to ASTM grades II, III or IV.

Glossary

Replicate sample	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.
Representativeness	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.
Research quality assurance plan	A quality assurance project plan written for research activities where non-standard procedures are used.
Riparian buffer zone	Land directly adjacent to a water body.
Sample custody	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.
Sample matrix	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.
Sample matrix spike	An environmental sample fortified to a known and validated concentration of analyte(s) before sample preparation and subsequent analysis.
Sampling Kit	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.
Screening study	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.
Secchi disk	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.
Sediment	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

Spiked samples	Any samples fortified with a known and validated concentration of analyte.
Split samples	Replicates of the same sample that are given to two independent laboratories for analysis.
Stream order	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.
Subsample	Refers to any derivative obtained from a sample. Examples of subsamples include: aliquots, filtrates, digestates, eluates, fractions, extracts, reaction products, supernatants, etc.
Surface water	Includes fresh or saline waters from water bodies such as streams, canals, rivers, lakes, ponds, bays and estuaries (natural or manmade).
Surrogate spikes	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.
System audit	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.
Trip blank	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.
Trophic level	The different feeding relationships in an ecosystem that determine the route of energy flow and the pattern of chemical cycling.
U.S. No. 30 mesh	Standard U.S. 30 sieve size.
Van Dorn bottle	A water quality sampling device which allows for discrete water samples to be taken at various depths.
Vascular plant	A plant of higher order containing conducting tissues consisting primarily of xylem and phloem. These tissues are also known as vascular tissues.
Wastewater	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 ¹ 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 Extractable & Volatile Organics Petroleum Hydrocarbons	FC 1131	Omit the acid rinse	May substitute ambient temperature water for the hot water rinses and hot detergent solution Omit the acid rinse
	Metals Radionuclides		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
	Inorganic Nonmetallics Physical & Aggregate Properties Aggregate Organics Biologicals Volatile Inorganics		Omit solvent rinse May omit the acid rinse	Rinse several times with water Rinse several times with sample water from the next sampling location

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
	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 Aggregate Organics Biologicals Volatile Inorganics		May omit the acid rinse	Rinse several times with water Rinse several times with sample water from the next sampling location
	Microbiological – Viruses Microbiological - Bacteria		Omit acid rinse	Rinse several times with water Rinse several times with sample water from the next sampling location

ⁱ 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 Luminex (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: Luminex, 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

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- 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.

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- 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.

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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).

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- 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

- 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

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- 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

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- 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

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- 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

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- 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.

- 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

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- 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

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- 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

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- 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).

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- 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.

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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

- 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
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**Bureau of Assessment and Restoration Support
Standards and Assessment Section**

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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
K	Off-scale low. Actual value is known to be less than the value given. This code shall be used if:
	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 <u>or equal to</u> the method detection limit. If the value is less than the method detection limit use "T" below.
N	Presumptive evidence of presence of material. This qualifier shall be used if:
	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 was not 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, 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 <u>code</u> applies to any value (except <u>field measurements of pH</u> , specific conductance, dissolved oxygen, temperature, total residual chlorine, transparency, <u>turbidity</u> 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.
!	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 descender ☐ 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

FQ 1000. FIELD QUALITY CONTROL REQUIREMENTS

Field quality control measures monitor the sampling event to ensure that the collected samples are representative of the sample source.

Field-collected blanks must demonstrate that the collected samples have not been contaminated by:

- The sampling environment
- The sampling equipment
- The sample container
- The sampling preservatives
- Sample transport
- Sample storage

FQ 1100. Sample Containers

Sample containers must be free from contamination by the analytes of interest or any interfering constituents and must be compatible with the sample type.

FQ 1200. Sampling Operations

1. When collected, analyze all quality control samples for the same parameters as the associated samples.

1.1. When collected, collect blanks for the following parameter groups and tests:

- Volatile Organics
- Extractable Organics
- Metals
- Ultratrace Metals
- Inorganic Nonmetallics
- Radionuclides
- Petroleum Hydrocarbons and Oil & Grease
- Volatile Inorganics
- Aggregate Organics except Biochemical Oxygen Demand

1.2. Blanks are not required for:

- Microbiological (all types)
- Toxicity
- Field parameters such as pH, Specific Conductance, Residual Chlorine, Temperature, Light Penetration, Dissolved Oxygen, ORP and Salinity
- Radon

- Algal Growth Potential
 - Biological Community
 - Physical and Aggregate Properties
 - Biochemical Oxygen Demand
2. Preserve, transport, document and handle all quality control samples as if they were samples. Once collected, they must remain with the sample set until the laboratory has received them.
 3. Except for trip blanks, prepare all quality control samples **on-site in the field**.
 - 3.1. Do not prepare precleaned equipment blanks in advance at the base of operations.
 - 3.2. Do not prepare field-cleaned equipment blanks after leaving the sampling site.
 4. Perform and document any field QC measures specified by the analytical method (such as trip blanks for volatile organics).

FQ 1210. QUALITY CONTROL BLANKS

FQ 1211. *Precleaned Equipment Blanks*

1. USE: Monitors on-site sampling environment, sampling equipment decontamination, sample container cleaning, the suitability of sample preservatives and analyte-free water, and sample transport and storage conditions for water, waste, soil, or sediment samples.
2. Collect these blanks using sampling equipment that has been brought to the site precleaned and ready for use. The cleaning procedures used for the blank collection must be identical to those used for the field sample collection.
3. Collect these blanks before the equipment set has been used.
4. Prepare equipment blanks by rinsing the sampling equipment set with the appropriate type of analyte-free water and collecting the rinse water in appropriate sample containers (see FQ 1100).

FQ 1212. *Field-Cleaned Equipment Blanks*

1. USE: Monitors on-site sampling environment, sampling equipment decontamination, sample container cleaning, the suitability of sample preservatives and analyte-free water, and sample transport and storage conditions.
2. Collect these blanks using sampling equipment that has been cleaned in the field (i.e., between sampling points). The cleaning procedures used for the blank collection must be identical to those used for the field sample collection.
3. Prepare field-cleaned equipment blanks immediately after the equipment is cleaned in the field and before leaving the sampling site.
4. Prepare equipment blanks by rinsing the sampling equipment set with the appropriate type of analyte-free water and collecting the rinse water in appropriate sample containers (see FQ 1100).
 - 4.1. For intermediate sampling devices or equipment, site-water rinsing is defined as the decontamination step, if this is the only cleaning that will be performed on the equipment prior to collecting the sample.

- 4.1.1. In this case, collect the equipment blank after rinsing the intermediate device 3 times with site water
- 4.1.2. Follow the site-water rinses with 3 rinses using analyte-free water.
- 4.1.3. Collect the equipment blank with a subsequent rinse of the device using additional analyte-free water to collect sufficient blank volume.

FQ 1213. *Trip Blanks*

1. USE: Monitors sample container cleaning, the suitability of sample preservatives and analyte-free water, and sample transport and storage conditions.
2. The organization that is providing the VOC vials must provide the trip blanks by filling two or more VOC vials with analyte-free water and preservatives (if needed).
 - 2.1. To prevent degradation of the trip blank, long-term storage of prepared trip blanks is not recommended.
3. These blanks are applicable if samples are to be analyzed for volatile constituents (volatile organics, methyl mercury, etc.) in water, waste, soils, or sediments.
4. Place a set of trip blanks in each transport container used to ship/store empty VOC vials. They must remain with the VOC vials during the sampling episode and must be transported to the analyzing laboratory in the same shipping or transport container(s) as the VOC samples.
5. Trip blanks must be opened **only** by the laboratory after the blank and associated samples have been received for analysis.

FQ 1214. *Field Blanks*

1. USE: Monitors on-site sampling environment, sample container cleaning, the suitability of sample preservatives and analyte-free water, and sample transport and storage conditions for water, waste, soil or sediment samples.
2. Prepare field blanks by pouring analyte-free water into sample containers for each parameter set to be collected.
3. Field blanks are not required if equipment blanks (FQ 1211 or FQ 1212) are collected.

FQ 1220. FIELD DUPLICATES

1. USE: Designed to measure the variability in the sampling process.
2. GENERAL CONSIDERATIONS:
 - 2.1. Collect duplicates by **repeating** (simultaneously or in rapid succession) the entire sample acquisition technique that was used to obtain the first sample.
 - 2.1.1. Collect, preserve, transport and document duplicates in the same manner as the samples. **These samples are not considered laboratory duplicates.**
 - 2.2. When collected, analyze field duplicates for the same parameters as the associated samples.
 - 2.3. If possible, collect duplicate samples from sampling locations where contamination is present.

- 2.4. Field duplicates must be collected if required by the analytical method and as required by a DEP program.

FQ 1221. *Water Duplicates*

Collect water duplicates by sampling from successively collected volumes (i.e., samples from the next volume of sample water).

FQ 1222. *Soil Duplicates*

Collect soil duplicates from the same sample source (i.e., soil from the same soil sampling device).

FQ 1230. MANDATORY FIELD QUALITY CONTROLS

1. The respondent, permittee or contractor and the sampling organization are responsible for ensuring that blanks (excluding trip blanks) are collected at a minimum of 5% of each reported test result/matrix combination for the life of a project.

1.1. Collect at least one blank for each reported test result/matrix combination each year for each project.

1.2. If a party wishes to claim that a positive result is due to external contamination sources during sample collection, transport or analysis, then at least one field collected blank (excludes trip blanks) must have been collected at the same time the samples were collected and analyzed with the same sample set.

1.3. A project will be defined by the organization responsible for collecting the samples for the project.

1.3.1. When applicable, define the scope of the project in conjunction with the appropriate DEP authority.

2. When collecting a set of blanks, use the following criteria:

2.1. Equipment Blanks:

2.1.1. Collect field-cleaned equipment blanks if any sample equipment decontamination is performed in the field.

2.1.2. If no decontamination is performed in the field, collect precleaned equipment blanks if the equipment is not certified clean by the vendor or the laboratory providing the equipment.

2.1.3. Equipment blanks are not required for volatile organic compounds.

2.2. Field Blanks:

2.2.1. Collect field blanks if no equipment except the sample container is used to collect the samples or if the sampling equipment is certified clean by the vendor or the laboratory providing the equipment.

2.2.1.1. If a sample container is used as an intermediate sample collection device, collect an equipment blank by rinsing the decontaminated collection container as the substitute for the field blank.

2.2.2. Field blanks are not required for volatile organic compounds.

2.3. Trip Blanks:

2.3.1. These blanks are applicable if samples are to be analyzed for volatile organic compounds. See FQ 1213 for frequency, preparation and handling requirements.

3. OPTIONAL QUALITY CONTROL MEASURES

3.1. The method or project may require collection of additional quality control measures as outlined in FQ 1210 (Blanks), FQ 1220 (Duplicates) and FQ 1240 (Split Samples).

FQ 1240. SPLIT SAMPLES

The DEP or the client may require split samples as a means of determining compliance or as an added measure of quality control. Unlike duplicate samples that measure the variability of both the sample collection and laboratory procedures, split samples measure only the variability **between** laboratories. Therefore, the laboratory samples must be subsamples of the same parent sample and every attempt must be made to ensure sample homogeneity.

Collect, preserve, transport and document split samples using the same protocols as the related samples. In addition, attempt to use the same preservatives (if required).

If split samples are incorporated as an added quality control measure, the DEP recommends that all involved parties agree on the logistics of collecting the samples, the supplier(s) of the preservatives and containers, the analytical method(s), and the statistics that will be used to evaluate the data.

FQ 1241. Soils, Sediments, Chemical Wastes and Sludges

Collecting split samples for these matrices is not recommended because a true split sample in these matrices is not possible.

FQ 1242. Water

Collect split samples for water in one of two ways:

1. Mix the sample in a large, appropriately precleaned, intermediate vessel (a churn splitter is recommended). This method shall not be used if volatile or extractable organics, oil and grease or total petroleum hydrocarbons are of interest. While continuing to thoroughly mix the sample, pour aliquots of the sample into the appropriate sample containers. Alternatively:

2. Fill the sample containers from consecutive sample volumes **from the same sampling device**. If the sampling device does not hold enough sample to fill the sample containers, use the following procedure:

2.1. Fill the first container with half of the sample, and pour the remaining sample into the second container.

2.2. Obtain an additional sample, pour the first half into the **second** container, and pour the remaining portion into the first container.

2.3. Continue with steps described in sections 2.1 and 2.2 above until both containers are filled.

FQ 1250. QUALITY CONTROL DOCUMENTATION

1. Document all field quality control samples in the permanent field records.
2. At a minimum, record the following information:

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FQ 1000 Field Quality Control Requirements

- 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.

FS 1000. GENERAL SAMPLING PROCEDURES

See also the following Standard Operating Procedures:

- FA 1000 and 2000 Administrative Procedures
- FC 1000 Cleaning/Decontamination Procedures
- FD 1000-9000 Documentation Procedures
- FM 1000 Field Planning and Mobilization
- FQ 1000 Field Quality Control Requirements

FS 1001. Preliminary Activities

1. Begin each sampling trip with some planning and coordination. Refer to FM 1000 for recommendations and suggestions on laboratory selection and communication, and field mobilization.

1.1. DEP recommends that a minimum of two people be assigned to a field team. In addition to safety concerns, the process of collecting the samples, labeling the containers and completing the field records is much easier if more than one person is present.

1.2. If responding to incidents involving hazardous substances, DEP recommends that four or five people be assigned to the team.

2. EQUIPMENT

2.1. Select appropriate equipment based on the sampling source (see FS 2000 to FS 8200), the analytes of interest and the sampling procedure.

2.1.1. If properly cleaned, sample containers may be used as collection devices or intermediate containers.

2.2. The equipment construction must be consistent with the analytes or analyte groups to be collected (see Tables FS 1000-1 and FS 1000-2).

2.3. Bring precleaned equipment to the field or use equipment that has been certified clean by the vendor or laboratory.

3. DEDICATED EQUIPMENT STORAGE

3.1. Store all dedicated equipment (except dedicated pump systems or dedicated drop pipes) in a controlled environment.

3.2. If possible, store equipment in an area that is located away from the sampling site. If equipment other than dedicated pumps or dedicated drop pipes is stored in monitoring wells, suspend the equipment above the formation water.

3.3. Securely seal the monitoring well in order to prevent tampering between sampling events.

3.4. Decontaminate all equipment (except dedicated pumps or drop pipes) before use according to the applicable procedures in FC 1000.

4. SAMPLE CONTAINERS

4.1. The analyses to be performed on the sample determine the construction of sample containers.

4.2. Inspect all containers and lids for flaws (cracks, chips, etc.) before use. Do not use any container with visible defects or discoloration.

FS 1002. *Contamination Prevention and Sample Collection Order*

1. CONTAMINATION PREVENTION

1.1. Take special effort to prevent cross contamination and contamination of the environment when collecting samples. Protect equipment, sample containers and supplies from accidental contamination.

1.1.1. Do not insert pump tubing, measurement probes, other implements, fingers, etc. into sample containers or into samples that have been collected for laboratory analysis.

1.1.1.1. If it is necessary to insert an item into the container or sample, ensure that the item is adequately decontaminated for the analytes of interest to be analyzed in the sample.

1.1.2. If possible, collect samples from the least contaminated sampling location (or background sampling location) to the most contaminated sampling location.

1.1.2.1. Collect the ambient or background samples first and store them in separate ice chests or shipping containers.

1.1.3. Collect samples in flowing water from downstream to upstream.

1.1.4. Do not store or ship highly contaminated samples (concentrated wastes, free product, etc.) or samples suspected of containing high concentrations of contaminants in the same ice chest or shipping container with other environmental samples.

1.1.4.1. Isolate these sample containers by sealing them in separate, untreated plastic bags immediately after collecting, preserving, labeling, etc.

1.1.4.2. Use a clean, untreated plastic bag to line the ice chest or shipping container.

2. SAMPLE COLLECTION ORDER

2.1. Sampling order is a recommendation to be modified depending on site circumstances. Unless field conditions justify other sampling regimens, collect samples in the following order:

- Volatile Organics and Volatile Inorganics
- Extractable Organics, Petroleum Hydrocarbons, Aggregate Organics and Oil & Grease
- Total Metals
- Dissolved Metals
- Inorganic Nonmetallics, Physical and Aggregate Properties, and Biologicals
- Radionuclides
- Microbiological

Note: If the pump used to collect groundwater samples cannot be used to collect volatile or extractable organics, then collect all other parameters, withdraw the pump and tubing, and collect the volatile and extractable organics.

3. COMPOSITE SAMPLES

- 3.1. Do not collect composite samples unless required by permit or DEP program.
- 3.2. If compositing is required, use the following procedure:
 - 3.2.1. Select sampling points from which to collect each aliquot.
 - 3.2.2. Using the appropriate sampling technique, collect equal aliquots (same sample size) from each location and place in a properly cleaned container.
 - 3.2.3. Record the approximate amount of each aliquot (volume or weight).
 - 3.2.4. Add preservative(s), if required.
 - 3.2.5. Label container and make appropriate field notes (see FD 1000-9000).
 - 3.2.6. Notify the laboratory that the sample is a composite sample.
 - 3.2.7. When collecting soil or sediment samples, combine the aliquots of the sample directly in the sample container with no pre-mixing. Notify the laboratory that the sample is an unmixed composite sample, and request that the laboratory thoroughly mix the sample before sample preparation or analysis.
 - 3.2.8. When collecting water composites see FS 2000, section 1.3 or pertinent sections of other water matrix SOPs for specific details on collection.

FS 1003. *Protective Gloves*

1. Gloves serve a dual purpose to:
 - Protect the sample collector from potential exposure to sample constituents
 - Minimize accidental contamination of samples by the collector
2. The DEP recommends wearing protective gloves when conducting all sampling activities. They must be worn except when:
 - The sample source is considered to be non-hazardous
 - The samples will not be analyzed for trace constituents
 - The part of the sampling equipment that is handled without gloves does not contact the sample source
3. Do not let gloves come into contact with the sample or with the interior or lip of the sample container.
4. Use clean, new, unpowdered and disposable gloves.
 - 4.1. DEP recommends latex gloves, however, other types of gloves may be used as long as the construction materials do not contaminate the sample or if internal safety protocols require greater protection.
 - 4.2. Note that certain materials (as might be potentially present in concentrated effluent) may pass through certain glove types and be absorbed in the skin. Many vendor catalogs provide information about the permeability of different gloves and the circumstances under which the glove material might be applicable.
 - 4.3. The powder in powdered gloves can contribute significant contamination and DEP does not recommend wearing powdered gloves unless it can be demonstrated that the powder does not interfere with the sample analysis.

5. If gloves are used, change:
 - After preliminary activities such as pump placement;
 - After collecting all the samples at a single sampling point; or
 - If torn, or used to handle extremely dirty or highly contaminated surfaces.
6. Properly dispose of all used gloves.

FS 1004. *Container and Equipment Rinsing*

When collecting aqueous samples, rinse the sample collection equipment with a portion of the sample water before taking the actual sample. Sample containers do not need to be rinsed. In the case of petroleum hydrocarbons, oil & grease or containers with premeasured preservatives, the sample containers cannot be rinsed.

FS 1005. *Fuel-Powered Equipment and Related Activities*

1. Place all fuel-powered equipment away from, and downwind of, any site activities (e.g., purging, sampling, decontamination). If field conditions preclude such placement (i.e., the wind is from the upstream direction in a boat), place the fuel source(s) as far away as possible from the sampling activities and describe the conditions in the field notes.
2. Handle fuel (i.e., filling vehicles and equipment) prior to the sampling day. If such activities must be performed during sampling, the personnel must wear disposable gloves. Dispense all fuels, dispose of gloves downwind, and well away from the sampling activities.
3. If sampling at active gas stations, stop sample collection activities during fuel deliveries.

FS 1006. *Preservation, Holding Times and Container Types*

1. Preserve all samples according to the requirements specified in Tables FS 1000-4 through FS 1000-10.
 - 1.1. The information listed in the above-referenced tables supersedes any preservation techniques, holding time or container type that might be discussed in individual analytical methods.
 - 1.2. If samples are collected only for total phosphorus and are not for NPDES compliance, thermal preservation (ice) is not required if the sample containers are pre-preserved with acid.
2. The preservation procedures in the referenced tables specify immediate preservation. "Immediate" is defined as "within 15 minutes of sample collection." Perform all preservation on-site (in the field).
 - 2.1. Preservation is not required if samples can be transported back to the laboratory within 15 minutes of collecting the sample and
 - 2.1.1. The laboratory begins sample analysis within the 15-minute window and documents the exact time the analysis began, or
 - 2.1.2. The laboratory adds the appropriate preservatives (including thermal preservation) within 15 minutes of sample collection and documents the exact time that the preservation was done.

3. PRESERVING COMPOSITE WATER SAMPLES

3.1. If the sample preservation requires thermal preservation (e.g., $<6^{\circ}\text{C}$), the samples must be cooled to the specified temperature.

3.1.1. Manually collected samples to be composited must be refrigerated at a temperature equal to or less than the required temperature.

3.1.2. Automatic samplers must be able to maintain the required temperature by packed ice or refrigeration.

3.2. When chemical preservation is also required, begin the preservation process within 15 minutes of the last collected sample.

3.3. Holding Times for Automatic Samplers:

3.3.1. If the collection period is 24 hours or less, the holding time begins at the last scheduled sample collection;

3.3.2. If the collection period exceeds 24 hours, the holding time begins with the time that the first sample is collected.

4. PH ADJUSTED PRESERVATION - Check the pH of pH-adjusted samples according to these frequencies:

4.1. During the first sampling event at a particular site, check all samples (includes each groundwater monitoring well, surface water location, or influent/effluent sampling location) that are pH-adjusted except volatile organics.

4.2. During subsequent visits to a particular site, check at least one sample per parameter group that must be pH-adjusted.

4.3. If the frequency of sample collection at a specified location is greater than once per month (i.e., weekly or daily), check the pH of at least one sample per parameter group (except volatile organics) according to the following schedule:

4.3.1. Weekly sampling: 1 pH check per month

4.3.2. Daily sampling: 1 pH check per week

4.4. If the frequency of sample collection at a specified location is once per month, check the pH of at least one sample per parameter group (except volatile organics) quarterly.

4.5. If site conditions vary from sampling event to sampling event, perform pH checks at increased intervals.

5. THERMAL PRESERVATION

5.1. When preservation requirements indicate cooling to a specific temperature, samples must be placed in wet ice within 15 minutes of sample collection (see 1006, section 2 above). Unless specified, do not freeze samples.

5.2. All supplies (ice, dry ice, etc.) necessary to meet a thermal preservation requirement must be onsite for immediate use.

5.3. Ship samples in wet ice. If samples are cooled to the required temperature before shipment, samples may be shipped with frozen ice packs if the specified temperature is maintained during shipment. The sample temperature must not exceed the specified temperature.

5.4. If immediate freezing is required, dry ice must be available in the field to begin the freezing process.

FS 1007. *Preventive and Routine Maintenance*

Preventive maintenance activities are necessary to ensure that the equipment can be used to obtain the expected results and to avoid unusable or broken equipment while in the field. Equipment is properly maintained when:

- It functions as expected during mobilization; and
- It is not a source of sample contamination (e.g., dust).

1. Follow the manufacturer's suggested maintenance activities and document all maintenance. At a minimum, DEP recommends the activities listed on Table FS 1000-12.

2. Maintain documentation for the following information for each piece of equipment or instrumentation. See FD 3000 also.

2.1. Designate the identity of specific instrumentation in the documentation with a unique description or code for each instrument unit employed. This identifier may include a manufacturer name, model number, serial number, inventory number or other unique identification.

2.2. Log all maintenance and repair performed for each instrument unit, including routine cleaning procedures and solution or parts replacement for instrument probes.

2.3. Include the calendar date for the procedures performed.

2.4. Record names of personnel performing the maintenance or repair tasks.

2.5. Describe any malfunctions necessitating repair or service.

2.6. Retain vendor service records for all affected instruments.

2.7. Record the following for rented equipment:

- Rental date(s)
- Equipment type and model or inventory number or other description

2.8. Retain the manufacturer's operating and maintenance instructions.

FS 1008. *Documentation and References*

1. REFERENCES: All sampling references must be available for consultation in the field. These include:

- DEP SOPs;
- Internal SOPs;
- Sampling and analysis plans; and/or
- Quality Assurance Project Plans.

2. DOCUMENTATION: Complete and sign all documentation (see FD 1000).

FS 1009. *Sample Documentation and Evidentiary Custody*

1. SAMPLE DOCUMENTATION

1.1. Document all activities related to a sampling event, including sample collection, equipment calibration, equipment cleaning and sample transport.

1.2. The required documentation related to each sampling or other field activity is specified in the associated SOPs; i.e., FQ 1000, FC 1000, the FS series, and the FT series.

1.3. The documentation requirements are also summarized in FD 1000, Field Documentation. FD 1000 additionally contains a list of example forms published with the SOPs that may be used to document various activities or as templates for creating customized forms.

2. LEGAL CHAIN OF CUSTODY (COC)

The use of legal or evidentiary Chain-of-Custody (COC) protocols is not usually required by DEP, except for cases involving civil or criminal enforcement. Do not use these procedures for routine sampling for compliance unless evidentiary custody protocols are specifically mandated in a permit or other legal order or when required for enforcement actions.

Evidentiary sample custody protocols are used to demonstrate that the samples and/or sample containers were handled and transferred in such a manner as to eliminate possible tampering.

When a client or situation requires legal COC, use the procedures in FD 7000 to document and track all time periods associated with the physical possession and storage of sample containers, samples, and subsamples from point of origin through the final analytical result and sample disposal.

When legal or evidentiary COC is required, samples must be:

- In the actual possession of a person who is authorized to handle the samples (e.g., sample collector, laboratory technician);
- In the view of the same person after being in their physical possession;
- Secured by the same person to prevent tampering; or
- Stored in a designated secure area.

2.1. Control and document access to all evidentiary samples and subsamples with adequate tracking. Documentation must include records about each of the activities and situations listed below, when applicable to sample evidence, and must track the location and physical handling of all samples by all persons at all times.

2.1.1. Limit the number of individuals who physically handle the samples as much as practicable.

2.1.2. When storing samples and subsamples, place samples in locked storage (e.g., locked vehicle, locked storeroom, etc.) at all times when not in the possession or view of authorized personnel.

2.1.3. Alternatively, maintain restricted access to facilities where samples are stored. Ensure that unauthorized personnel are not able to gain access to the samples at any time.

2.1.4. Do not leave samples in unoccupied motel or hotel rooms or other areas where access cannot be controlled by the person(s) responsible for custody without first securing samples and shipping or storage containers with tamper-indicating evidence tape or custody seals. Ice chests or other storage containers used to store sample containers in hotel rooms may be sealed instead of sealing each sample container stored within.

2.2. Use a Chain of Custody form or other transmittal record to document sample transfers to other parties. Other records and forms may be used to document internal activities if they meet the requirements for legal chain of custody.

2.3. Legal COC begins when the precleaned sample containers are dispatched to the field.

2.3.1. The person who relinquishes the prepared sample kits or containers and the individual who receives the sample kits or containers must sign the COC form unless the same party provides the containers and collects the samples.

2.3.2. All parties handling the empty sample containers and samples are responsible for documenting sample custody, including relinquishing and receiving samples, except commercial common carriers.

2.4. Shipping Samples under Legal COC

2.4.1. Complete all relevant information on the COC transmittal form or record (see FD 7200, section 2).

2.4.2. Internal records must document the handling of the samples and shipping containers in preparation for shipment. The names of all persons who have prepared the shipment must be recorded. All time intervals associated with handling and preparation must be accounted for.

2.4.3. Place the forms in a sealed waterproof bag and place in the shipping container with the samples.

2.4.4. Seal the shipping container with tamper-proof seals (see 2.6 below) so that any tampering can be clearly seen by the individual who receives the samples.

2.4.5. Note: The common carrier does not sign COC records. However, the common carrier (when used) must be identified.

2.5. Delivering Samples to the Laboratory

2.5.1. All individuals who handle and relinquish the sample containers must sign the transmittal form. The legal custody responsibilities of the field operations end when the samples are relinquished to the laboratory.

2.6. Chain of Custody Seals: If required, affix tamper-indicating evidence tape or seals to all sample, storage and shipping container closures when transferring or shipping sample container kits or samples to another party.

2.6.1. Place the seal so that the closure cannot be opened without breaking the seal.

2.6.2. Record the time, calendar date and signatures of responsible personnel affixing and breaking all seals for each sample container and shipping container.

2.6.3. Affix new seals every time a seal is broken until continuation of evidentiary custody is no longer required.

FS 1010. *Health and Safety*

Implement all local, state and federal requirements relating the health and safety.

FS 1011. *Hazardous Wastes*

Follow all local, state and federal requirements pertaining to the storage and disposal of any hazardous or investigation-derived wastes.

1. Properly manage all investigation-derived waste (IDW) so contamination is not spread into previously uncontaminated areas.

1.1. IDW includes all water, soil, drilling mud, decontamination wastes, discarded personal protective equipment (PPE), etc. from site investigations, exploratory borings, piezometer and monitoring well installation, refurbishment, and abandonment, and other investigative activities. Containerize the IDW at the time it is generated.

1.2. Determine if the IDW must be managed as Resource Conservation and Recovery Act (RCRA) regulated hazardous waste through appropriate testing or generator knowledge. Manage all IDW that is determined to be RCRA regulated hazardous waste according to the local state and federal requirements.

1.3. Properly dispose of IDW that is not a RCRA-regulated hazardous waste but is contaminated above the Department's Soil Cleanup Target Levels or the state standards and/or minimum criteria for ground water quality.

1.4. IDW that is not contaminated or contains contaminants below the Department's Soil Cleanup Target Levels or the state standards and/or minimum criteria for ground water quality may be disposed of onsite as long as the IDW will not cause a surface water violation.

1.5. Maintain all containers holding IDW in good condition:

1.5.1. Periodically inspect the containers for damage

1.5.2. Ensure that all required labeling (DOT, RCRA, etc.) are clearly visible.

Appendix FS 1000
Tables, Figures and Forms

Table FS 1000-1	Equipment Construction Materials
Table FS 1000-2	Construction Material Selection for Equipment and Sample Containers
Table FS 1000-3	Equipment Use and Construction
Table FS 1000-4	40 CFR Part 136 Table II: Required Containers, Preservation Techniques, and Holding Times (Water/Wastewater Samples)
Table FS 1000-5	Approved Water and Wastewater Procedures, Containers, Preservation and Holding Times for Analytes not found in 40 CFR Part 136
Table FS 1000-6	Recommended Sample Containers, Sample Volumes, Preservation Techniques and Holding Times for Residuals, Soil and Sediment Samples.
Table FS 1000-7	Sample Handling, Preservation and Holding Time Table for SW 846 Method 5035
Table FS 1000-8	Preservation Methods and Holding Times for Drinking Water Samples that Differ from 40 CFR Part 136, Table II
Table FS 1000-9	Containers, Preservation and Holding Times for Biosolids Samples and Protozoans
Table FS 1000-10	Container Materials, Preservation, and Holding Times for Fish and Shellfish
Table FS 1000-11	Holding Times for SPLP or TCLP Extraction, Sample Preparation and Determinative Analysis
Table FS 1000-12	Preventive Maintenance Tasks
Figure FS 1000-1	Organic Trap Configuration for Collecting Extractable Organics with a Peristaltic Pump

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Table FS 1000-1
Equipment Construction Materials

Construction Material ¹	Acceptable Analyte Groups	Precautions
Metals		
316 Stainless Steel	All analyte groups. Recommended for inorganic nonmetallics, metals, volatile and extractable organics.	Do not use if weathered, corroded or pitted. ²
300-Series Stainless Steel (304, 303, 302)	Suitable for all analyte groups (if used, check for corrosion before use). Recommended for inorganic nonmetallics, metals, volatile and extractable organics.	Do not use if weathered, corroded or pitted. ² If corroded, there is a potential for samples to be contaminated with iron, chromium, copper or nickel. Check for compatibility with water chemistry for dedicated applications. Do not use in low pH, high chloride, or high TDS waters.
Low Carbon Steel Galvanized Steel Carbon Steel	Inorganic nonmetallics only.	Coring devices are acceptable for all analyte groups if appropriate liners are used. Use Teflon liners for organics. Use plastic or Teflon liners for metals. Do not use if weathered, corroded or pitted. ² If corroded, there is a potential for samples to be contaminated with iron and manganese. Galvanized equipment will also contaminate with zinc and cadmium. If used to collect large samples (e.g., dredges), collect organic and metal samples may be collected from portions of the interior of the collected material.
Brass	Inorganic nonmetallics only.	Do not use if weathered, corroded or pitted. ²
Plastics³		
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.

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Table FS 1000-1
Equipment Construction Materials

Construction Material ¹	Acceptable Analyte Groups	Precautions
Tygon, Silicone, Neoprene	All analyte groups except extractable and volatile organics.	Do not use when collecting extractable or volatile organic samples. Do not use silicone if sampling for silica.
Viton	All analyte groups except extractable and volatile organics. ⁴	Minimize contact with sample. Use only if no alternative material exists.
Glass		
Glass, borosilicate	All analyte groups except silica and boron.	

Adapted from USGS Field Manual, Chapter 2, January 2000.

¹ Refers to construction material of the portions of the sampling equipment that come in contact with the sample (e.g., housing of variable speed submersible pump must be stainless steel if extractable organics are sampled; the housing of a variable speed submersible pump used to sample metals may be plastic.)

² Corroded/weathered surfaces are active sorption sites for organic compounds.

³ Plastics used in connection with inorganic trace element samples (including metals) must be uncolored or white.

⁴ May be allowable for specialized parts where no alternative material exists (e.g., Viton seals are the best available seal for some dedicated pump systems), however, contact with the sample must be minimized.

Table FS 1000-2
Construction Material Selection for Equipment and Sample Containers

Analyte Group	Acceptable Materials
Extractable Organics	Teflon Stainless steel Glass Polypropylene (All types) Polyethylene (All types) All parts of the system including connectors and gaskets must be considered – Viton may be used if no other material is acceptable.
Volatile Organics	Teflon Stainless steel Glass Polypropylene (All types) Polyethylene (All types) All parts of the system including connectors and gaskets must be considered – Viton may be used if no other material is acceptable.
Metals	Teflon Stainless steel Polyethylene (All types) Polypropylene (All types) Tygon, Viton, Silicone, Neoprene PVC Glass (except silica and boron)
Ultratrace Metals	Teflon Polyethylene (All types) Polypropylene (All types) Polycarbonate Mercury must be in glass or Teflon
Inorganic Nonmetallics	Teflon Stainless steel Low carbon, Galvanized or Carbon steel Polyethylene (All types) Polypropylene (All types) Tygon, Viton, Silicone, Neoprene PVC Glass Brass

Table FS 1000-2
Construction Material Selection for Equipment and Sample Containers

Analyte Group	Acceptable Materials
Microbiological samples	Teflon Stainless steel Polyethylene (All types) Polypropylene (All types) Tygon, Viton, Silicone, Neoprene PVC Glass Sterilize all sample containers. Thoroughly clean sampling equipment and rinse several times with sample water before collection. Sampling equipment does not require sterilization Do not rinse sample containers

Table FS 1000-3
Equipment Use and Construction

<u>EQUIPMENT</u>	<u>CONSTRUCTION</u>	<u>USE</u>	<u>PERMISSIBLE ANALYTE GROUPS</u>	<u>RESTRICTIONS AND PRECAUTIONS</u>
	<u>HOUSING</u> ¹	<u>TUBING</u>		
WATER SAMPLING				
GROUNDWATER				
1 Positive displacement pumps ²				
a. Submersible (turbine, helical rotor, gear driven)	SS, Teflon	SS, Teflon, PE, PP	Purging	3,4,5; must be variable speed
			Sampling	3,4,5 must be variable speed
	SS, Teflon	Non-inert ⁶	Purging	3,4,5 must be variable speed; polishing required ⁷
			Sampling	Must be variable speed If sampling for metals, the tubing must be non-metallic if not SS
	Non-inert ⁶	Non-inert ⁶	Purging	3,4,5 must be variable speed; polishing required ⁷
			Sampling	Must be variable speed If sampling for metals, the tubing must be non-metallic if not SS
b. Bladder pump (no gas contact)	SS, Teflon, PE, PP or PVC if permanently installed	SS, Teflon, PE, PP	Purging	3,4,5 must be variable speed
			Sampling	3,4 must be variable speed Bladder must be Teflon if sampling for volatile or extractable organics or PE or PP if used in portable pumps
	SS, Teflon, PE, PP	Non-inert ⁶	Purging	3,4 must be variable speed; polishing required ⁷
			Sampling	This configuration is not recommended 3,4 must be variable speed If sampling for metals, the tubing must be non-metallic if not SS
	Non-inert ⁶	Non-inert ⁶	Purging	3,4 must be variable speed; polishing required ⁷
			Sampling	3,4 must be variable speed; polishing required ⁷ If sampling for metals, the tubing must be non-metallic if not SS

Table FS 1000-3
Equipment Use and Construction

<u>EQUIPMENT</u>	<u>CONSTRUCTION</u> ¹	<u>TUBING</u>	<u>USE</u>	<u>PERMISSIBLE ANALYTE GROUPS</u>	<u>RESTRICTIONS AND PRECAUTIONS</u>
2. Suction lift pumps					
a. Centrifugal	N/A	SS, Teflon, PE, PP	Purging	All analyte groups	⁴ foot-valve required Must be variable speed
	N/A	Non-inert ⁶	Purging	All analyte groups	⁴ foot-valve required; polishing required/ Must be variable speed
b. Peristaltic	N/A	SS, Teflon, PE, PP	Purging	All analyte groups	⁴ foot-valve required; polishing required/ or continuous pumping required Must be variable speed
			Sampling	All analyte groups <u>except</u> volatile organics	⁴ Silicone tubing in pump head Must be variable speed
	N/A	Non-inert ⁶	Purging	All analyte groups	⁴ foot-valve required Must be variable speed
			Sampling	All analyte groups <u>except</u> volatile and extractable organics	⁴ Silicone tubing in pump head Must be variable speed
3. Bailers	SS, Teflon, PE, PP	N/A	Purging	All analyte groups	None; <u>not recommended</u>
		N/A	Sampling	All analyte groups	None; <u>not recommended</u>
	Non-inert ⁶	N/A	Purging	All analyte groups <u>except</u> volatile and extractable organics	None; <u>not recommended</u> If sampling for metals, the tubing must be non-metallic if not SS
			Sampling	All analyte groups <u>except</u> volatile and extractable organics	None; <u>not recommended</u> If sampling for metals, the tubing must be non-metallic if not SS
<u>SURFACE WATER</u>					
1. Intermediate containers such as pond sampler, scoops, beakers, buckets, and dippers	SS, Teflon, Teflon-coated, PE, PP	N/A	Grab sampling	All analyte groups	None
	Glass	N/A		All analyte groups except boron and fluoride	None
	Non-inert ⁶	N/A		All analyte groups <u>except</u> volatile and extractable organics	None

Table FS 1000-3
Equipment Use and Construction

<u>EQUIPMENT</u>	<u>CONSTRUCTION</u>	<u>USE</u>	<u>PERMISSIBLE ANALYTE GROUPS</u>	<u>RESTRICTIONS AND PRECAUTIONS</u>
	<u>HOUSING</u> ¹	<u>TUBING</u>		
2. Nansen, Kemmerer, Van Dorn, Alpha and Beta Samplers, Niskin (or equivalent)	SS, Teflon, Teflon-coated, PE, PP	N/A	Specific depth grab sampling	All analyte groups
	Non-inert ⁶	N/A		All analyte groups <u>except</u> volatile and extractable organics
3. DO Dunker	SS, Teflon, glass, PE, PP	N/A	Water column composite sampling	All analyte groups
4. Bailers – double valve	SS, Teflon, PE, PP	N/A	Grab sampling	All analyte groups
	Non-inert ⁶	N/A	Grab sampling	All analyte groups <u>except</u> volatile and extractable organics If sampling for metals, the tubing must be non-metallic if not SS
5. Peristaltic pump	N/A	SS, Teflon, PE, PP	Specific depth sampling	All analyte groups <u>except</u> volatile organics
	N/A	Non-inert ⁶		All analyte groups <u>except</u> volatile and extractable organics
<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> <u>HOUSING</u> ¹	<u>TUBING</u>	<u>USE</u>	<u>PERMISSIBLE ANALYTE GROUPS</u>	<u>RESTRICTIONS AND PRECAUTIONS</u>
SOLID SAMPLING					
SOILS					
1. Core barrel (or liner)	SS, Teflon, glass, Teflon-coated, aluminum, PE, PP	N/A	Sampling	All analyte groups ⁸	9, 10, 11
	Non-inert ⁶ nonmetallics	N/A	Sampling	All analyte groups	12
	Non-inert ⁶ metals	N/A	Sampling	All analyte groups	12
2. Trowel, scoop, spoon or spatula	SS, Teflon, Teflon-coated, PE, PP	N/A	Sampling	All analyte groups ⁸	
			Compositing	All analyte groups except volatile organics	Samples for volatile organics must grab samples
	Plastic	N/A	Sampling and compositing	All analyte groups <u>except</u> volatile and extractable organics	None Must be nonmetallic if not SS
3. Mixing tray (pan)	SS, Teflon, glass, Teflon-coated, aluminum , PE, PP	N/A	Sampling	All analyte groups ⁸	11
			Compositing or homogenizing	All analyte groups except volatile organics	11
	Non-inert ⁶	N/A	Compositing or homogenizing	All analyte groups	10,11,12 must be nonmetallic if not SS
4. Shovel, bucket auger	SS	N/A	Sampling	All analyte groups ⁸	None
	Non-SS	N/A	Sampling	All analyte groups ⁸	10,11,12
5. Split spoon	SS or carbon steel w/ Teflon insert	N/A	Sampling	All analyte groups ⁸	10,11,12
6. Shelby tube	SS	N/A	Sampling	All analyte groups ⁸	9
	Carbon steel	N/A	Sampling	All analyte groups	9,10,12
SEDIMENT					
1. Coring devices	SS, Teflon, glass, Teflon-coated, aluminum, PE, PP	N/A	Sampling	All analyte groups ⁸	9,10,11

Table FS 1000-3
Equipment Use and Construction

<u>EQUIPMENT</u>	<u>CONSTRUCTION</u> <u>HOUSING</u> ¹	<u>TUBING</u>	<u>USE</u>	<u>PERMISSIBLE ANALYTE GROUPS</u>	<u>RESTRICTIONS AND PRECAUTIONS</u>
	Non-inert ⁶ nonmetallics	N/A	Sampling	All analyte groups	¹²
	Non-inert ⁶ metals	N/A	Sampling	All analyte groups	^{9,10,11}
2. Grab – Young, Petersen, Shipek	Teflon, Teflon-lined, SS	N/A	Sampling	All analyte groups ⁸	None
	Carbon steel	N/A	Sampling	All analyte groups	^{10,11}
3. Dredges – Eckman, Ponar, Petit Ponar Van Veen	SS	N/A	Sampling	All analyte groups ⁸	None
	Carbon steel, brass	N/A	Sampling	All analyte groups	^{10,11}
4. Trowel, scoop, spoon or spatula	SS, Teflon, Teflon-coated, PE, PP	N/A	Sampling	All analyte groups ⁸	
			Compositing	All analyte groups except volatile organics	Samples for volatile organics be grab samples
	Plastic	N/A	Sampling and compositing	All analyte groups <u>except</u> volatile and extractable organics	None must be nonmetallic if not SS
5. Mixing tray (pan)	SS, Teflon, glass, Teflon-coated, aluminum, PE, PP	N/A	Sampling	All analyte groups ⁸	¹¹
			Compositing or homogenizing	All analyte groups except volatile organics	¹¹
	Non-inert ⁶	N/A	Compositing or homogenizing	All analyte groups <u>except</u> volatile and extractable organics	none ¹¹ must be nonmetallic if not SS
WASTE ¹³					
Scoop	SS	N/A	Liquids, solids & sludges	All analyte groups ⁸	Cannot collect deeper phases
Spoon	SS	N/A	Solids, sludges	All analyte groups ⁸	Cannot collect deeper phases
Push tube	SS	N/A	Solids, sludges	All analyte groups ⁸	Cannot collect deeper phases
Auger	SS	N/A	Solids	All analyte groups ⁸	None

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<u>EQUIPMENT</u>	<u>CONSTRUCTION</u>		<u>USE</u>	<u>PERMISSIBLE ANALYTE GROUPS</u>	<u>RESTRICTIONS AND PRECAUTIONS</u>
	<u>HOUSING</u> ¹	<u>TUBING</u>			
Sediment sampler	SS	N/A	Impoundments, piles	All analyte groups ⁸	None
Ponar dredge	SS	N/A	Solids, sludges & sediments	All analyte groups ⁸	None
Coliwasa, Drum thief	Glass	N/A	Liquids, sludges	All analyte groups	None
Mucksucker, Dipstick	Teflon		Liquids, sludges	All analyte groups	Not recommended for tanks > 11 feet deep
Bacon bomb	SS	N/A	Liquids	All analyte groups ⁸	Not recommended for viscous wastes
Bailer	SS, Teflon	N/A	Liquids	All analyte groups ⁸	Do not use with heterogeneous wastes Not recommended for viscous wastes
Peristaltic pump	N/A	Teflon, Glass	Liquids	All analyte groups except volatile organics	Do not use in flammable atmosphere Not recommended for viscous wastes
Backhoe bucket	Steel	N/A	Solids, Sludges		Difficult to clean Volatiles and metals must be taken from the interior part of the sample
Split spoon	SS	N/A	Solids	All analyte groups ⁸	
Roto-Hammer	Steel	N/A	Solids	All analyte groups ⁸	Physically breaks up sample Not for flammable atmospheres

Acronyms:

N/A not applicable
SS stainless steel
HDPE high-density polyethylene
PE polyethylene
PVC polyvinyl chloride
PP polypropylene

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Equipment Use and Construction

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- ¹ Refers to tubing and pump housings/internal parts that are in contact with purged or sampled water (interior and exterior of delivery tube, inner lining of the discharge tube, etc.).
- ² If used to collect volatile or extractable organics, all power cords and other tubing must be encased in Teflon, PE or PP.
- ³ If used as a non-dedicated system, pump must be completely disassembled, if practical, and cleaned between wells.
- ⁴ Delivery tubing must be precleaned and precut at the base of operations or laboratory. If the same tubing is used during the sampling event, it must be cleaned and decontaminated between uses.
- ⁵ In-line check valve required.
- ⁶ "Non-inert" pertains to materials that are reactive (adsorb, absorb, etc.) to the analytes being sampled. For organics, materials include rubber, plastics (except PE and PP), and PVC. For metals, materials include brass, galvanized, and carbon steel.
- ⁷ "Polishing": When purging for volatile or extractable organics, the entire length of tubing or the portion which comes in contact with the formation water must be constructed of Teflon, SS, PE or PP. If other materials (e.g., PVC, garden hoses, etc.) are used, the following protocols must be followed: 1) slowly withdraw the pump from the water column during the last phase of purging, to remove any water from the well that may have contacted the exterior of the pump and/or tubing; 2) remove a single well volume with the sampling device before sampling begins. **Do not use Tygon** for purging if purgeable or extractable organics are of interest. Polishing **is not recommended**; use of sampling equipment constructed of appropriate materials is preferred.
- ⁸ Do not use if collecting for hexavalent chromium (Chromium⁺⁶)
- ⁹ If samples are sealed in the liner for transport to the laboratory, the sample for VOC analysis must be taken from the interior part of the core.
- ¹⁰ If a non-stainless steel (carbon steel, aluminum) liner, core barrel or implement is used, take the samples for metals, purgeable organics and organics from the interior part of the core sample.
- ¹¹ Aluminum foil, trays or liners may be used only if aluminum is not an analyte of interest.
- ¹² If non-inert-liner, core barrel or implement is used, take samples from the interior part of the collected sample.
- ¹³ If disposable equipment of alternative construction materials is used, the construction material must be compatible with the chemical composition of the waste, cannot alter the characteristics of the waste sample in any way, and cannot contribute analytes of interest or any interfering components.

Table FS1000-4

40 CFR Part 136 TABLE II: Required Containers, Preservation Techniques, and Holding Times
Applicable to **all** Non-Potable Water Samples (includes wastewater, surface water, and groundwater)

Parameter No./Name (refers to parameter number on Tables IA,B, C, D,E, F, G & H as noted)	Container ¹	Preservation ^{2, 3}	Maximum holding time ⁴
Table IA—Bacterial Tests:			
1–5. Coliform, total, fecal, and <i>E. coli</i>	PA, G	Cool, <10 °C, 0.0008% Na ₂ S ₂ O ₃ ⁵	6 hours ^{6, 7}
6. Fecal streptococci	PA, G	Cool, <10 °C, 0.0008% Na ₂ S ₂ O ₃ ⁵	6 hours ⁶
7. Enterococci	PA, G	Cool, <10 °C, 0.0008% Na ₂ S ₂ O ₃ ⁵	6 hours ⁶
8. Salmonella	PA, G	Cool, <10 °C, 0.0008% Na ₂ S ₂ O ₃ ⁵	6 hours ⁶
Table IA— Aquatic Toxicity Tests:			
9–11. Toxicity, acute and chronic	P, FP, G	Cool, ≤6 °C ⁸	36 hours
Table IB—Inorganic Tests:			
1. Acidity	P, FP, G	Cool, ≤6 °C ⁹	14 days
2. Alkalinity	P, FP, G	Cool, ≤6 °C ⁹	14 days
4. Ammonia	P, FP, G	Cool, ≤6 °C ⁹ , H ₂ SO ₄ to pH<2	28 days
9. Biochemical oxygen demand	P, FP, G	Cool, ≤6 °C ⁹	48 hours
10. Boron	P, FP, or Quartz	HNO ₃ to pH<2	6 months
11. Bromide	P, FP, G	None required	28 days
14. Biochemical oxygen demand, carbonaceous	P, FP, G	Cool, ≤6 °C ⁹	48 hours
15. Chemical oxygen demand	P, FP, G	Cool, ≤6 °C ⁹ , H ₂ SO ₄ to pH<2	28 days
16. Chloride	P, FP, G	None required	28 days
17. Chlorine, total residual	P, G	None required	Analyze within 15 minutes
21. Color	P, FP, G	Cool, ≤6 °C ⁹	48 hours
23–24. Cyanide, total or available (or CATC)	P, FP, G	Cool, ≤6 °C ⁹ , NaOH to pH>12 ¹⁰ , reducing agent ⁵	14 days
25. Fluoride	P	None required	28 days
27. Hardness	P, FP, G	HNO ₃ or H ₂ SO ₄ to pH<2	6 months
28. Hydrogen ion (pH)	P, FP, G	None required	Analyze within 15 minutes
31, 43. Kjeldahl and organic N	P, FP, G	Cool, ≤6 °C ⁹ , H ₂ SO ₄ to pH<2	28 days
Table IB—Metals:			
7 18. Chromium VI	P, FP, G	Cool, ≤6 °C ⁹ , pH = 9.3–9.7 ¹²	28 days
35. Mercury (CVAA)	P, FP, G	HNO ₃ to pH<2	28 days

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40 CFR Part 136 TABLE II: Required Containers, Preservation Techniques, and Holding Times
Applicable to **all** Non-Potable Water Samples (includes wastewater, surface water, and groundwater)

Parameter No./Name (refers to parameter number on Tables IA,B, C, D,E, F, G & H as noted)	Container ¹	Preservation ^{2, 3}	Maximum holding time ⁴
35. Mercury (CVAFS)	FP, G; and FP-lined cap ¹³	5 mL/L 12N HCl or 5 mL/L BrCl ¹³	90 days ¹³
3, 5–8, 12, 13, 19, 20, 22, 26, 29, 30, 32–34, 36, 37, 45, 47, 51, 52, 58–60, 62, 63, 70–72, 74, 75. Metals, except boron, chromium VI, and mercury.	P, FP, G	HNO ₃ to pH<2, or at least 24 hours prior to analysis ¹⁴	6 months
38. Nitrate	P, FP, G	Cool, ≤6 °C ⁹	48 hours
39. Nitrate-nitrite	P, FP, G	Cool, ≤6 °C ⁹ , H ₂ SO ₄ to pH<2	28 days
40. Nitrite	P, FP, G	Cool, ≤6 °C ⁹	48 hours
41. Oil and grease	G	Cool, ≤6 °C ⁹ , HCl or H ₂ SO ₄ to pH<2	28 days
42. Organic Carbon	P, FP, G	Cool, ≤6 °C ⁹ , HCl, H ₂ SO ₄ , or H ₃ PO ₄ to pH<2.	28 days
44. Orthophosphate	P, FP, G	Cool, ≤6 °C ⁹	Filter within 15 minutes; Analyze within 48 hours
46. Oxygen, Dissolved Probe	G, Bottle and top	None required	Analyze within 15 minutes
47. Winkler	G, Bottle and top	Fix on site and store in dark	8 hours
48. Phenols	G	Cool, ≤6 °C ⁹ , H ₂ SO ₄ to pH<2	28 days
49. Phosphorous (elemental)	G	Cool, ≤6 °C ⁹	48 hours
50. Phosphorous, total	P, FP, G	Cool, ≤6 °C ⁹ , H ₂ SO ₄ to pH<2	28 days
53. Residue, total	P, FP, G	Cool, ≤6 °C ⁹	7 days
54. Residue, Filterable	P, FP, G	Cool, ≤6 °C ⁹	7 days
55. Residue, Nonfilterable (TSS)	P, FP, G	Cool, ≤6 °C ⁹	7 days
56. Residue, Settleable	P, FP, G	Cool, ≤6 °C ⁹	48 hours
57. Residue, Volatile	P, FP, G	Cool, ≤6 °C ⁹	7 days
61. Silica	P or Quartz	Cool, ≤6 °C ⁹	28 days
64. Specific conductance	P, FP, G	Cool, ≤6 °C ⁹	28 days
65. Sulfate	P, FP, G	Cool, ≤6 °C ⁹	28 days
66. Sulfide	P, FP, G	Cool, ≤6 °C ⁹ , add zinc acetate plus sodium hydroxide to pH>9	7 days
67. Sulfite	P, FP, G	None required	Analyze within 15 minutes
68. Surfactants	P, FP, G	Cool, ≤6 °C ⁹	48 hours

Table FS1000-4

40 CFR Part 136 TABLE II: Required Containers, Preservation Techniques, and Holding Times
Applicable to all Non-Potable Water Samples (includes wastewater, surface water, and groundwater)

Parameter No./Name (refers to parameter number on Tables IA,B, C, D,E, F, G & H as noted)	Container ¹	Preservation ^{2, 3}	Maximum holding time ⁴
69. Temperature	P, FP, G	None required	Analyze
73. Turbidity	P, FP, G	Cool, ≤6 °C ⁹	48 hours

Table IC—Organic Tests 8			
13, 18–20, 22, 24–28, 34–37, 39–43, 45–47, 56, 76, 104, 105, 108–111, 113. Purgeable Halocarbons	G, FP-lined septum	Cool, ≤6 °C ⁹ , 0.008% Na ₂ S ₂ O ₃ ⁵	14 days
6, 57, 106. Purgeable aromatic hydrocarbons	G, FP-lined septum	Cool, ≤6 °C ⁹ , 0.008% Na ₂ S ₂ O ₃ ⁵ , HCl to pH 2 ¹⁶	14 days ¹⁶
3, 4. Acrolein and acrylonitrile	G, FP-lined septum	Cool, ≤6 °C ⁹ , 0.008% Na ₂ S ₂ O ₃ ⁵ , pH to 4–5 ¹⁷	14 days ¹⁷
23, 30, 44, 49, 53, 77, 80, 81, 98, 100, 112. Phenols ¹⁸	G, FP-lined cap	Cool, ≤6 °C ⁹ , 0.008% Na ₂ S ₂ O ₃ ⁵	7 days until extraction, 40 days after extraction
7, 38. Benzidines ^{18, 19}	G, FP-lined cap	Cool, ≤6 °C ⁹ , 0.008% Na ₂ S ₂ O ₃ ⁵	7 days until extraction ²⁰
14, 17, 48, 50–52. Phthalate esters ¹⁸	G, FP-lined cap	Cool, ≤6 °C ⁹	7 days until extraction, 40 days after extraction
82–84. Nitrosamines ^{18, 21}	G, FP-lined cap	Cool, ≤6 °C ⁹ , store in dark, 0.008% Na ₂ S ₂ O ₃ ⁵	7 days until extraction, 40 days after extraction
88–94. PCBs ¹⁸	G, FP-lined cap	Cool, ≤6 °C ⁹	1 year until extraction, 1 year after extraction
54, 55, 75, 79. Nitroaromatics and isophorone ¹⁸	G, FP-lined cap	Cool, ≤6 °C ⁹ , store in dark, 0.008% Na ₂ S ₂ O ₃ ⁵	7 days until extraction, 40 days after extraction
1, 2, 5, 8–12, 32, 33, 58, 59, 74, 78, 99, 101. Polynuclear aromatic hydrocarbons ¹⁸	G, FP-lined cap	Cool, ≤6 °C ⁹ , store in dark, 0.008% Na ₂ S ₂ O ₃ ⁵	7 days until extraction, 40 days after extraction
15, 16, 21, 31, 87. Haloethers ¹⁸	G, FP-lined cap	Cool, ≤6 °C ⁹ , 0.008% Na ₂ S ₂ O ₃ ⁵	7 days until extraction, 40 days after extraction
29, 35–37, 63–65, 107. Chlorinated hydrocarbons ¹⁸	G, FP-lined cap	Cool, ≤6 °C ⁹	7 days until extraction, 40 days after extraction
60–62, 66–72, 85, 86, 95–97, 102, 103. CDDs/CDFs ¹⁸			
Aqueous Samples: Field and Lab Preservation	G	Cool, ≤6 °C ⁹ , 0.008% Na ₂ S ₂ O ₃ ⁵ , pH<9	1 year

Table FS1000-4

40 CFR Part 136 TABLE II: Required Containers, Preservation Techniques, and Holding Times
Applicable to all Non-Potable Water Samples (includes wastewater, surface water, and groundwater)

Parameter No./Name (refers to parameter number on Tables IA,B, C, D,E, F, G & H as noted)	Container ¹	Preservation ^{2, 3}	Maximum holding time ⁴
Solids and Mixed-Phase Samples: Field Preservation	G	Cool, ≤6 °C ⁹	7 days
Tissue Samples: Field Preservation	G	Cool, ≤6 °C ⁹	24 hours
Solids, Mixed-Phase, and Tissue Samples: Lab Preservation	G	Freeze, ≤-10 °C	1 year
Table ID—Pesticides			
Tests: 1–70. Pesticides ¹⁸	G, FP-lined cap	Cool, ≤6 °C ⁹ , pH 5–9 ²²	7 days until extraction, 40 days after extraction
Table IE—Radiological Tests:			
1–5. Alpha, beta, and radium	P, FP, G	HNO ₃ to pH<2	6 months
Table IH—Bacterial Tests:			
1. <i>E. coli</i>			
2. Enterococci	PA, G	Cool, <10 °C, 0.008% Na ₂ S ₂ O ₃ ⁵	6 hours ⁶
Table IIH—Protozoan Tests:			
8. Cryptosporidium	LDPE; field filtration	0–8 °C	96 hours. ²³
9. Giardia	LDPE; field filtration	0–8 °C	96 hours ²³

Reference: This table is adapted from Table II, 40 CFR Part 136, 2007

¹ “P” is polyethylene; “FP” is fluoropolymer (polytetrafluoroethylene (PTFE; Teflon®), or other fluoropolymer, unless stated otherwise in this Table II; “G” is glass; “PA” is any plastic that is made of a sterilizable material (polypropylene or other autoclavable plastic); “LDPE” is low density polyethylene.

² Except where noted in this Table II and the method for the parameter, preserve each grab sample within 15 minutes of collection. For a composite sample collected with an automated sampler (e.g., using a 24-hour composite sampler; see 40 CFR 122.21(g)(7)(i) or 40 CFR Part 403, Appendix E), refrigerate the sample at ≤6 °C during collection unless specified otherwise in this Table II or in the method(s). For a composite sample to be split into separate aliquots for preservation and/or analysis, maintain the sample at ≤6 °C, unless specified otherwise in this Table II or in the method(s), until collection, splitting, and preservation is completed. Add the preservative to the sample container prior to sample collection when the preservative will not compromise the integrity of a grab sample, a composite sample, or an aliquot split from a composite sample; otherwise, preserve the grab sample, composite sample,

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).

³ When any sample is to be shipped by common carrier or sent via the U.S. Postal Service, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring such compliance. For the preservation requirements of Table II, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials Regulations do not apply to the following materials: Hydrochloric acid (HCl) in water solutions at concentrations of 0.04% by weight or less (pH about 1.96 or greater); Nitric acid (HNO₃) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H₂SO₄) in water solutions at concentrations of 0.35% by weight or less (pH about 1.15 or greater); and Sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH about 12.30 or less).

⁴ Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before the start of analysis and still be considered valid (e.g., samples analyzed for fecal coliforms may be held up to 6 hours prior to commencing analysis). Samples may be held for longer periods only if the permittee or monitoring laboratory has data on file to show that, for the specific types of samples under study, the analytes are stable for the longer time, and has received a variance from the Regional Administrator under § 136.3(e). For a grab sample, the holding time begins at the time of collection. For a composite sample collected with an automated sampler (e.g., using a 24-hour composite sampler; see 40 CFR 122.21(g)(7)(i) or 40 CFR Part 403, Appendix E), the holding time begins at the time of the end of collection of the composite sample. For a set of grab samples composited in the field or laboratory, the holding time begins at the time of collection of the last grab sample in the set. Some samples may not be stable for the maximum time period given in the table. A permittee or monitoring laboratory is obligated to hold the sample for a shorter time if it knows that a shorter time is necessary to maintain sample stability. See § 136.3(e) for details. The date and time of collection of an individual grab sample is the date and time at which the sample is collected. For a set of grab samples to be composited, and that are all collected on the same calendar date, the date of collection is the date on which the samples are collected. For a set of grab samples to be composited, and that are collected across two calendar dates, the date of collection is the dates of the two days; e.g., November 14–15. For a composite sample collected automatically on a given date, the

Table FS1000-4

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date of collection is the date on which the sample is collected. For a composite sample collected automatically, and that is collected across two calendar dates, the date of collection is the dates of the two days; e.g., November 14–15.

⁵ Add a reducing agent only if an oxidant (e.g., chlorine) is present. Reducing agents shown to be effective are sodium thiosulfate ($\text{Na}_2\text{S}_2\text{O}_3$), ascorbic acid, sodium arsenite (NaAsO_2), or sodium borohydride (NaBH_4). However, some of these agents have been shown to produce a positive or negative cyanide bias, depending on other substances in the sample and the analytical method used. Therefore, do not add an excess of reducing agent. Methods recommending ascorbic acid (e.g., EPA Method 335.4) specify adding ascorbic acid crystals, 0.1–0.6 g, until a drop of sample produces no color on potassium iodide (KI) starch paper, then adding 0.06 g (60 mg) for each liter of sample volume. If NaBH_4 or NaAsO_2 is used, 25 mg/L NaBH_4 or 100 mg/L NaAsO_2 will reduce more than 50 mg/L of chlorine (see method “Kelada-01” and/or Standard Method

4500–CN⁻ for more information). After adding reducing agent, test the sample using KI paper, a test strip (e.g. for chlorine, 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.

⁶ Samples analysis should begin immediately, preferably within 2 hours of collection. The maximum transport time to the laboratory is 6 hours, and samples should be processed within 2 hours of receipt at the laboratory.

⁷ For fecal coliform samples for sewage sludge (biosolids) only, the holding time is extended to 24 hours for the following sample types using either EPA Method 1680 (LTB–EC) or 1681 (A–1): Class A composted, Class B aerobically digested, and Class B anaerobically digested.

⁸ Sufficient ice should be placed with the samples in the shipping container to ensure that ice is still present when the samples arrive at the laboratory. However, even if ice is present when the samples arrive, it is necessary to immediately measure the temperature of the samples and confirm that the preservation temperature maximum has not been exceeded. In the isolated cases where it can be documented that this holding temperature cannot be met, the permittee can be given the option of on-site testing or can request a variance. The request for a variance should include supportive data which show that the toxicity of the effluent samples is not reduced because of the increased holding temperature.

⁹ Aqueous samples must be preserved at $\leq 6^\circ\text{C}$, 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 “ $\leq 6^\circ\text{C}$ ” is used in place of the “ 4°C ” and “ $< 4^\circ\text{C}$ ” sample temperature requirements listed in some methods. It is not necessary to measure the sample temperature to three significant figures ($1/100^{\text{th}}$ of 1 degree); rather, three

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significant figures are specified so that rounding down to 6 °C may not be used to meet the ≤6 °C requirement. The preservation temperature does not apply to samples that are analyzed immediately (less than 15 minutes).

¹⁰ Sample collection and preservation: Collect a volume of sample appropriate to the analytical method in a bottle of the material specified. If the sample can be analyzed within 48 hours and sulfide is not present, adjust the pH to > 12 with sodium hydroxide solution (e.g., 5% w/v), refrigerate as specified, and analyze within 48 hours. Otherwise, to extend the holding time to 14 days and mitigate interferences, treat the sample immediately using any or all of the following techniques, as necessary, followed by adjustment of the sample pH to > 12 and refrigeration as specified. There may be interferences that are not mitigated by approved procedures. Any procedure for removal or suppression of an interference may be employed, provided the laboratory demonstrates that it more accurately measures cyanide. Particulate cyanide (e.g., ferric ferrocyanide) or a strong cyanide complex (e.g., cobalt cyanide) are more accurately measured if the laboratory holds the sample at room temperature and pH > 12 for a minimum of 4 hours prior to analysis, and performs UV digestion or dissolution under alkaline (pH=12) conditions, if necessary.

(1) SULFUR: To remove elemental sulfur (S₈), filter the sample immediately. If the filtration time will exceed 15 minutes, use a larger filter or a method that requires a smaller sample volume (e.g., EPA Method 335.4 or Lachat Method 01). Adjust the pH of the filtrate to > 12 with NaOH, refrigerate the filter and filtrate, and ship or transport to the laboratory. In the laboratory, extract the filter with 100 mL of 5% NaOH solution for a minimum of 2 hours. Filter the extract and discard the solids. Combine the 5% NaOH-extracted filtrate with the initial filtrate, lower the pH to approximately 12 with concentrated hydrochloric or sulfuric acid, and analyze the combined filtrate. Because the detection limit for cyanide will be increased by dilution by the filtrate from the solids, test the sample with and without the solids procedure if a low detection limit for cyanide is necessary. Do not use the solids procedure if a higher cyanide concentration is obtained without it. Alternatively, analyze the filtrates from the sample and the solids separately, add the amounts determined (in µg or mg), and divide by the original sample volume to obtain the cyanide concentration.

(2) SULFIDE: If the sample contains sulfide as determined by lead acetate paper, or if sulfide is known or suspected to be present, immediately conduct one of the volatilization treatments or the precipitation treatment as follows: Volatilization—Headspace expelling. In a fume hood or well-ventilated area, transfer 0.75 liter of sample to a 4.4 L collapsible container (e.g., 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 >

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12, refrigerate, and ship or transport to the laboratory. Scaling to a smaller or larger sample volume must maintain the air to sample volume ratio. A larger volume of air will result in too great a loss of cyanide (> 10%). Precipitation: If the sample contains particulate matter that would be removed by filtration, filter the sample prior to treatment to assure that cyanide associated with the particulate matter is included in the measurement. Ship or transport the filter to the laboratory. In the laboratory, extract the filter with 100 mL of 5% NaOH solution for a minimum of 2 hours. Filter the extract and discard the solids. Combine the 5% NaOH-extracted filtrate with the initial filtrate, lower the pH to approximately 12 with concentrated hydrochloric or sulfuric acid, and analyze the combined filtrate. Because the detection limit for cyanide will be increased by dilution by the filtrate from the solids, test the sample with and without the solids procedure if a low detection limit for cyanide is necessary. Do not use the solids procedure if a higher cyanide concentration is obtained without it. Alternatively, analyze the filtrates from the sample and the solids separately, add the amounts determined (in µg or mg), and divide by the original sample volume to obtain the cyanide concentration. For removal of sulfide by precipitation, raise the pH of the sample to > 12 with NaOH solution, then add approximately 1 mg of powdered cadmium chloride for each mL of sample. For example, add approximately 500 mg to a 500-mL sample. Cap and shake the container to mix. Allow the precipitate to settle and test the sample with lead acetate paper. If necessary, add cadmium chloride but avoid adding an excess. Finally, filter through 0.45 micron filter. Cool the sample as specified and ship or transport the filtrate and filter to the laboratory. In the laboratory, extract the filter with 100 mL of 5% NaOH solution for a minimum of 2 hours. Filter the extract and discard the solids. Combine the 5% NaOH-extracted filtrate with the initial filtrate, lower the pH to approximately 12 with concentrated hydrochloric or sulfuric acid, and analyze the combined filtrate. Because the detection limit for cyanide will be increased by dilution by the filtrate from the solids, test the sample with and without the solids procedure if a low detection limit for cyanide is necessary. Do not use the solids procedure if a higher cyanide concentration is obtained without it. Alternatively, analyze the filtrates from the sample and the solids separately, add the amounts determined (in µg or mg), and divide by the original sample volume to obtain the cyanide concentration. If a ligand-exchange method is used (e.g., ASTM D6888), it may be necessary to increase the ligand-exchange reagent to offset any excess of cadmium chloride.

(3) SULFITE, THIOSULFATE, OR THIOCYANATE: If sulfite, thiosulfate, or thiocyanate is known or suspected to be present, use UV digestion with a glass coil (Method Kelada-01) or ligand exchange (Method OIA-1677) to preclude cyanide loss or positive interference.

(4) ALDEHYDE: If formaldehyde, acetaldehyde, or another water-soluble aldehyde is known or suspected to be present, treat the sample with 20 mL of 3.5% ethylenediamine solution per liter of sample.

(5) CARBONATE: Carbonate interference is evidenced by noticeable effervescence upon acidification in the distillation flask, a reduction in the pH of the absorber solution, and incomplete cyanide spike recovery. When significant carbonate is present, adjust the pH to ≥12 using calcium hydroxide instead of sodium hydroxide. Allow the precipitate to settle and decant or filter the sample prior to analysis (also see Standard Method 4500-CN.B.3.d).

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(6) CHLORINE, HYPOCHLORITE, OR OTHER OXIDANT: Treat a sample known or suspected to contain chlorine, hypochlorite, or other oxidant as directed in footnote 5.

¹¹ For dissolved metals, filter grab samples within 15 minutes of collection and before adding preservatives. For a composite sample collected with an automated sampler (e.g., using a 24-hour composite sampler; see 40 CFR 122.21(g)(7)(i) or 40 CFR Part 403, Appendix E), filter the sample within 15 minutes after completion of collection and before adding preservatives. If it is known or suspected that dissolved sample integrity will be compromised during collection of a composite sample collected automatically over time (e.g., by interchange of a metal between dissolved and suspended forms), collect and filter grab samples to be composited (footnote 2) in place of a composite sample collected automatically.

¹² To achieve the 28-day holding time, use the ammonium sulfate buffer solution specified in EPA Method 218.6. The allowance in this footnote supersedes preservation and holding time requirements in the approved hexavalent chromium methods, unless this supersession would compromise the measurement, in which case requirements in the method must be followed.

¹³ Samples collected for the determination of trace level mercury (<100 ng/L) using EPA Method 1631 must be collected in tightly-capped fluoropolymer or glass bottles and preserved with BrCl or HCl solution within 48 hours of sample collection. The time to preservation may be extended to 28 days if a sample is oxidized in the sample bottle. A sample collected for dissolved trace level mercury should be filtered in the laboratory within 24 hours of the time of collection. However, if circumstances preclude overnight shipment, the sample should be filtered in a designated clean area in the field in accordance with procedures given in Method 1669. If sample integrity will not be maintained by shipment to and filtration in the laboratory, the sample must be filtered in a designated clean area in the field within the time period necessary to maintain sample integrity. A sample that has been collected for determination of total or dissolved trace level mercury must be analyzed within 90 days of sample collection.

¹⁴ An aqueous sample may be collected and shipped without acid preservation. However, acid must be added at least 24 hours before analysis to dissolve any metals that adsorb to the container walls. If the sample must be analyzed within 24 hours of collection, add the acid immediately (see footnote 2). Soil and sediment samples do not need to be preserved with acid. The allowances in this footnote supersede the preservation and holding time requirements in the approved metals methods.

¹⁵ Guidance applies to samples to be analyzed by GC, LC, or GC/MS for specific compounds.

¹⁶ If the sample is not adjusted to pH 2, then the sample must be analyzed within seven days of sampling.

¹⁷ The pH adjustment is not required if acrolein will not be measured. Samples for acrolein receiving no pH adjustment must be analyzed within 3 days of sampling.

Table FS1000-4

40 CFR Part 136 TABLE II: Required Containers, Preservation Techniques, and Holding Times

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¹⁸ When the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding times should be observed for optimum safeguard of sample integrity (i.e., use all necessary preservatives and hold for the shortest time listed). When the analytes of concern fall within two or more chemical categories, the sample may be preserved by cooling to ≤ 6 °C, reducing residual chlorine with 0.008% sodium thiosulfate, storing in the dark, and adjusting the pH to 6–9; samples preserved in this manner may be held for seven days before extraction and for forty days after extraction. Exceptions to this optional preservation and holding time procedure are noted in footnote 5 (regarding the requirement for thiosulfate reduction), and footnotes 19, 20 (regarding the analysis of benzidine).

¹⁹ If 1,2-diphenylhydrazine is likely to be present, adjust the pH of the sample to 4.0 ± 0.2 to prevent rearrangement to benzidine.

²⁰ Extracts may be stored up to 30 days at < 0 °C.

²¹ For the analysis of diphenylnitrosamine, add 0.008% $\text{Na}_2\text{S}_2\text{O}_3$ and adjust pH to 7–10 with NaOH within 24 hours of sampling

²² The pH adjustment may be performed upon receipt at the laboratory and may be omitted if the samples are extracted within 72 hours of collection. For the analysis of aldrin, add 0.008% $\text{Na}_2\text{S}_2\text{O}_3$.

²³ Holding time is calculated from time of sample collection to elution for samples shipped to the laboratory in bulk and calculated from the time of sample filtration to elution for samples filtered in the field

Table FS 1000-5
Approved Water and Wastewater Procedures, Containers, Preservation and Holding Times
For Analytes not Found in 40 CFR 136

Analyte	Methods	Reference ¹	Container ²	Preservation ³	Maximum Holding Time ⁴
Bromine	DPD Colorimetric ⁵	SM 4500-Cl-G	P, G	None required	Analyze immediately
Bromates	Ion Chromatography	EPA 300.0 ⁶	P, G	Cool 4°C	30 days
Chlorophylls	Spectrophotometric	SM 10200 H	P, G ⁷	Dark 4°C Filtered, dark, -20°C	48 hours chilled until filtration ⁸ , and analyze immediately or 48 hours chilled until filtration ⁸ , and 28 days (frozen) after filtration
Corrosivity	Calculated (CaCO ₃ Stability, Langelier Index)	SM 2330 ASTM D513-92	P, G	Cool 4°C ⁹	7 days ⁹
FL-PRO	Gas Chromatography	DEP (11/1/95)	G only	Cool 4°C, H ₂ SO ₄ or HCl to pH<2	7 days until extraction, 40 days after extraction
Odor	Human Panel	SM 2150	G only	Cool 4°C	6 hours
Salinity	Electrometric ¹⁰ Hydrometric ¹⁰	SM 2520 B SM 2520 C	G, wax seal	Analyze immediately or use wax seal	30 days ¹⁰
Taste	Human Panel	SM 2160 B, C, D ASTM E679-91	G only	Cool 4°C	24 hours
Total Dissolved Gases	Direct-sensing Membrane-diffusion	SM 2810	_____	_____	Analyze in-situ
Total Petroleum Hydrocarbons	Gravimetry	EPA 1664	G only	Cool 4°C, H ₂ SO ₄ or HCl to pH<2	28 days
Transparency	Irradiometric ¹¹	62-302.200(6), FAC	_____	_____	Analyze in-situ
Un-ionized Ammonia	Calculated ¹²	DEP-SOP ¹³	P, G	Cool 4°C Na ₂ S ₂ O ₃ ¹²	8 hours unpreserved 28 days preserved ¹²
Organic Pesticides ¹⁴	GC and HPLC	EPA (600-series) ¹⁴	¹⁵	¹⁵	¹⁵

¹ SM XXXX = procedures from "Standard Methods for the Examination of Water and Wastewater", APHA-AWWA-WPCF, 20th edition, 1998 and Standard Methods Online.

ASTM XXXX-YY = procedure from "Annual Book of ASTM Standards", Volumes 11.01 and 11.02 (Water I and II), 1999.

² P = plastic, G = glass.

³ When specified, sample preservation should be performed immediately upon sample collection.

⁴ The times listed are the maximum times that samples may be held before analysis and still be considered valid.

Table FS 1000-5
Approved Water and Wastewater Procedures, Containers, Preservation and Holding Times
For Analytes not Found in 40 CFR 136

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- ⁵ The approved procedure is for residual chlorine. However, in the absence of chlorine, the DPD colorimetric procedure can be adapted to measure bromine content of the sample. In such case, the validity of this assumption must be verified by using another procedure for chlorine which is not affected by the presence of bromine (i.e., negligible interference).
- ⁶ The Determination of Inorganic Anions in Water by Ion Chromatography", EPA Method 300.0, Revised August 1993, by John D. Pfaff, U. S. EPA Cincinnati, Ohio 45268.
- ⁷ Collect samples in opaque bottles and process under reduced light.
- ⁸ Samples must be filtered within 48 hours of collection. Add magnesium carbonate to the filter while the last of the sample passes through the filter..
- ⁹ Temperature and pH must be measured on site at the time of sample collection. 7 days is the maximum time for laboratory analysis of total alkalinity, calcium ion and total solids.
- ¹⁰ The electrometric and hydrometric analytical methods are suited for field use. The argentometric method is suited for laboratory use. Samples collected for laboratory analysis, when properly sealed with paraffin waxed stopper, may be held indefinitely. The maximum holding time of 30 days is recommended as a practical regulatory limit.
- ¹¹ Transparency in surface waters is defined as a compensation point for photosynthetic activity, i.e., the depth at which one percent of the light intensity entering at the water surface remains unabsorbed. The DEP Chapter 62-302, FAC requires that the light intensities at the surface and subsurface be measured simultaneously by irradiance meters such as the Kahlsico Underwater Irradiometer, Model No. 268 WA 310, or an equivalent device having a comparable spectral response.
- ¹² The results of the measurements of pH, temperature, salinity (if applicable) and the ammonium ion concentration in the sample are used to calculate the concentration of ammonia in the unionized state. Temperature, pH and salinity must be measured on-site at the time of sample collection. Laboratory analysis of the ammonium ion concentration should be conducted within eight hours of sample collection. If prompt analysis of ammonia is impossible, preserve samples with H₂SO₄ to pH between 1.5 and 2. Acid-preserved samples, stored at 4°C, may be held up to 28 days for ammonia determination. Sodium thiosulfate should only be used if fresh samples contain residual chlorine.
- ¹³ DEP Central Analytical Laboratory, Tallahassee, FL, Revision No. 2, 2-12-2001. The document is available from the DEP Standards & Assessment Section..
- ¹⁴ Other pesticides listed in approved EPA methods (608.1, 608.2, 614, 614.1, 615, 617, 618, 619, 622, 622.1, 627, 629, 631, 632, 632.1, 633, 642, 643, 644 and 645) that are not included in Table ID of 40 CFR Part 136 (July 2007).
- ¹⁵ Container, preservation and holding time as specified in each individual method must be followed.

Table FS 1000-6
Recommended Sample Containers, Sample Volumes, Preservation Techniques and Holding Times for Residuals, Soil and Sediment Samples

Analyte	Methods	References	Container	Preservation	Maximum Holding Times
Volatile Organics	Purge-and-Trap GC and GC-MS	8015, 8260, 8021, 5035	See Table 1000-7		
Semivolatile Organics	GC, HPLC, and GC-MS	8041, 8061, 8070, 8081, 8082, 8091, 8111, 8121, 8131, 8141, 8151, 8270, 8275, 8280, 8290, 8310, 8315, 8316, 8318, 8321, 8325, 8330, 8331, 8332, 8410, 8430, 8440, FL-PRO	Glass, 8 oz widemouth with Teflon® -Lined lid	Cool 4°C ¹	14 days until extraction, 40 days after extraction
Dioxins		8290	Amber Glass, 8 oz widemouth with Teflon® -Lined lid	Cool 4°C ¹ in dark	30 days until extraction, 45 days after extraction
Total Metals-except mercury and chromium VI methods	Flame AA, Furnace AA, Hydride and ICP	All 7000-series (except 7195, 7196, 7197, 7198, 7470 and 7471), and 6010 (ICP)	Glass or plastic 8 oz widemouth (200 grams sample)	None	6 months
Chromium VI	Colorimetric, Chelation with Flame AA (200 gram sample)	7196 and 7197 (prep 3060)	Glass or plastic, 8 oz widemouth (200 gram sample)	Cool 4° ± 2°C ¹	1 month until extraction, 4 days after extraction ²
Mercury	Manual Cold Vapor AA	7471	Glass or plastic 8 oz widemouth (200 grams sample)	Cool 4° ± 2°C ¹	28 days
Microbiology (MPN)		MPN	Sterile glass or plastic	Cool 4°C ¹	24 hours
Aggregate Properties			Glass or plastic	Cool 4°C ¹	14 days
Inorganic nonmetallics all except:			Glass or plastic	Cool 4°C ¹	28 days
----- Sulfite, Nitrate, Nitrite & o-phosphate			Glass or plastic		48 hours
----- Elemental Phosphorus			Glass		48 hours

Table FS 1000-6

Recommended Sample Containers, Sample Volumes, Preservation Techniques and Holding Times for Residuals, Soil and Sediment Samples

The term "residuals" include: (1) sludges of domestic origin having no specific requirements in Tables FS-1000-4 or FS-1000-9; (2) sludges of industrial origin; and (3) concentrated waste samples.

¹ Keep soils, sediments and sludges cool at 4°C from collection time until analysis. No preservation is required for concentrated waste samples.

² Storage Temperature is 4°C, $\pm 2^\circ\text{C}$

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 ^①	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 ₄ / 4°C	5035 - Section 7.2	14 D	Any recognized VOC Method
				5035 - 6.1.1 ^②	4°C	5035 - Section 7.2	48 H	Any recognized VOC Method
				5035 - 6.1.1 ^②	4°C / -10°C ^{③,④}	5035 - Section 7.2	48 H / 14 D ^⑤	Any recognized VOC Method
	EnCore or equivalent	5035 - Section 6.2.1	EnCore or equivalent	5035 - 6.1.1 ^{②,⑥,⑦}	4°C	5035 - Section 7.2	48 H	Any recognized VOC Method
		5035 - Section 6.2.1	EnCore or equivalent	5035 - 6.1.1 ^{⑥,⑦}	NaHSO ₄ / 4°C	5035 - Section 7.2 ^⑤	48 H / 14 D ^⑤	Any recognized VOC Method
		5035 - Section 6.2.1	EnCore or equivalent	5035-6.1.1 ^{②⑥⑦}	4°C / -10°C ^{③,④}	5035 - Section 7.2 ^⑤	48 H / 14 D ^⑤	Any recognized VOC Method
>200 ug/kg	EnCore or equivalent	5035 - Section 6.2.2.3 ^⑥	EnCore or equivalent	5035 - 6.1.3 ^{⑥,⑦}	4°C	5035 - Sections 7.3.2 & 7.3.3 ^⑥	48 H / 14 D ^⑤	Any recognized VOC Method
>200 ug/kg ^⑧	Coring Device	5035 - Section 6.2.2.3 ^⑧	Glass Vial w/ PTFE-silicone Septum	6.1.3 ^⑧	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

- 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 ¹	Holding Time ²	Holding Time for Extract ³	Container ⁴
MICROBIOLOGICAL-BACTERIA	Cool < 10°C, Na ₂ S ₂ O ₃ ⁵			P or G
Total Coliforms, fecal coliforms & <i>E. coli</i> in drinking water	Cool < 10°C ⁶ , Na ₂ S ₂ O ₃ ⁵	30 Hours ⁷		P or G
Total coliforms and fecal coliforms in source water Heterotrophic bacteria in drinking water	Cool < 10°C, Na ₂ S ₂ O ₃ ⁵	8 hours		P or G
Gross Alpha	Conc. HCl or HNO ₃ to pH <2 ^{8,9}	6 mo		P or G
Gross beta	Conc. HCl or HNO to pH <2 ^{8,9}	6 mo		P or G
Strontium-89	Conc. HCl or HNO to pH <2 ^{8,9}	6 mo		P or G
Strontium-90	Conc. HCl or HNO to pH <2 ^{8,9}	6 mo		P or G
Radium-226	Conc. HCl or HNO to pH <2 ^{8,9}	6 mo		P or G
Radium-228	Conc. HCl or HNO to pH <2 ^{8,9}	6 mo		P or G
Cesium-134	Concentrated HCl to pH <<2 ^{8,9}	6 mo		P or G
Iodine-131	None	8 da		P or G
Tritium	None	6 months		G
Uranium	Conc. HCl or HNO ₃ to pH <2 ^{8,9}	6 mo		P or G
Photon emitters	Conc. HCl or HNO ₃ to pH <2 ^{8,9}	6 mo		P or G
Asbestos	Cool 4°C	48 hours		P or G
Bromate	Ethylenediamine (50mg/L)	28 days		P or G
Cyanide	Cool, 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 ¹	Holding Time ²	Holding Time for Extract ³	Container ⁴
504.1	Sodium Thiosulfate Cool, 4°C,	14 days	4°C, 24 hours	Glass with PTFE-Lined Septum
505	Sodium Thiosulfate Cool, 4°C	14 days (7 days for Heptachlor)	4°C, 24 hours	Glass with PTFE-Lined Septum
506	Sodium Thiosulfate Cool, 4°C, Dark	14 days	4°C, dark, 14 days	Amber Glass with PTFE-lined Cap
507	Sodium Thiosulfate Cool, 4°C, Dark	14 days (see method for exceptions)	4°C, dark, 14 days	Amber Glass with PTFE-lined Cap
508	Sodium Thiosulfate Cool, 4°C, Dark	7 days (see method for exceptions)	4°C, dark, 14 days	Glass with PTFE-lined Cap
508A	Cool, 4°C	14 days	30 days	Glass with PTFE-lined Cap
508.1	Sodium Sulfite, HCl pH<2, Cool, 4°C	14 days (see method for exceptions)	30 days	Glass with PTFE-lined Cap
515.1	Sodium Thiosulfate Cool, 4°C, Dark	14 days	4°C, dark, 28 days	Amber Glass with PTFE-lined Cap
515.2	Sodium Thiosulfate HCl pH<2, Cool, 4°C, Dark	14 days	≤ 4°C, dark, 14 days	Amber Glass with PTFE-lined Cap
515.3	Sodium Thiosulfate HCl pH<2, Cool, 4°C, Dark	14 days	≤ 4°C, dark, 14 days	Amber Glass with PTFE-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 PTFE-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 PTFE-lined Cap
531.1, 6610	Sodium Thiosulfate Monochloroacetic acid, pH<3, Cool, 4°C	Cool 4°C, 28 days		Glass with PTFE-lined Septum
531.2	Sodium Thiosulfate, Potassium Dihydrogen Citrate buffer to pH 4,	28 days		

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Preservation Methods and Holding Times for Drinking Water Samples that Differ from 40 CFR Part 136, Table II

Analyte	Preservation ¹	Holding Time ²	Holding Time for Extract ³	Container ⁴
	dark, ≤10°C for first 48 hr, ≤6°C thereafter			
547	Sodium Thiosulfate Cool, 4°C	14 days (18 mo. frozen)		Glass with 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 ₂ SO ₄ pH<2 if biologically active), Cool, 4°C, Dark	7 days	21 days	High Density Amber Plastic or Silanized Amber Glass
550, 550.1	Sodium Thiosulfate Cool, 4°C, HCl pH<2	7 days	550, 30 days 550.1, 40 days Dark, 4°C	Amber Glass with 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

¹ Preservation, when required, must be done immediately upon sample collection.

² Stated values are the maximum regulatory holding times. Sample processing must begin by the stated time.

³ Stated time is the maximum time a prepared sample extract may be held before analysis.

⁴ (P) polyethylene or (G) or glass. For microbiology, plastic sample containers must be made of sterilizable materials (poly-propylene or other autoclavable plastic).

⁵ Addition of sodium thiosulfate is only required if the sample has a detectable amount of residual chlorine, as indicated by a field test using EPA Method 330.4 or 330.2 or equivalent.

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Preservation Methods and Holding Times for Drinking Water Samples that Differ from 40 CFR Part 136, Table II

- ⁶ Temperature requirement applies only to source water samples, however once received by the laboratory, if sample processing does not begin on the same working day, samples must be refrigerated.
- ⁷ If samples are analyzed after 30 hours, but within 48 hours of collection, the laboratory is to indicate in the analytical report that the data may be invalid because of excessive delay in sample processing. No samples received after 48 hours are to be accepted or analyzed for compliance with the regulations of the Department of Environmental Protection or the Department of Health.
- ⁸ It is recommended that the preservative be added at the time of collection unless suspended solids activity is to be measured. It is also recommended that samples be filtered, if suspended or settleable solids are present, prior to adding preservative, at the time of collection. However, if the sample has to be shipped to a laboratory or storage area, acidification of the sample (in its original container) may be delayed for a period not to exceed 5 days. A minimum of 16 hours must elapse between acidification and analysis.
- ⁹ If HCl is used to acidify samples, which are to be analyzed for gross alpha or gross beta activities, the acid salts must be converted to nitrate salts before transfer of the samples to planchets.

Table FS 1000-9
Containers, Preservation and Holding Times for Biosolids Samples and Protozoans

<i>ANALYTE NAME</i>	<i>CONTAINER</i>	<i>PRESERVATION</i>	<i>MAX HOLDING TIME</i>
Fecal Coliform	Plastic or Glass	Cool 4°C	24 hours
Salmonella	Plastic or Glass	< 10°C	24 hours
Enteric Viruses	Plastic or Glass	Up to 25°C	2 hours
Enteric Viruses	Plastic or Glass	2 to 10°C	48 hours
Specific Oxygen Uptake Rate	Plastic or Glass	None	As Soon As Possible
Helminth OVA	Plastic or Glass	< 4°C (Do not Freeze)	24 hours
Cryptosporidium/Giardia	Plastic or Glass	0 - 8°C (Do not Freeze)*	96 Hours
Total Solids	Plastic or Glass	≤6°C (Do not Freeze)	7 days
Metallics	Plastic or Glass	See Tables FS 1000-4, FS 1000-5 and FS 1000-6	
Other Inorganic Pollutants	Plastic or Glass	See Tables FS 1000-4, FS 1000-5 and FS 1000-6	

***Dechlorinate bulk samples when applicable**

Table FS 1000-10
Container Materials, Preservation, and Holding Times for Fish and Shellfish

Analyte	Matrix	Sample Container	Field (Transport to Lab)		Laboratory	
			Preservation	Maximum Shipping Time	Storage	Holding Time
	Whole Organism (Fish, shellfish, etc.	Foil-wrap each organism (or composite for shellfish) and transport in waterproof plastic bag	Cool in wet ice or: ----- Freeze on dry ice	24 hours ----- 48 hours		
Mercury	Tissue (fillets and edible portions, homogenates)	Plastic, borosilicate glass, quartz, PTFE			Freeze at <-20°C	28 days
Other metals	Tissue (fillets and edible portions, homogenates)	Plastic, borosilicate glass, quartz, PTFE			Freeze at <-20°C	6 months
Organics	Tissue (fillets and edible portions, homogenates)	Borosilicate glass, PTFE, quartz, aluminum foil			Freeze at <-20°C	1 year
Dioxin	Tissue (fillets and edible portions, homogenates)	Amber containers: Borosilicate glass, PTFE, quartz, aluminum foil			Freeze at <-20°C	30 days until extraction, 15 days after extraction
Lipids	Tissue (fillets and edible portions, homogenates)	Plastic, borosilicate glass, quartz, PTFE			Freeze at <-20°C	1 year

PTFE = Polytetrafluoroethylene (Teflon)

Table FS 1000-11
Holding Times for SPLP or TCLP Extraction, Sample Preparation and Determinative Analysis

Holding Time (Days)				
	From: Field Collection	From: SPLP or TCLP Extraction	From: Preparative Extraction	Total Elapsed Time
	To: SPLP or TCLP Extraction	To: Preparative Extraction	To: Determinative Analysis	
Volatiles	14	NA	14	28
Semi-Volatiles	14	7	40	61
Mercury	28	NA	28	56
Metals, except Mercury	180	NA	180	360

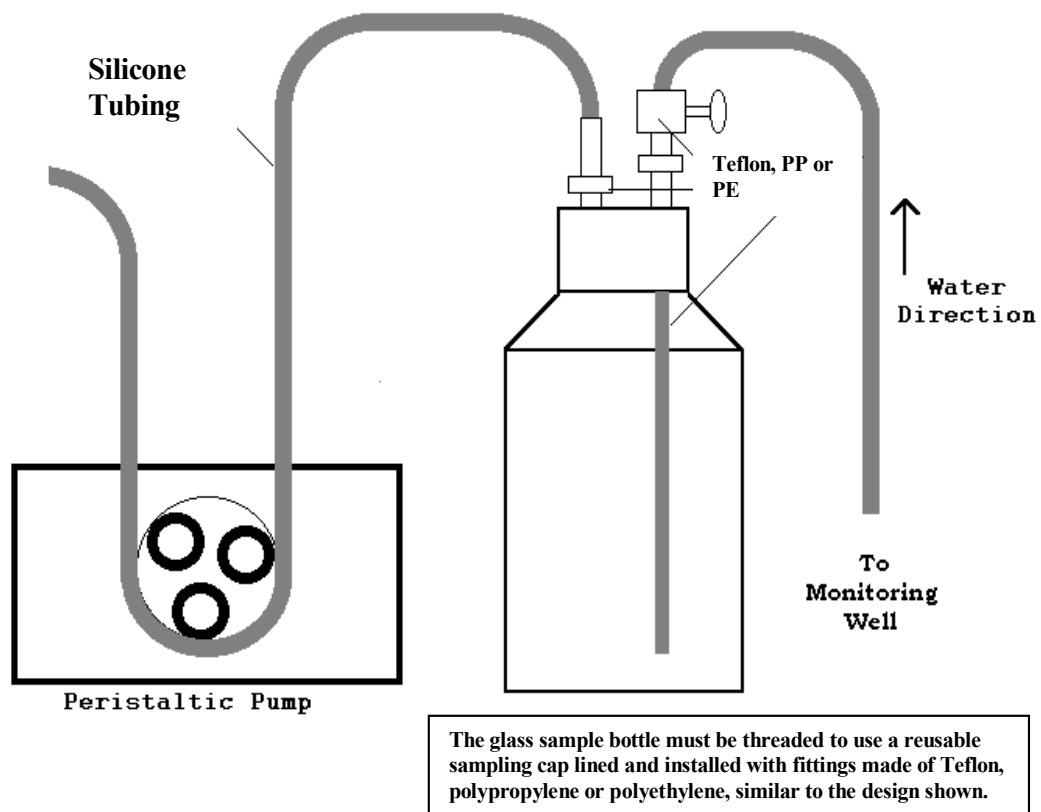
NA – Not Applicable

Table FS 1000-12
Preventive Maintenance Tasks

INSTRUMENT/ACTIVITY	FREQUENCY
REFRIGERATORS, INCUBATORS, OVENS	
Clean interior	Monthly
Check thermometer temperature against certified thermometer or equivalent	Annually
ANYTICAL BALANCES	
Clean pan and compartment	Daily ¹
Check with Class S weights	Monthly
Manufacturer cleaning and calibration	Annually
pH AND ION SELECTIVE ELECTRODES	
PROBE	
Check probe for cracks and proper levels of filling solution; check reference junction; clean electrode	Daily, Replace as necessary
Check response time	Daily ¹
METER	
Check batteries and electronics for loose connections and cracked leads	Daily ¹ , Replace as necessary
TURBIDIMETER	
Clean instrument housing	Monthly
Clean cells	Daily ¹
CONDUCTIVITY METER	
Check batteries and probe cables	Daily ¹
Replatinize Probe	Per manufacturer's recommendations
DISSOLVED OXYGEN METERS	
PROBE	
Check membrane for deterioration; check filling solution	Daily ¹ , Replace as necessary
METER	
Battery level and electronics checked	Daily ¹ , Replace as necessary
THERMOMETERS	
Check for cracks and gaps in the mercury	Daily ¹ , Replace as necessary
TEMPERATURE PROBE	
Check connections, cables	Daily ¹
Check against calibrated thermometer	Daily ¹
AUTOMATIC SAMPLE COLLECTION SYSTEMS (e.g., ISCO, Sigma)	
Check sampler operation (forward, reverse, automatic through three cycles of the purge-pump-purge cycle)	Daily ¹ Prior to Sampling Event
Check purge-pump-purge cycle when sampler is installed	Daily ¹ Prior to Sampling Event
Check the flow pacer that activates the sampler to assure proper operation	Daily ¹ Prior to Sampling Event
Check desiccant	Daily ¹ , Replace as Necessary
Check batteries	Daily ¹ , Replace as Necessary
Check pumping rate against manufacturer's specifications	Daily ¹ , Replace as Necessary

¹Daily 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 (HNO₃) that is suitable for use for metals analysis. Use concentrated HNO₃ or 1:1 HNO₃ 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 HNO₃ or 1:1 HNO₃ 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 Cl₂.

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 (HNO₃).

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_3 or 1:1 HNO_3 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.

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: ± 0.2 Standard Units
- Specific Conductance: $\pm 5.0\%$ of reading
- Dissolved Oxygen: $\leq 20\%$ Saturation
- Turbidity: ≤ 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 ≤ 20 NTU criterion for turbidity. However, when collecting groundwater samples for metals or certain inorganic (e.g., phosphorus forms) or extractable organic (e.g. polynuclear aromatic hydrocarbons) chemicals, make every attempt to reduce turbidity to ≤ 20 NTU to avoid a potential turbidity-associated bias for these analytes. See section 3.5, below.

3.4 Document and report the following, as applicable, except that the last four (4) items only need to be submitted once:

- Purging rate.
- Drawdown in the well, if any.
- Pump or tubing intake placement.
- Length and location of the screened interval.
- A description of the process and the data used to design the well.
- The equipment and procedure used to install the well.

- The well development procedure.
- Pertinent lithologic or hydrogeologic information.

3.5 If the criteria in section 3.1 above for dissolved oxygen and/or turbidity cannot be met, then three (3) consecutive measurements of the five (5) parameters listed below must be within the stated limits.

3.5.1 The measurements evaluated must be the last three consecutive measurements taken before purging is stopped. The range between the highest and the lowest values for the last three measurements cannot exceed the stated limits.

- Temperature: $\pm 0.2^{\circ} \text{C}$
- pH: ± 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 ≤ 500 mL/minute (a 1/8" stream) or approximately 0.1 gal/minute before collecting samples. When sampling for volatile organic compounds, reduce the flow to ≤ 100 mL/minute before collecting the samples.

2. INTERMITTENTLY RUNNING PUMPS

2.1 Select the spigot that is closest to the pump and before any storage tanks (if possible).

2.2 Remove all hoses, aerators and filters (if possible).

2.3 Open the spigot and purge sufficient volume at a maximum, practical flow rate to flush the spigot and lines and until the purging completion criteria in FS 2212, section 3, have been met.

2.4 If a storage tank is located between the pump and the spigot, purge the volume of the tank, lines and spigot.

2.5 Ensure that the purge stabilization measurement of dissolved oxygen is not biased with aeration of the sample by a high flow rate in the flow-through container.

2.6 Reduce the flow rate to ≤ 500 mL/minute (a 1/8" stream) or approximately 0.1 gal/minute before collecting samples. When sampling for volatile organic compounds, reduce the flow to ≤ 100 mL/minute before collecting the samples.

FS 2216. *Purging Airstrippers and Remedial Treatment Systems*

If collecting samples for groundwater contamination monitoring, follow FS 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 ≤ 100 mL/minute when collecting VOC samples.
- 3.4 Dedicated Sampling Equipment
 - 3.4.1 Whenever possible, use dedicated equipment because it significantly reduces the chance of cross-contamination.
 - 3.4.2 Dedicated is defined as equipment that is to be used solely for one location for the life of that equipment (e.g., permanently mounted pump).
 - 3.4.3 All material construction and restrictions from Table FS 2200-1 also apply to dedicated equipment. Purchase equipment with the most sensitive analyte of interest in mind.
- 3.5 Cleaning/Decontamination
 - 3.5.1 Clean or ensure dedicated pumps are clean before installation. They do not need to be cleaned prior to each use but must be cleaned if they are withdrawn for repair or servicing.
 - 3.5.2 Clean or make sure any permanently mounted tubing is clean before installation.
 - 3.5.3 Change or clean tubing when the pump is withdrawn for servicing.
 - 3.5.4 Clean any replaceable or temporary parts as specified in FC 1000.
 - 3.5.5 Collect equipment blanks on dedicated pumping systems when the tubing is cleaned or replaced.
 - 3.5.6 Clean or ensure dedicated bailers are clean before placing them into the well.
 - 3.5.7 Collect an equipment blank on dedicated bailers before introducing them into the water column.

3.5.8 Suspend dedicated bailers above the water column if they are stored in the well.

FS 2221. *Sampling Wells Without Plumbing*

1. SAMPLING WITH PUMPS: Variable speed stainless steel and Teflon submersible pumps and stainless steel, Teflon or Polyethylene bladder pumps, and permanently installed PVC-bodied variable speed submersible or bladder pumps, as long as the pump remains in contact with the water in the well at all times, may be used to sample for all organics. The delivery tubing must be Teflon, Polyethylene or PP. **Extractable organics** may be collected through a peristaltic pump if ≤ 1 foot of silicone tubing is used in the pump head or a vacuum trap is used (see Figure FS 2200-1 for specific configuration). Follow all notes and restrictions as defined in Table FS 2200-1 and discussed in Equipment and Supplies (FS 2201) when using pumps to collect samples.

Do not lower the pump or tubing to the bottom of the well.

1.1 Peristaltic Pump

1.1.1 Volatile Organics Using Manual Fill and Drain Method: Collect volatile organics last. If the pump tubing is placed within the screened interval, the tubing cannot be reinserted into the well, and steps 1.1.1.3 through 1.1.1.6 below are prohibited.

- 1.1.1.1 Ensure that there is sufficient tubing volume to fill the requisite number of VOC vials.
- 1.1.1.2 Remove the drop tubing from the inlet side of the pump.
- 1.1.1.3 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 ≤ 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 ≤ 100 mL/minute.

1.1.2.8 Or, remove the drop tubing from the inlet side of the pump and carefully allow the groundwater to drain into the sample vials. Avoid turbulence. Do not aerate the sample. The flow rate must be ≤ 100 mL/minute.

1.1.2.9 Repeat steps 1.1.2.2 through 1.1.2.8 until enough vials are filled.

1.1.3 Extractable Organics Collected Through Silicone Pump-Head Tubing:

1.1.3.1 Ensure that a 1-foot maximum length of new silicone tubing was installed in the peristaltic pump head assembly before the well was purged if the same pump is being used to purge and sample the well. Otherwise, install a new length of tubing as described above.

1.1.3.2 Collect extractable organic samples directly from the effluent delivery tubing (attached to discharge side of the silicone pump head tubing) into the sample container.

1.1.3.3 If there is a concern that sample analytes are absorbed, adsorbed, leached or otherwise affected or lost by pumping through the silicone pump-head tubing, sample the well using the organic trap assembly in 1.1.4 below.

1.1.4 Extractable Organics Using an Optional Organic Trap Assembly

1.1.4.1 Assemble the components of the pump and trap according to Figure FS 2200-1.

1.1.4.2 The sample container should be the trap bottle.

1.1.4.3 All equipment that contacts the groundwater **before** the sample container must be constructed of Teflon, Polyethylene, PP, stainless steel or glass, including the transport tubing to and from the sample container, the interior liner of the container cap and all fittings. **Do not use a rubber stopper as a cap.**

1.1.4.4 Connect the outflow tubing from the container to the influent side of the peristaltic pump.

1.1.4.5 Prevent the water in the down-hole delivery tubing from flowing back into the well while performing this connection.

1.1.4.6 Turn the pump on and reduce the flow rate to a smooth and even flow.

1.1.4.7 Discard a small portion of the sample to allow an air space.

1.1.4.8 Preserve (if required), label and complete the field notes.

1.1.5 Inorganics

1.1.5.1 Inorganic samples may be collected from the effluent tubing.

1.1.5.2 If samples are collected from the pump, decontaminate all tubing (including the tubing in the head) or change it between wells.

1.1.5.3 Preserve (if required), label and complete field notes.

1.2 Variable Speed Bladder Pump

1.2.1 If sampling for organics the pump body must be constructed of stainless steel and the valves and bladder must be Teflon. All tubing must be Teflon, Polyethylene, or PP and any cabling must be sealed in Teflon, Polyethylene or PP, or made of stainless steel.

1.2.2 After purging to a smooth even flow, reduce the flow rate.

1.2.3 When sampling for volatile organic compounds, reduce the flow rate to 100 mL/minute or less, if possible.

1.3 Variable Speed Submersible Pump

1.3.1 The housing must be stainless steel.

1.3.2 If sampling for organics, the internal impellers, seals and gaskets must be constructed of stainless steel, Teflon, Polyethylene or PP. The delivery tubing must be Teflon, Polyethylene or PP and the electrical cord must be sealed in Teflon and any cabling must be sealed in Teflon or constructed of stainless steel.

1.3.3 After purging to a smooth even flow, reduce the flow rate.

1.3.4 When sampling for volatile organic compounds, reduce the flow rate to 100 mL/minute or less, if possible.

2. SAMPLING WITH BAILERS: A high degree of skill and coordination are necessary to collect representative samples with a bailer. When properly used, bailers may be used to collect samples for certain analyte groups and under specific conditions (see Table FS 2200-3). They must be of an appropriate type and construction (see FS 2201, section 3), and must be used as outlined below. If in doubt about the appropriateness of using a bailer at a site or during a particular sampling event, contact the appropriate DEP program or project manager.

2.1 General Considerations

2.1.1 Minimize handling the bailer as much as possible.

2.1.1.1 Wear sampling gloves.

2.1.1.2 Remove the bailer from its protective wrapping just before use.

2.1.1.3 Attach a lanyard of appropriate material (see FS 2201, section 4).

2.1.1.4 Use the lanyard to move and position the bailers.

2.1.2 Do not allow the bailer or lanyard to touch the ground.

2.1.3 Rinsing

2.1.3.1 If the bailer is certified precleaned, no rinsing is necessary.

2.1.3.2 If both a pump and a bailer are to be used to collect samples, rinse the exterior and interior of the bailer with sample water from the pump before removing the pump.

2.1.3.3 If the purge pump is not appropriate for collecting samples (e.g., non-inert components), rinse the bailer with by collecting a single bailer of the groundwater to be sampled. Use the technique described in section 2.2, Bailing Technique, below.

2.1.3.4 Discard the water appropriately.

2.1.3.5 **Do not** rinse the bailer if Oil & Grease, TRPHs, etc., (see FS 2006) are to be collected.

2.2 Bailing Technique

2.2.1 Collect all samples that are required to be collected with a pump before collecting samples with the bailer.

2.2.2 Raise and lower the bailer gently to minimize stirring up particulate matter in the well and the water column which can increase sample turbidity.

2.2.3 Lower the bailer carefully into the well to a depth approximately a foot above the water column. Ensure that the length of the bailer does not exceed the length of the water column.

2.2.3.1 When the bailer is in position, lower the bailer into the water column at a rate of 2 cm/sec until the desired depth is reached (see section 2.2.3 above).

2.2.4 Do not lower the top of the bailer more than one (1) foot below the top of the water table so that water is removed from the top of the water column.

2.2.5 Allow time for the bailer to fill with aquifer water as it descends into the water column.

2.2.6 Do not allow the bailer to touch the bottom of the well or particulate matter will be incorporated into the sample.

2.2.6.1 Carefully raise the bailer (see section 2.2.2 above). Retrieve the bailer at the same rate of 2 cm/sec until the bottom of the bailer has cleared to top of the water column.

2.2.7 Lower the bailer to approximately the same depth each time.

2.2.8 Collect the sample.

2.2.8.1 Install a device to control the flow from the bottom of the bailer and discard the first few inches of water. Reduce the flow to ≤ 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- μ 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

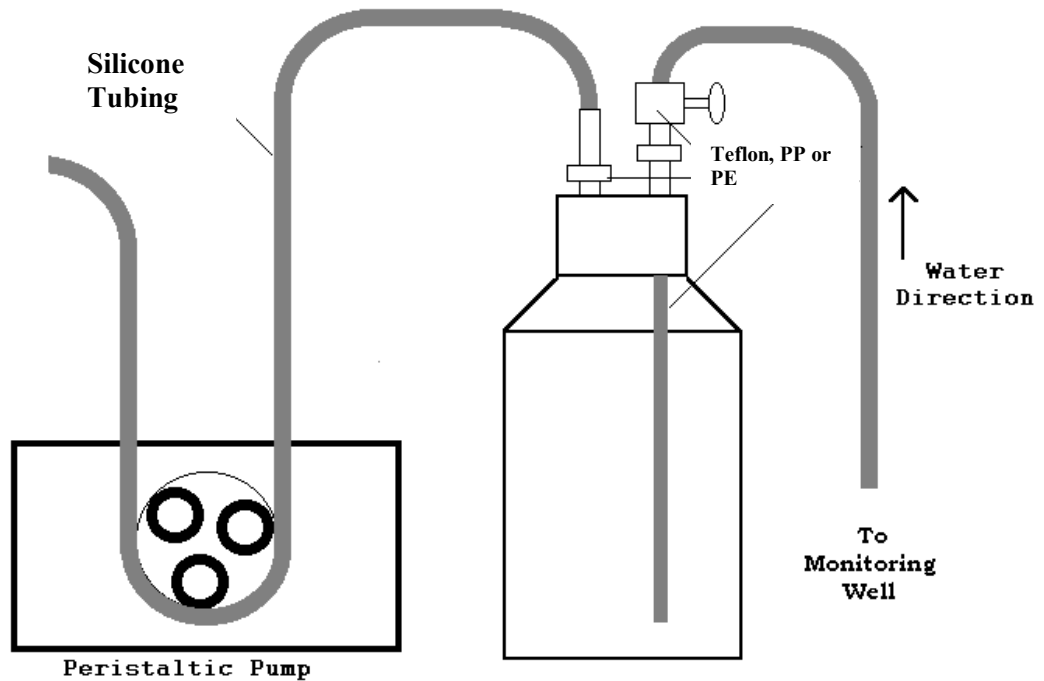
Table FS 2200-3
Allowable Uses for Bailers

• 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.

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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

Scenario 1: WELL SCREEN COMPLETELY SUBMERGED

Option 1a: Minimal Purge Volume: Pump or tubing is placed within the middle of the screen interval. The following conditions must be met to use this option:

1. The well screen interval is ≤ 10 feet.
2. Although drawdown may occur in the well when purging is initiated, the drawdown has to stabilize (Aquifer Recovery Rate = Purge Rate).
3. The samples will be obtained with the same equipment that was used to purge the well. Therefore, centrifugal pumps and bailers are not suitable for use in Option 1a.

If one or more of these conditions do not apply, use Option 1b.

Option 1b: Conventional Purge: Pump, tubing, or bailer ¹ is placed above the screen at the top of the water column.

¹ DEP does not recommend the use of a bailer for purging; however, if a bailer is used it shall be lowered and raised at the rate of 2 cm/sec in the top of the water column.

Scenario 2: WELL SCREEN PARTIALLY SUBMERGED

Option 2a: A bailer ¹ is placed at the top of the water column and is used to purge and sample the well.

Option 2b: Pump or tubing is placed within the middle of the saturated portion of the screen interval.

If the pump or tubing that was used for purging will not be used to obtain the sample, then position the pump or tubing at the top of the water column for purging.

Purging Procedure #1

1. After the drawdown in the well stabilizes, purge at least one equipment volume then collect the first set of stabilization parameters.
2. Thereafter, collect stabilization parameters ≥ 2 to 3 minutes apart.
3. Purge at least three equipment volumes before sampling.

Purging Procedure #2

1. Purge at least one well volume then collect first set of stabilization parameters.
2. Thereafter, collect stabilization parameters $\geq$ every 1/4 well volume.

Purging Procedure #3

1. Purge at least one well volume then collect first set of stabilization parameters.
2. Thereafter, collect stabilization parameters ≥ 2 to 3 minutes apart.

Purging Completion

If **Dissolved Oxygen** is $\leq 20\%$ of saturation for the measured temperature and **Turbidity** is ≤ 20 NTUs, then purging is complete when **three** consecutive readings of the parameters listed below are within the following ranges:

Temperature $\pm 0.2^\circ\text{C}$
pH ± 0.2 Standard Units
Specific Conductance $\pm 5.0\%$ of reading

If **Dissolved Oxygen (DO)** is $> 20\%$ of saturation for the measured temperature and/or **Turbidity** is > 20 NTUs after every attempt has been made to reduce DO and/or turbidity, then purging is complete when **three** consecutive readings of the parameters listed below are within the following ranges:

Temperature $\pm 0.2^\circ\text{C}$
pH ± 0.2 Standard Units
Specific Conductance $\pm 5.0\%$ of reading
Dissolved Oxygen ± 0.2 mg/L or readings are within 10% (whichever is greater).
Turbidity ± 5 NTUs or readings are within 10% (whichever is greater).

If the well is expected to purge dry, position the pump or tubing within the screened interval and purge at ≤ 100 mL/minute until two equipment volumes are removed. Use the same pump for purging and sampling.

If the **well purges dry** at the lowest achievable flow rate (pumping at 100 mL/minute or less), then after a sufficient amount of water recharges in the well, collect the samples.

In either case listed above, before samples are collected, measure (once) **pH, temperature, specific conductance, dissolved oxygen, and turbidity.**

If one or more parameters do not stabilize **after 5 volumes of the screened interval** (purging procedure #1) or **5 well volumes** (purging procedure #s 2 & 3) are removed, purging may be discontinued at the discretion of the sampling team leader.

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 ≤ 100 mL/minute when collecting VOC samples.

1.3. Sample Containers with no Preservatives

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 ≤ 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 ≤ 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 ≤ 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 ≤ 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 ≤ 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 ≤ 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_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 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," 18th, 19th or 20th 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 H₂SO₄ (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

EQUIPMENT	USE
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 (≤ 200 $\mu\text{g/kg}$ 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°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/ivers, 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

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]

Device	Use	Advantages	Disadvantages
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 ² 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:

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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 ¹	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 ²	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

¹ 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.

² 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)

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- 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.

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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.

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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.

Appendix FS 6100
Tables, Figures and Forms

Table FS 6100-1 Summary of Shellfish Sampling Equipment

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TABLE FS 6100-1. SUMMARY OF SHELLFISH SAMPLING EQUIPMENT

Device	Use	Advantages	Disadvantages
ACTIVE METHODS			
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.
MECHANICAL GRABS:			
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.
LINE OR CABLE-OPERATED GRAB BUCKETS:			
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.
PASSIVE METHODS			
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

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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:

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- 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.

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- 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.

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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.

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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

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FS 6200 Finfish Tissue Sampling

TABLE FS 6200-1. SUMMARY OF FISH SAMPLING EQUIPMENT

Device	Use	Advantages	Disadvantages
ACTIVE METHODS			
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.
PASSIVE METHODS			
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

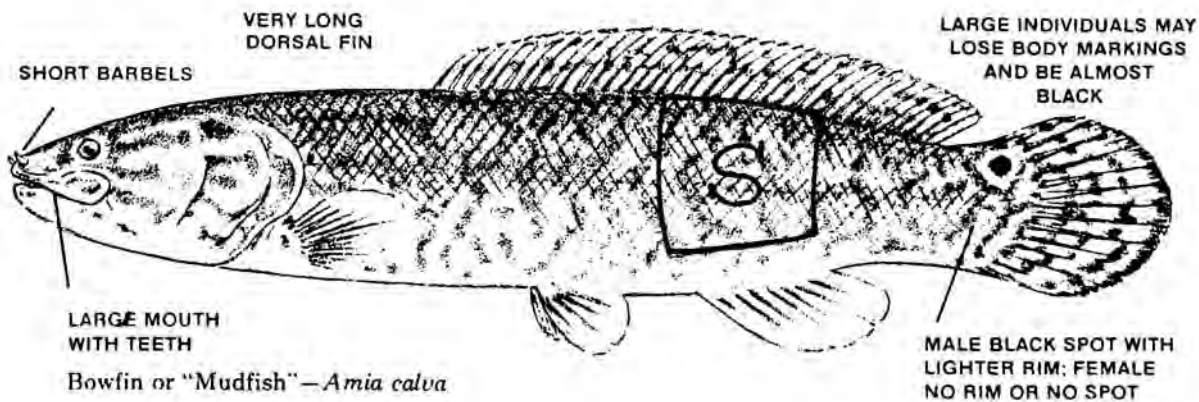
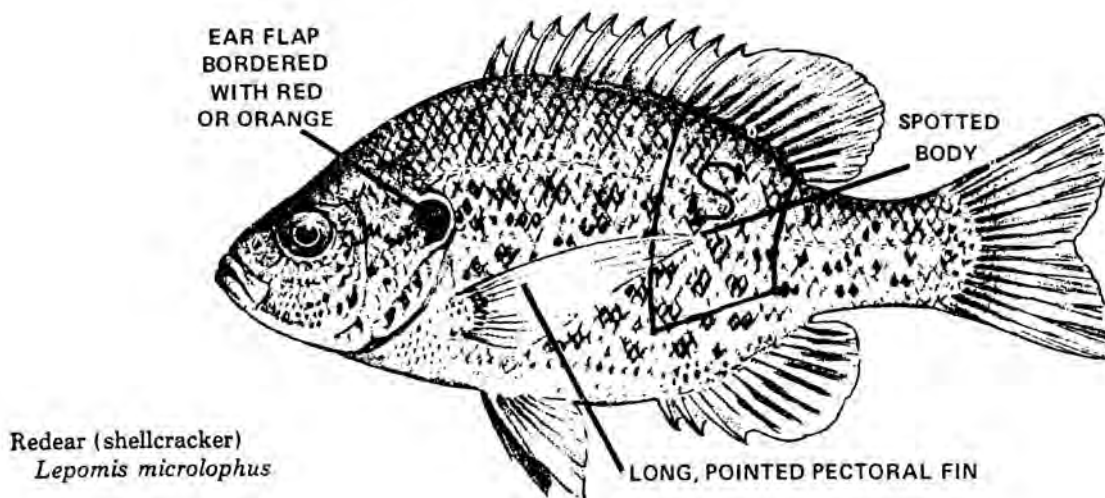
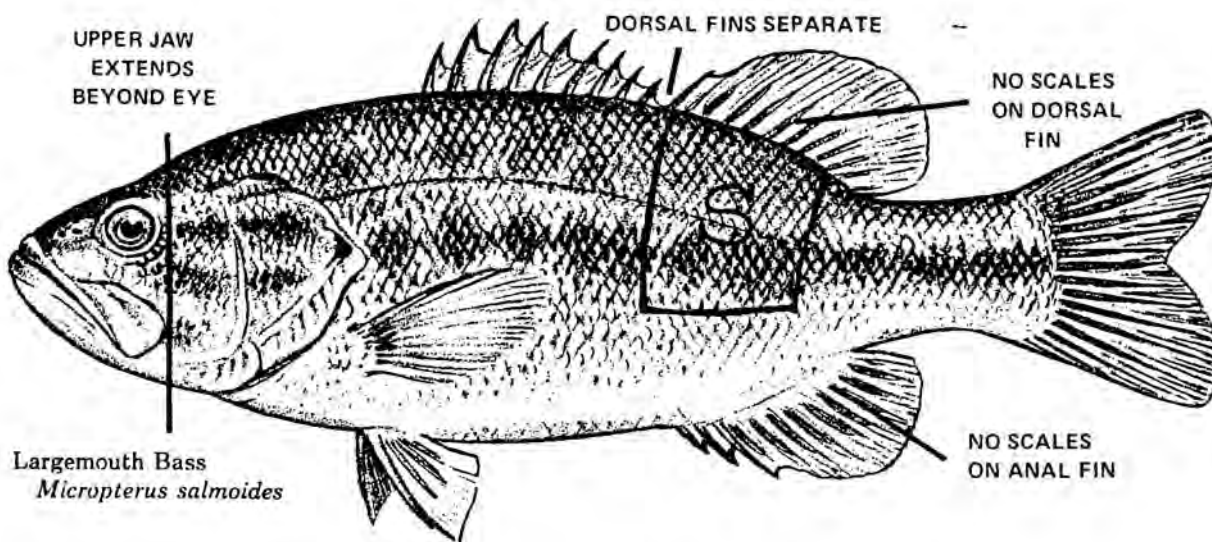
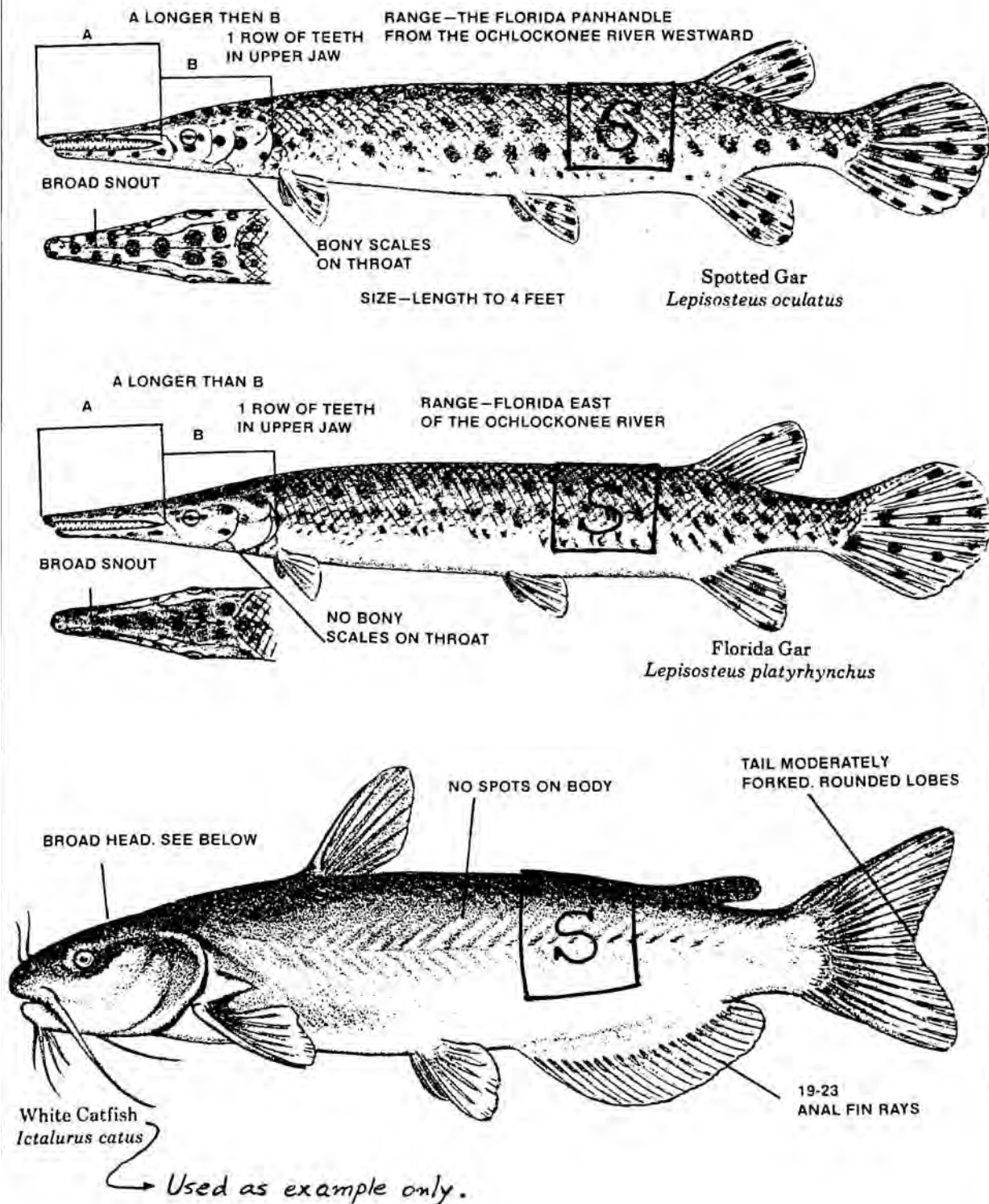


Figure FS 6200-1
Dissection Guide for Spotted Gar, Florida Gar and White Catfish



**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.

3. Phytoplankton Sampling

For more information on sample collection, see also the following section:

- FS 2100 Surface Water Sampling

4. EQUIPMENT AND SUPPLIES

- 1 L Nalgene wide-mouth dark sample bottle
- Van Dorn Bottle
- Lugol's solution
- Buffered formalin
- Cooler with ice

5. METHODS

5.1. 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.

5.2. 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.

5.3. Collect samples directly with the sample bottles for surface collection or with the additional equipment for various water depths.

6. SAMPLE PRESERVATION AND HANDLING

6.1. Place sample on ice.

6.2. 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 7100. Periphyton Sampling

FS 7110. 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 7120. 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 m², (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 m²) 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 7130. 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 7200. Macrophyte Sampling

FS 7220. 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

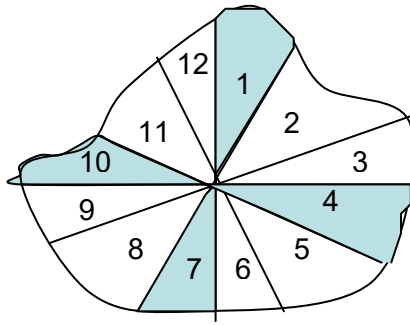
3.1. Prior to visiting the lake:

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).

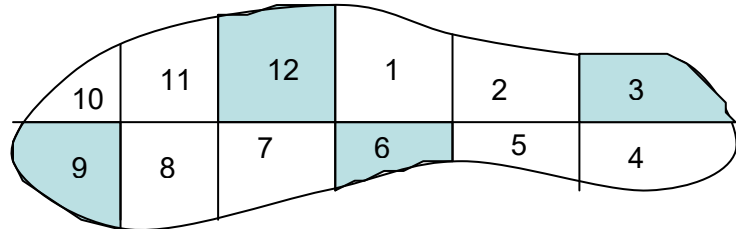
3.1.4. If section 1 is selected as the starting section, sections 1, 4, 7, and 10 will be sampled. If section 2 is selected, sections 2, 5, 8, and 11 are sampled. If section 3 is selected, sections 3, 6, 9, and 12 are sampled. On the Lake Vegetation Index Data Sheet, record the sections of the lake associated 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 7300. Benthic Macroinvertebrate Sampling

FS 7310. 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 ≤ 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 7320. 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 ≤ 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 7330. 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 7340. 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 cm² 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 7350. 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 7360. 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

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

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Form FD 9000-1: Biorecon Field Sheet

STORET Station	Location
Latitude: N ° ' " Longitude: W ° ' "	Watershed / Basin
Date/Time Collected	Collected, & Sorted By:
types of habitats sampled	QC'd By:

** Rare (1-3), Common (4-10), Abundant (11-100), Dominant (>100).

Taxa	Tally	Abun Code	Taxa	Tally	Abun Code	Taxa	Tally	Abun Code
Diptera			Trombidiformes			Ephemeroptera		
Ceratopogonidae			Acarina			Acerpenna pygmaea		
Culicidae			Oligochaeta			Baetidae		
Empididae			Naiidae			Baetis sp.		
Chironomidae			Lumbriculidae			Baetisca sp.		
Simulium sp.			Tubificidae			Brachycercus sp.		
Stratiomyidae			Hirudinea			Caenis sp.		
Tipulidae			Pelecypoda			Callibaetis sp.		
			Corbicula fluminea			Centroptilum sp.		
			Elliptio sp.			Heptagenia sp.		
			Pisidiidae			Hexagenia sp.		
						Isonychia sp.		
Gastropoda			Megaloptera			Leptophlebia sp.		
Ancylidae			Corydalus cornutus			Neophemera sp.		
Elimia sp.			Sialis sp.			Stenacron sp.		
Physella sp.						Stenonema sp.		
Pomacea sp.			Hemiptera			Tricorythodes sp.		
Planorbella sp.			Belostoma sp.					
Hydrobiidae			Corixidae					
Viviparus sp.			Gerridae			Plecoptera		
Melanoides tuberculata			Hydrometra sp.			Acroneuria sp.		
			Pelocoris sp.			Amphinemura sp.		
			Pleidae			Hydroperla sp.		
Odonata			Ranatra sp.			Isoperla sp.		
Argia sp.			Velidae			Leuctra sp.		
Aeschnidae						Neoperla sp.		
Boyeria vinos.			Other (name groups)			Paragnetina sp.		
Calopteryx sp.						Perlesta sp.		
Enallagma sp.						Perlinella sp.		
Epiptera sp.						Pteronarcys sp.		
Erythemis simplicicollis						Taeniopteryx sp.		
Gomphus sp.						Talioptera sp.		
Hetaerina sp.								
Ischnura sp.								
Libellulidae						Trichoptera		
Macromia sp.						Anisocentropus sp.		
Neurocordulia sp.						Brachycentrus sp.		
Progomphus sp.						Cernotina sp.		
Pachydiplax longipennis						Cheumatopsyche sp.		
			Decapoda			Chimarra sp.		
			Palaemonetes sp.			Diplectrona sp.		
Coleoptera			Procambarus sp.			Hydroptila sp.		
Ancyronyx variagata						Hydropsyche sp.		
Curculionidae						Lype diversa		
Dineutus sp.			Amphipoda			Macrostemum sp.		
Dubiraphia vittata			Gammarus sp.			Nectopsyche sp.		
Dytiscidae			Hyalella azteca			Oecetis sp.		
Gyretes sp.			Crangonys sp.			Oxyethira sp.		
Microcylloepus pusillus						Polycentropus sp.		
Stenelmis sp.			Isopoda			Triaenodes sp.		
			Caecidotea (Asellus) sp.					
Column Total: Taxa			Column Total: Taxa			Column Total: Taxa		

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.

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Form FD 9000-2: COMPOSITE LAKE SAMPLING SHEET (< 1000 ACRES)

Date:		Name of Lake:		Gear used:	PONAR	EKMAN	OTHER
Comments:							
Drop #	Depth (m)	Sediment Type (circle all that apply)	Drop #	Depth (m)	Sediment Type (circle all that apply)		
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.

**Table FS 7000-1:
MAXIMUM NUMBER OF SPECIMENS RETAINED FOR BIORECON IDENTIFICATION**

Taxon	Target # to Pick
Oligochaeta	5
Acarina	5
Hirudinea	5
Ephemeroptera	
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
Odonata	15
Trichoptera	
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
Plecoptera	
Capniidae	15
Chloroperlidae	15
Leuctridae	15
Nemouridae	5
Peltoperlidae	5
Perlidae	15
Perlodidae	15
Pteroncyidae	5
Taeniopterygidae	5
Hemiptera (any)	5
Megaloptera (any)	5
Neuroptera	5
Diptera (of any other kind)	5
Ceratopogonidae	5
Chaoboridae	5
Empididae	5
Collembola	5
Amphipoda	15
Decapoda	5
Isopoda	5
Gastropoda	15
Pelecypoda	5
Lepidoptera	5
Coleoptera	
Chrysomelidae	5
Dryopidae	5
Dytiscidae	15
Elmidae	15
Gyrinidae	5
Haliplidae	5
Hydraenidae	5
Hydrophilidae	15
Noteridae	5
Psephenidae	5
Ptilodactylidae	5
Scirtidae	5

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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
			NV (0-1)	V (1-5)						NV (0-1)	V (1-5)		
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		Algal Thickness Rank						
	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:

Form FD 9000-7: Lake Vegetation Index Data Field Sheet

Lake Vegetation Index Data Sheet (10-19-06)															
Waterbody:						Date:						County:			
Analyst:						STORET:						Signature:			
Lake water level (circle 1): high, normal, low						Algal mats present (circle 1): yes, no						Lake units sampled (circle one group): 1, 4, 7, 10			
Plants in bold=exotic. (1)= category 1 invasive (worst), (2)=category 2 invasive. Except where noted on sheet, species level identification required.												2, 5, 8, 11 3, 6, 9, 12			
It is important to note dominant or co-dominant taxa (by areal extent) for each unit. Use "D" to denote dominant taxon, or "C" for the 2 co-dominant taxa.															
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
Acer rubrum	4.65							Habenaria repens	4.58						
Alternanthera philoxeroides(2)	0.00							Hydrilla verticillata(1)	0.00						
Azolla caroliniana	1.81							Hydrochloa caroliniensis (Luziola fluit	4.79						
Baccharis glomeruliflora	6.12							Hydrocotyle umbellata	1.92						
Bacopa caroliniana	5.31							Hygrophila polysperma(1)	0.00						
Bacopa monnieri	4.49							Hypericum fasciculatum	7.27						
Bidens laevis	7.19							Hypericum hypericoides	5.44						
Bidens mitis	6.31							Hypericum myrtifolium	6.56						
Blechnum serrulatum	7.15							Ilex cassine	7.66						
Boehmeria cylindrica	5.91							Ipomoea aquatica(1)	0.00						
Bracharia mutica	0.00							Ipomoea sagittata	6.42						
Brasenia schreberi	8.79							Itea virginica	7.09						
Cabomba caroliniana	5.07							Juncus effusus	3.25						
Carex albolutescens (C. longii)	3.47							Juncus marginatus	3.65						
Carex verrucosa	7.97							Juncus megacephalus	5.70						
Centella asiatica	1.92							Juncus repens	6.91						
Cephalanthus occidentalis	7.27							Lachnanthes carolina	3.76						
Ceratophyllum demersum	4.16							Leersia hexandra	5.61						
Ceratopteris thalictroides	2.93							Lemna minor	3.77						
Chara spp.	3.90							Leucothoe racemosa	9.44						
Cladium jamaicense	9.04							Limnobia spongia	4.79						
Clethra alnifolia	5.63							Limnophila sessiliflora(2)	0.00						
Cliftonia monophylla	5.63							Liquidamber styraciflua	5.56						
Colocasia esculenta(1)	0.00							Ludwigia arcuata	5.32						
Commelina diffusa	2.02							Ludwigia leptocarpa	3.47						
Crinum americanum	8.67							Ludwigia octovalvis	4.09						
Cyperus alternifolius(2) (C. involu	0.00							Ludwigia peruviana	0.62						
Cyperus articulatus	6.64							Ludwigia repens	5.20						
Cyperus haspan	5.68							Lyonia ferruginea	8.39						
Cyperus lanceolatus	2.04							Lyonia ligustrina	8.67						
Cyperus polystachyos	1.56							Lyonia lucida	7.06						
Cyperus prolifer(2)	0.00							Magnolia virginiana	9.44						
Cyperus surinamensis	2.03							Mayaca fluviatilis	8.45						
Cyrilla racemiflora	5.20							Melaleuca quinquenervia(1)	0.00						
Decodon verticillatus	7.80							Micranthemum glomeratum	5.85						
Diodia virginiana	4.96							Micranthemum umbrosum	5.66						
Echinochloa crusgalli	0.22							Mikania scandens	1.95						
Eclipta alba	none							Mimosa pigra(1)	0.00						
Egeria densa	0.49							Myrica cerifera	3.82						
Eichhornia crassipes(1)	0.00							Myriophyllum aquaticum	0.67						
Eleocharis baldwinii	2.82							Myriophyllum heterophyllum	4.77						
Eleocharis cellulosa	7.80							Myriophyllum laxum	5.85						
Eleocharis equisetoides	9.10							Myriophyllum pinnatum	5.85						
Eleocharis interstincta	7.80							Myriophyllum spicatum(2)	0.00						
Erechtites hieracifolia	1.37							Najas guadalupensis	5.07						
Eriocaulon compressum	7.50							Najas marina	5.50						
Eriocaulon decangulare	7.50							Najas minor	3.64						
Eupatorium capillifolium	0.83							Nasturtium officinale	2.93						
Fuirena breviseta	7.60							Nelumbo lutea	6.26						
Fuirena scirpoidea	6.50							Nitella spp.	7.28						
Gordonia lasianthus	9.03														

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						
Panicum repens(1)	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						
Pennisetum purpureum(1)	0.00							Utricularia foliosa	6.44						
Phragmites australis	4.39							Utricularia inflata	5.85						
Pinus elliotii	4.21							Utricularia purpurea	6.50						
Pistia stratioides(1)	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							Wedelia trilobata(2)	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														
Sapium sebiferum(1)	0.00														
Saururus cernuus	7.33														
Schinus terebinthifolius(1)	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 rinse water 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 μ 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 (KBrO₃) 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

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FS 8200 Clean Sampling For Ultratrace Metals in Surface Waters

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.

Table FT 1000-1: Field Testing Acceptance Criteria	
Parameter	Acceptance Criteria
pH (FT 1100)	± 0.2 Standard pH Units of buffer or more stringent program criteria
Specific Conductance (FT 1200)	$\pm 5\%$ 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)	± 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

Table FT 1000-1: Field Testing Acceptance Criteria	
Parameter	Acceptance Criteria
pH (FT 1100)	± 0.2 Standard pH Units of buffer or more stringent program criteria
Specific Conductance (FT 1200)	$\pm 5\%$ 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)	± 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⁺-B.

1.3. Recordkeeping and Documentation Supplies:

- Field notebook (w/ waterproof paper is recommended) or forms
- Indelible pens

2. Calibration and Use

2.1. General Concerns

2.1.1. The acceptance criterion for the initial calibration or the calibration verification is a reading of the standard within +/- 0.2-unit of the expected value.

2.1.2. On a weekly basis, check the calibration to ensure the % theoretical slope is greater than 90% (if applicable to your instrument type).

2.1.2.1. Note the % slope in the calibration records.

2.1.2.2. A % slope of less than 90% indicates a bad electrode that must be changed or repaired.

2.1.2.3. If % slope cannot be determined on your meter, or the manufacturer's optimum specifications are different, follow the manufacturer's recommendation for maintaining optimum meter performance.

2.2. Interferences

2.2.1. Sodium at pH $\geq$ 10.0 units can be reduced or eliminated by using a low sodium error electrode.

- 2.2.2. Coatings of oils, greases, and particles may impair the electrode's response. Pat the electrode bulb dry with lint-free paper or cloth and rinse with de-ionized water. For cleaning hard-to-remove films, use acetone very sparingly so that the electronic surface is not damaged.
- 2.2.3. Temperature effects on the electrometric measurement of pH are controlled by using instruments having temperature compensation or by calibrating the meter at the temperature of the samples.
- 2.2.4. Poorly buffered solutions with low specific conductance ($< 200 \mu\text{mhos/cm}$) 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 ± 0.2 pH units of the stated buffer value. For example, if reading the pH 4.0 buffer, the result must be in the 3.8 to 4.2 range. Certain regulatory programs may have more stringent acceptance criteria.
 - 2.3.2.4. After sample measurement(s), perform a continuing calibration verification (CCV). Read a buffer as a sample. To be acceptable, a

calibration verification must be within +/- 0.2 pH units of the stated buffer value. This CCV (if within acceptance criteria) can be used as the beginning of the chronological bracket. Certain regulatory programs may have more stringent acceptance criteria.

- 2.4. Measuring pH *in situ*: After calibrating the multi-probe sensors as outlined in 2.3 above, follow the meter's instructions to select the display for reading the pH of the sample. Immerse the probe at the desired depth in the water and wait for stabilization of the reading before recording the measurement.
- 2.5. Measuring pH in Flow-through Cells: When using a flow-through cell, the procedure described above in section 2.4 is applicable.
- 2.6. Measuring pH in Samples: After an acceptable initial calibration or calibration verification, follow these procedures to take a pH reading of a freshly collected sample (within 15 minutes of collection).
 - 2.6.1. Pour enough of the fresh sample into a clean cup to take the reading.
 - 2.6.2. Place the pH electrode in the sample (in the cup) and swirl the electrode.
 - 2.6.3. Wait for stabilization, and read the pH value.
 - 2.6.4. Turn the meter off after the last sample reading, rinse the electrode thoroughly with de-ionized water and replace the electrode's cap.
3. PREVENTIVE MAINTENANCE: Refer to FT 1000, section 3.
4. DOCUMENTATION
 - 4.1. Standard and Reagent Documentation: Document information about standards and reagents used for calibrations, verifications, and sample measurements.
 - 4.1.1. Note the date of receipt, the expiration date and the date of first use for all standards and reagents.
 - 4.1.1.1. Document acceptable verification of any standard used after its expiration date.
 - 4.1.2. Record the concentration or other value for the standard in the appropriate measurement units.
 - 4.1.2.1. Note vendor catalog number and description for preformulated solutions as well as for neat liquids and powdered standards.
 - 4.1.2.2. Retain vendor assay specifications for standards as part of the calibration record.
 - 4.1.3. Record the grade of standard or reagent used.
 - 4.1.4. When formulated in-house, document all calculations used to formulate calibration standards.
 - 4.1.4.1. Record the date of preparation for all in-house formulations.
 - 4.1.5. Describe or cite the procedure(s) used to prepare any standards in-house (DEP SOP or internal SOP).
 - 4.2. Field Instrument Calibration Documentation: Document acceptable calibration and calibration verification for each instrument unit and field test or analysis, linking this record with affected sample measurements.

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- 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 $\pm 5\%$ 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 $\pm 5\%$ 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, 20th edition, if other calculations (i.e., determining cell constant, etc.) are required. See FT 1210 below.

3.5 *In situ* Measurements at Depth or With Flow-through Cells: After calibrating the instrument as outlined in 3.2 above, follow the manufacturer's instructions to measure the conductivity of the sample.

3.5.1. For *in situ* measurements immerse the probe at the desired depth and wait for stabilization of the reading and record its value. Follow a similar procedure when using a flow-through cell.

3.5.1.1 Preferably measure groundwater sample conductivity *in situ* with a downhole probe or in a flow-through system.

4. PREVENTATIVE MAINTENANCE: Refer to FT 1000, section 3.

5. DOCUMENTATION

5.1. Standard and Reagent Documentation: Document information about standards and reagents used for calibrations, verifications and sample measurements.

5.1.1. Note the date of receipt, the expiration date and the date of first use for all standards and reagents.

5.1.1.1. Document acceptable verification of any standard used after its expiration date.

5.1.2. Record the concentration or other value for the standard in the appropriate measurement units.

5.1.2.1. Note vendor catalog number and description for preformulated solutions as well as for neat liquids and powdered standards.

5.1.2.2. Retain vendor assay specifications for standards as part of the calibration record.

5.1.3. Record the grade of standard or reagent used.

5.1.4. When formulated in-house, document all calculations used to formulate calibration standards.

5.1.4.1. Record the date of preparation for all in-house formulations.

5.1.5. Describe or cite the procedure(s) used to prepare any standards in-house (DEP SOP or internal SOP).

5.2. Field Instrument Calibration Documentation: Document acceptable calibration and calibration verification for each instrument unit and field test or analysis, linking this record with affected sample measurements.

5.2.1. Retain vendor certifications of all factory-calibrated instrumentation.

5.2.2. Designate the identity of specific instrumentation in the documentation with a unique description or code for each instrument unit used.

- 5.2.2.1. Record manufacturer name, model number, and identifying number such as a serial number for each instrument unit.
- 5.2.3. Record the time and date of all initial calibrations and all calibration verifications.
- 5.2.4. Record the instrument reading (value in appropriate measurement units) of all calibration verifications.
- 5.2.5. Record the name of the analyst(s) performing the calibration.
- 5.2.6. Document the specific standards used to calibrate or verify the instrument or field test with the following information:
- Type of standard or standard name (e.g., conductivity standard)
 - Value of standard, including correct units (e.g., conductivity = 100 μ 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 µmho/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).

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2.2.2. De-ionized water for calibration of the densimeter (if used).

2.3. Recordkeeping and Documentation Supplies:

- Field logbook (w/ waterproof paper is recommended) or field forms
- Indelible pens

3. CALIBRATION AND USE

3.1. Conductivity Method

3.1.1. Calibration: - Calibrate the instrument per manufacturer's instructions using one calibration standard, either standard seawater or a KCl solution, as applicable. The acceptance criterion for initial calibration or a calibration verification is that the instrument reading is within +/- 5% of the standard value. For example, when calibrating with standard seawater, $S = 35$, the meter must read in the 34 to 36 range in order to be acceptable.

3.1.1.1. Use standard seawater ($S = 35$) when measuring salinity in the open ocean or estuaries with a predominance of seawater.

3.1.1.2. KCl may be used in estuarine waters with low salinity ($S = 0 - 40$).

3.1.1.3. If verifying or calibrating with a "zero" standard, do not use analyte-free water or air check (dry electrode) as the blank.

3.1.1.4. If the meter does not provide a direct reading of salinity, use the equation found in SM2520B to convert the readings to salinity.

3.1.1.5. Follow the calibration activities in FT 1000, section 2.2.

3.1.1.6. Do not reuse standards for initial calibrations.

3.1.2. Field Use: - Rinse the probe with DI water after calibration and before each sample measurements. Follow the manufacturer's instructions for temperature compensation, if needed. Report salinities with only one decimal figure.

3.1.3. General Concerns for Conductivity Method

3.1.3.1. Ensure stable sample and sensor temperature before calibrating or taking sample readings. Drifting sensor or sample temperature may produce erroneous sample measurements, calibrations, or verifications.

3.1.3.2. Thoroughly rinse the conductivity (salinity) sensor with deionized water and fresh standard when calibrating or verifying the calibration or when taking sample measurements. For in-situ measurements, ensure adequate flushing of the sensor with fresh sample water prior to taking measurements. Any residual standard, sample, or deionized water remaining on the sensor may affect the measurement of the subsequent standard or sample. This is especially true when samples or low-concentration standards are measured subsequent to measuring high-concentration standards.

3.1.3.3. Drifting readings or an inability to calibrate the sensor may also indicate a fouled electrode. Clean the electrodes per the manufacturer's instructions.

3.1.3.4. When successful calibration and verification cannot be achieved after ensuring that temperatures have stabilized and the sensor electrodes are clean and free of residual sample or standard from the previous measurement, suspect opened containers of standards, especially after repeated openings, when near the

manufacturer's expiration date or when little standard volume remains in the container. Low-concentration conductivity standards are seldom stable for an extended period after opening.

3.2. Density Method

The vibrating flow densimeter is an instrument that allows for precise and rapid measurements of the density of a liquid, such as water. The principle of operation is the effect of the density of the sample on the frequency of a vibrating tube encased in a constant-temperature jacket. The measurement is made by passing the water (sample) through the vibrating tube and reading the period of vibration that is electronically sensed and displayed by the densimeter. The sample density (D) is proportional to the square of the period of vibration (T):

$$D = a + bT^2$$

Where a and b are terms determined by calibration, b being determined by calibration of the densimeter with Standard Seawater. The difference between the density of the sample (D) and that of pure water (D₀) is given by:

$$D - D_0 = b (T^2 - T_0^2)$$

Where T and T₀ 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 – D₀) 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.

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- 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)

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- 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.

- 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_2S) will undergo oxidation if high enough potential (voltage) is applied, creating current flow, yielding faulty readings. If such interferences are suspected, change the membrane electrode more frequently and calibrate at more frequent intervals.

2.1.6. Ensure that the temperature of the sensor and sample are stable. Unstable temperatures will produce erroneous calibrations, verifications or sample measurements.

2.1.7. Erroneous calibrations or verifications may result if the saturated air chamber is not vented to atmospheric pressure, properly humidified and protected from temperature fluctuations produced by common field conditions such as evaporation or fluctuation in sunlight intensity.

2.2. Follow the quality control requirements for calibration (see activities in FT 1000, section 2.2).

2.3. 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

Table FT 1500-1: Solubility of Oxygen in Water			
at Atmospheric Pressure^{1,2}			
Temperature	Oxygen Solubility	Temperature	Oxygen Solubility
°C	mg/L	°C	mg/L
0.0	14.621	26.0	8.113
1.0	14.216	27.0	7.968
2.0	13.829	28.0	7.827
3.0	13.460	29.0	7.691
4.0	13.107	30.0	7.559
5.0	12.770	31.0	7.430
6.0	12.447	32.0	7.305
7.0	12.139	33.0	7.183
8.0	11.843	34.0	7.065
9.0	11.559	35.0	6.950
10.0	11.288	36.0	6.837
11.0	11.027	37.0	6.727
12.0	10.777	38.0	6.620
13.0	10.537	39.0	6.515
14.0	10.306	40.0	6.412
15.0	10.084	41.0	6.312
16.0	9.870	42.0	6.213
17.0	9.665	43.0	6.116
18.0	9.467	44.0	6.021
19.0	9.276	45.0	5.927
20.0	9.092	46.0	5.835
21.0	8.915	47.0	5.744
22.0	8.743	48.0	5.654
23.0	8.578	49.0	5.565
24.0	8.418	50.0	5.477
25.0	8.263		
1. The table provides three decimal places to aid interpolation			
2. Under equilibrium conditions, the partial pressure of oxygen in air-saturated water is equal to that of the oxygen in water-saturated			

FT 1600. Field Measurement of Turbidity

Use in conjunction with:

- FT 1000 General Field Testing and Measurement
- FS 1000 General Sampling Procedures
- FD 1000 Documentation Procedures

1. INTRODUCTION: Turbidity measures the scattering effect that suspended solids have on the propagation of light through a body of water (surface or ground waters). The higher the effect (i.e., intensity of scattered light), the higher the turbidity value. Suspended and colloidal matter such as clay, silt, finely divided organic and inorganic matter, and plankton and other microscopic organisms cause turbidity in water.

This SOP describes the use of true nephelometric measurement using instruments meeting the specifications outlined in 2.1.

Exceptions to the requirements specified in 2.1 below include:

- 1.1. In situ probes with turbidity sensors used for screening purposes (e.g., groundwater purge stabilization measurements).
- 1.2. Non standard light sources, detectors or other turbidity measuring devices may be proposed for use in studies that entail comparison measurements (dredge and fill) or unattended deployment for monitoring purposes.
- 1.3. **Do not report results from “non standard” sensors or configurations for regulatory purposes such as permit compliance unless the Department has approved the use for the specific project.**
- 1.4. All “non standard” instrument must be calibrated/check according to the principles outlined in this SOP.

2. EQUIPMENT AND SUPPLIES

- 2.1. Field Instrument: Use a turbidimeter (nephelometer) or a spectrophotometer consisting of a light source and one or more photoelectric detectors with a readout device to indicate the intensity of light. The instrument must meet these specifications:
 - 2.1.1. The light source must have a tungsten-filament lamp operated at a color temperature between 2000 and 3000 K.
 - 2.1.2. The distance traversed by the incident light and scattered light within the sample tube must not exceed 10 cm.
 - 2.1.3. The light detector, positioned at 90° to the incident light, must have an acceptance angle that does not exceed $\pm 30^\circ$ 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.

- 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_i = cross-sectional area of subsection i (ft²)

V_i = 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.

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

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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.

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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-Cl-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-Cl-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);

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- 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).

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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.

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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

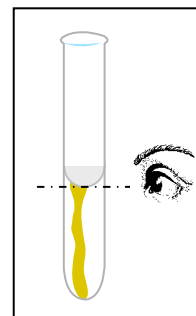
Residual chlorine can be measured using several different titrimetric methods. These methods take more time, require some skill in making chemical measurements, require several different reagents, and must be performed within 15 minutes of sample collection. Unless the expected concentration levels are 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.

Titration 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.



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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

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- 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 (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:

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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.

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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**.

FT 2000 Field Measurement of Residual Chlorine

3.7. Calculate the concentration in sample **B**:

$$\text{Residual Chlorine in } \mathbf{B} \text{ (mg/L)} = [\mathbf{C} \times 2] - \mathbf{A}$$

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

FT 2000 Field Measurement of Residual Chlorine

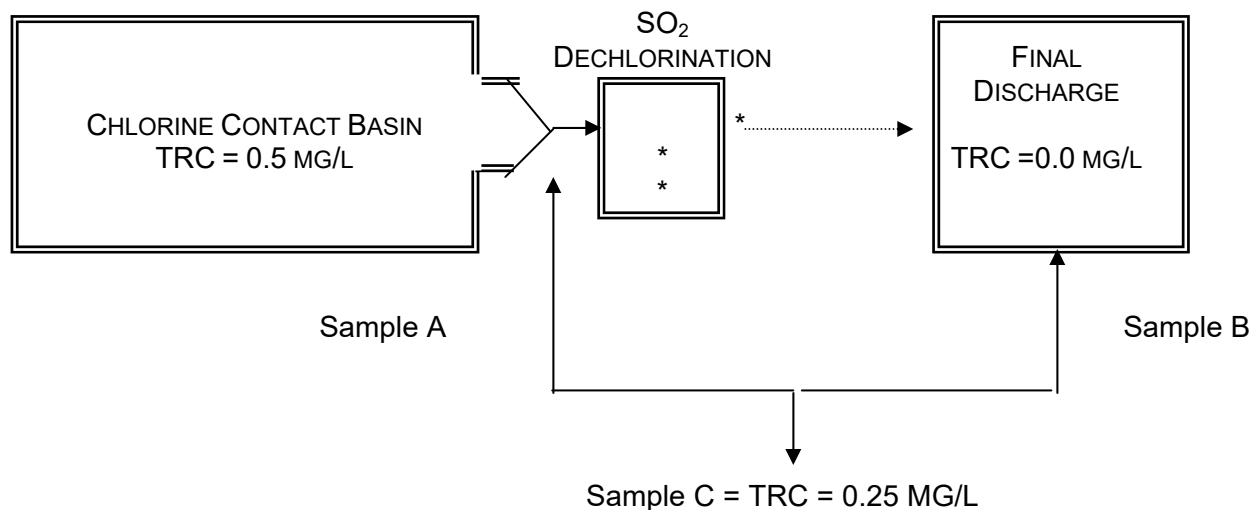
- 4.2.7. Retain manufacturers' instrument specifications.
- 4.2.8. Document whether successful initial calibration occurred.
- 4.2.9. Document whether each calibration verification passed or failed.
- 4.2.10. Document any corrective actions taken to correct instrument performance according to records 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 SO₂ 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 2100. OXIDATION-REDUCTION POTENTIAL (ORP)

Use in conjunction with:

- FA 1000 Administrative
- FC 1000 Decontamination
- FD 1000 Documentation Procedures
- FM 1000 Field Mobilization
- FQ 1000 Field Quality Control Requirements
- FS 1000 General Sampling Procedures
- FT 1000 General Field Testing and Measurement

1. INTRODUCTION AND SCOPE

Oxidation Reduction Potential (ORP) is a measurement of the potential for a reaction to occur. These reactions mediate the behavior of many chemical constituents in drinking, process and wastewaters as well as most aquatic environments.

The obtained value is a crude estimate of the oxygen status of a sample. A positive value indicates that the water is in an oxidized state or oxygen is present. A negative value is indicative of an anaerobic type environment or reducing condition.

2. EQUIPMENT AND SUPPLIES

2.1. Field Instrument: Millivolt meter or pH meter with millivolt reading capability to ± 1400 mV.

2.1.1. Redox electrodes: either an inert indicator electrode and reference electrode or combination electrode.

2.1.2. Indicator electrode: the most commonly used is the platinum electrode. A noble metal or graphite electrode can be used for specific applications (refer to SM 2580B for selected sample types).

2.1.3. Reference electrode: consisting of a half-cell providing a constant electrode potential (most commonly used are calomel or silver:silver-chloride electrodes).

2.2. Standards: Purchase or prepare standard redox solutions (refer to SM 2580B for suggested standard solutions and preparation procedures).

2.3. Recordkeeping and Documentation Supplies:

- Field record forms (e.g., forms FD 9000-7, FD 9000-8 and FD 9000-9) or field notebook
- Indelible pens

3. CALIBRATION AND USE

3.1. General Concerns: Follow the manufacturer's instructions for using and preparing electrodes.

3.1.1. For specific indicator electrodes, select a standard solution of known redox potential to verify the electrode response at the temperature of measurement (refer to section 2.2 above).

3.1.2. Minimize sample contact with the atmosphere by analyzing at time of sample collection.

3.1.3. The temperature of the standard solution, when read, must be at a temperature as close as possible to that of the sample.

3.2. Interferences

3.2.1. Contamination of the electrode surface can lead to excess drift, poor electrode response and artifact potentials.

3.2.2. Redox potential is sensitive to pH of the sample.

3.3. Calibration

3.3.1. Verify electrode response before use, preferably in the field. If the verification is performed at the base of operations, the instrument must be reverified prior to use. Perform calibration activities according to FT 1000, section 2.2.

3.3.2. Use a shorting lead to verify the zero point on the meter's millivolt scale.

3.3.3. Equilibrate the standard solution to the temperature of the sample.

3.3.4. Immerse the electrodes and gently stir the standard solution in a beaker (or flow cell). Turn the meter on, placing the function switch in the millivolt mode.

3.3.5. Let the electrode equilibrate for several minutes and record the reading to the nearest millivolt. The reading must be within ± 10 mV from the theoretical redox standard value at that temperature. If not, determine the problem and correct it before proceeding. Switch to temperature display and read the value.

3.3.6. Record the mV reading and temperature in the field notebook or in form FD 9000-8.

3.3.7. Rinse the electrode with distilled water and proceed with the sample measurement.

3.4. Measuring ORP in Samples

3.4.1. After verifying calibration, rinse the electrodes thoroughly with sample water and then immerse them in the gently stirred sample.

3.4.2. Let equilibrate and record the ORP value, to the nearest millivolt, and the sample temperature. Record them in the field notebook or a form designed for this purpose.

3.4.3. Reverify calibration more frequently if turbid, organic-rich or high-dissolved solutions are being measured.

3.4.4. After use, rinse the outside of the electrode with distilled water. Use a liquid non-phosphate detergent solution, if needed, to remove oily residues.

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 (FDEP 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., pH buffer)
- Value of standard, including correct units (e.g., pH = 7.0 SU)
- 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 (FDEP 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 2110. REFERENCES

1. American Public Health Association, American Water Works Association, Water Pollution Control Federation, SM 2580B, Standard Methods for the Examination of Water and Wastewater, 20th Edition, 1999.
2. U.S. Geological Survey, National Field Manual for the Collection of Water-Quality Data: Techniques of Water-Resources Investigations, Book 9, Chapter 6.5 Reduction-Oxidation Potential (Electrode Method), <http://water.usgs.gov/owq/FieldManual/>.
3. U.S. Environmental Protection Agency and U.S. Army Corps of Engineers, U.S. Army Engineer Waterways Experiment Station, Procedures for Handling and Chemical Analysis of Sediment and Water Samples, Technical Report, EPA/CE-81-1, pp. 3-52 to 3-53, 1981.

Appendix FT 2100
Tables, Figures and Forms

Form FD 9000-7	Field Parameter Data Sheet for Surface Water
Form FD 9000-8	Field Instrument Calibration Records

Form FD 9000-7: FIELD PARAMETER DATA SHEET FOR SURFACE WATER

SURVEY/PROJECT: _____

METER # _____

[illegible]

FIELD CONDITIONS FOR STATION# _____ AT TIME _____ :

CLOUD COVER (%): _____

WIND DIRECTION: _____

TIDAL STAGE:

PREVIOUS RAINFALL: _____

WIND SPEED (MPH/KNOTS): _____

WAVE CONDITIONS:

Note: This Sheet is used for recording Sample Data – Calibration information must also be documented

Form FD 9000-8: FIELD INSTRUMENT CALIBRATION FORM

INSTRUMENT (MAKER/MODEL#) _____

INSTRUMENT #

PARAMETER: *[check only one]*

☐ TEMPERATURE

□ CONDUCTIVITY

☐ SALINITY

☐ pH

☐ ORP

☐ TURBIDITY

□ RESIDUAL CI

☐ DO☐ OTHER

STANDARDS: [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

Standard B

Standard C

[illegible]

FT 2200. FIELD MEASUREMENT OF SULFITE

Use in conjunction with:

- FA 1000 Administrative
- FC 1000 Decontamination
- FD 1000 Documentation Procedures
- FM 1000 Field Mobilization
- FQ 1000 Field Quality Control Requirements
- FS 1000 General Sampling Procedures
- FT 1000 General Field Testing and Measurement

1. INTRODUCTION AND SCOPE: Sulfite ions may be present in surface and ground waters as the result of effluents discharged from domestic and industrial treatment plants because sulfite is often added for dissolved oxygen control to the feedwaters in industrial boilers and the excess is found in the effluents. Sulfite may also result from the conversion of sulfur dioxide added to treatment plant effluents for dechlorination purposes.

Because of its short lifetime and potential for chemical conversion, EPA requires that the measurement of sulfite be done immediately upon sample collection (within 15 min, pursuant to table II in 40 CFR 136). The only EPA approved method for sulfite is the Iodometric+Titrimetric (EPA 377.1 or SM 4500-SO₃²⁻ B. Quantitative and chronological brackets are not required for this method.

1.1. Scope: The iodometric titration method is suitable for relatively clean waters with concentrations above its detection limit of about 2.0 mg SO₃²⁻/L.

1.2. Interferences: The presence of sulfide, thiosulfate, and ferrous iron (Fe⁺⁺) can cause apparently high results for sulfite. The presence of other metal ions (such as Cu⁺⁺) can promote the catalysis of sulfite to sulfate and cause a negative bias in the results. The EDTA reduces the interferences by the metals only. Remove sulfide by adding 0.5 g zinc acetate to the collected sample.

NOTE: If the permitted facility has an in-house laboratory that can perform the titration step of this SOP within 30 min of sample collection, this step may be carried out in the in-house laboratory. In such circumstances, the laboratory must follow and document the procedure as outlined in this SOP.

2. EQUIPMENT AND SUPPLIES

2.1. Glassware: Use class A pipets for transferring samples and reagents; use a class A buret for titration.

2.2. Reagents: The following are needed in the field (and in the lab, as applicable):

2.2.1. Sulfuric Acid, H₂SO₄, 1+1.

2.2.2. Zinc Acetate, C₄H₆O₄Zn, in crystalline form [only if sulfide is present in sample].

2.2.3. Standard Potassium Iodide-Iodate titrant, 0.002083M: dissolve 0.4458 g primary-grade anhydrous KIO₃ (dried for 4 h at 120°C), 4.35 g KI, and 0.310 g Sodium Bicarbonate (NaHCO₃) in distilled water and dilute to 1000 mL; 1.00 mL = 500 µg SO₃²⁻.

2.2.4. Sulfamic Acid, $\text{NH}_2\text{SO}_3\text{H}$, in crystalline form.

2.2.5. EDTA Reagent: Dissolve 2.5 g disodium EDTA in 100 mL distilled water.

2.2.6. Starch indicator: Either purchased or prepared by this procedure. To 5 g starch (potato, arrowroot, or soluble) in a mortar, add a little cold distilled water and grind to a paste. Add mixture to 1.0 L boiling distilled water, stir, and let settle overnight. Use clear supernatant. Preserve by adding either 1.3 g salicylic acid, 4 g ZnCl_2 , or a combination of 4 g sodium propionate and 2 g sodium azide to 1.0 L starch solution.

2.3. Recordkeeping and Documentation Supplies:

- Field notebook (w/ waterproof paper is recommended)
- Field record forms
- Indelible pens

3. SAMPLE COLLECTION: Collect a fresh sample, taking care to minimize contact with air.

3.1. If the sample temperature is greater than 50°C , cool the sample first:

3.1.1. Collect the sample in a clean glass bottle (100 mL, minimum volume) and cap it without headspace.

3.1.2. Place the bottle inside a large (about 1 gallon) clean plastic pail and add cool distilled water to submerge the sample bottle.

3.1.3. Let the bottle cool in the pail for 3 – 5 minutes for the temperature to equilibrate, and measure it with a field thermometer. Record this temperature.

3.1.4. Keep the carboy with DI water in a shaded place to keep it cool. The heat exchange should be sufficient to bring the sample temperature to below 50°C .

3.2. Sample Fixation: Fix the sample immediately after collection, by adding 1 mL EDTA solution to 100 mL of sample.

3.2.1. If sulfide is present, add 0.5 g zinc acetate to 100 mL of sample and let it settle.

4. TITRATION:

4.1. Fill the buret with the standard KI-KIO_3 solution, and record the initial volume.

4.1.1. Read the volume from the **bottom** of the meniscus.

4.2. Add 1 mL H_2SO_4 and 0.1 g $\text{NH}_2\text{SO}_3\text{H}$ crystals to a 250-mL Erlenmeyer flask or other suitable titration vessel.

4.3. Do not disturb the settled material in the sample bottle.

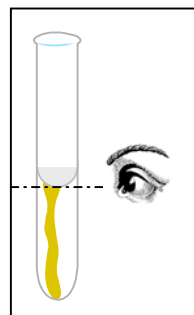
4.3.1. Withdraw a small amount of the sample in the pipet, rinse, and discard.

4.3.2. Carefully withdraw 50 mL of the settled sample by volumetrically pipetting the supernatant from the top of the sample.

4.4. Add the sample to the titration vessel, keeping the pipet tip **below** the liquid surface.

4.5. Add 1 mL of starch indicator and immediately begin the titration with the titrant, the standard KI-KIO_3 solution.

4.6. Swirl the flask gently while adding the titrant. When a blue color begins to appear in the solution, add the titrant dropwise and mix thoroughly between drops.



4.7. The reaction is complete when the blue color remains permanently. Take the reading on the buret at the completion of the titration and record the reading.

4.8. Titrate a blank by repeating 4.1.1 through 4.1.7 using 50 mL of distilled water in a clean flask as the sample.

5. CALCULATIONS:

5.1. Subtract the final buret reading (4.7 above) from the initial reading (4.1 above). This is the volume of the titrant.

5.2. Calculate the sample sulfite concentration as:

$$\text{mg SO}_3^{2-}/\text{L} = [(A - B) \times M \times 240,000] / \text{mL of sample}$$

Where: A = mL of titrant for sample,

B = mL of titrant for blank, and

M = molarity of standard KI-KIO₃, titrant

Note: M will equal 0.002083 if exactly 0.4458 g of KIO₃ is used to prepare the titrant. If some other weight was used, calculate the molarity by dividing the weighed amount by 214.0002.

5.3. Report the results with two significant figures.

6. MAINTENANCE: The volumetric glassware that is used to transfer and to titrate must be thoroughly clean.

6.1. 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.

6.2. Check the glassware before use by filling with de-ionized or distilled water and allowing it to drain. Do not use the glassware if droplets appear.

6.3. Clean by using hot sudsy water, and a buret brush or soaking in sudsy water.

6.3.1. Rinse with tap water to remove and the soap.

6.3.2. Rinse with de-ionized water and check for water droplets.

6.3.3. Additional cleaning with chromic acid, or alcoholic potassium hydroxide may be needed to remove stubborn oil or films.

7. DOCUMENTATION

7.1. Standard and Reagent Documentation: Document information about standards and reagents used for calibrations, verifications and sample measurements.

7.1.1. Note the date of receipt, the expiration date and the date of first use for all standards and reagents.

7.1.1.1. Document acceptable verification of any standard used after its expiration date.

7.1.2. Record the concentration or other value for the standard in the appropriate measurement units.

7.1.2.1. Note vendor catalog number and description for preformulated solutions as well as for neat liquids and powdered standards.

- 7.1.2.2. Retain vendor assay specifications for standards as part of the calibration record.
- 7.1.3. Record the grade of standard or reagent used.
- 7.1.4. When formulated in-house, document all calculations used to formulate calibration standards.
- 7.1.4.1. Record the date of preparation for all in-house formulations.
- 7.1.5. Describe or cite the procedure(s) used to prepare any standards in-house (FDEP SOP or internal SOP).
- 7.2. 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
- 7.3. For each sample and blank, record the volume of each sample, and the beginning and ending readings on the buret.
- 7.4. Show all calculations to determine the final concentration in the sample.

FT 2210. REFERENCES

1. U.S. Environmental Protection Agency, EPA 377.1, Methods for the Chemical Analysis of Water and Waste, EPA-600/4-79-020, Revised 1983.
2. American Public Health Association, American Water Works Association, Water Pollution Control Federation, SM 4500-SO₃²⁻-B, Standard Methods for the Examination of Water and Wastewater, 20th Edition, 1999.

FT 2300. FIELD MEASUREMENT OF SEDIMENT OXYGEN DEMAND (SOD)

Use in conjunction with:

- FA 1000 Administrative
- FC 1000 Decontamination
- FD 1000 Documentation Procedures
- FM 1000 Field Mobilization
- FQ 1000 Field Quality Control Requirements
- FS 1000 General Sampling Procedures
- FT 1000 General Field Testing and Measurement

1. INTRODUCTION: Sediments are generally in a reduced chemical state and have a potential to remove oxygen from overlying water. This situation results from the migration of dissolved oxygen to the sediment water interface followed by subsequent chemical reaction and/or migration of reduced chemical species (ferrous iron, manganous manganese, sulfide) from the sediment to the overlying water followed by subsequent oxidation. This sediment oxygen demand (SOD) procedure characterizes the sediment in terms of the rate of exertion of oxygen demand.

This procedure is a lengthy one that may require days or weeks to complete. The actual time depends on the rate of oxygen demand exerted by the sample. **Perform this procedure *in situ*.**

2. EQUIPMENT AND SUPPLIES

2.1. Test Chamber: Submerged chambers reported in the literature range from 33 to 115 cm in diameter. See Figure FT 2300-1 for a schematic representation of these chambers.

2.1.1. Embed the chamber in the sediment to the outside flange. The flange prevents the apparatus from sinking further into the sediment and the chamber extension into the sediment restricts transfers of interstitial water.

2.1.2. The chamber must have an instrument port for inserting a DO meter or have a permanently mounted DO probe. A sampling port is optional.

2.1.3. The chamber must also incorporate some method of stirring (magnetic stirrer, or a method to pump water through the chamber).

2.2. Dissolved Oxygen Meter: DO meter, equipped with sufficient cable to reach the sediments, and capable of measuring DO with a precision of 0.1 mg/L. This meter must also measure the water temperature to a 0.1°C reading.

2.3. Boat and Supplies: A boat may be required to deploy and retrieve the apparatus and to conduct the readings. Depending on the depth of the water, it may also be required that some personnel may have to conduct limited diving operations (to install and inspect the chamber). Certified SCUBA divers will be required.

2.4. Documentation: Field notebook, forms FD 9000-8 and FD 9000-15, and indelible pens.

3. PROCEDURE

- 3.1. Calibrate the DO meter according to the procedure in FT 1500. Perform the initial calibration immediately before deployment in the chamber, and conduct a calibration verification at the conclusion of the measurements. This final calibration verification must be within 0.2 mg/L of the expected value for the measurements to be acceptable. Qualify the SOD result if this calibration verification fails to meet the acceptance criterion.
- 3.2. Insert the electrode in the chamber and lower the chamber in place.
- 3.3. Verify that the chamber has correctly penetrated the bottom.
- 3.4. Measure the DO concentration within the chamber as a function of time.
- 3.5. Record the water temperature within the chamber at the time of each DO measurement.
- 3.6. If required, the water in the chamber may be sampled for analyses of other parameters. In this case, withdraw these samples by means of an appropriately constructed syringe (see FS 1000, Tables FS 1000-1, FS 1000-2 and FS 1000-3) inserted into one of the available sampling ports. Do not re-aerate the sample when collected.

4. CALCULATIONS

- 4.1. Calculate the initial amount of oxygen in the chamber:

$$A_o = \frac{100 (3.14 R^2 H) X}{3.14 R^2}$$

Where:

R = radius of the chamber (cm)

H = internal height of the chamber above the sediments (cm)

X = measured dissolved oxygen concentration (mg/L)

A_o = amount of oxygen in the chamber at time zero (mg)

- 4.2. Calculate the rate of oxygen depletion:

$$R \text{ (mg/m}^2\text{/day)} = [A_2 - A_1] / [T_2 - T_1]$$

Where:

R = rate of oxygen uptake (mg/m²/day)

A₂ = oxygen within the chamber at time T₂ (mg)

A₁ = oxygen within the chamber at time T₁ (mg)

T₂ = time, second sampling period (days)

T₁ = time, first sampling period (days)

5. DOCUMENTATION

- 5.1. Document DO probe information according to requirements in FT 1500, section 4.
- 5.2. Record all field-testing measurement data on form FD 9000-15 or equivalent, or the field notebook, to include the following:

DEP-SOP-001/01
FT 2300 Field Measurement of Sediment Oxygen Demand

- 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
- Calculated rate of oxygen depletion
- Initials or name of analyst performing the measurement
- Unique identification of the specific instrument unit(s) used for the test(s)

FT 2310. REFERENCES

1. U.S. Environmental Protection Agency and U.S. Army Corps of Engineers, U.S. Army Engineer Waterways Experiment Station, Procedures for Handling and Chemical Analysis of Sediment and Water Samples, EPA/CE-81-1, pp. 3-396 to 3-403, May 1981.

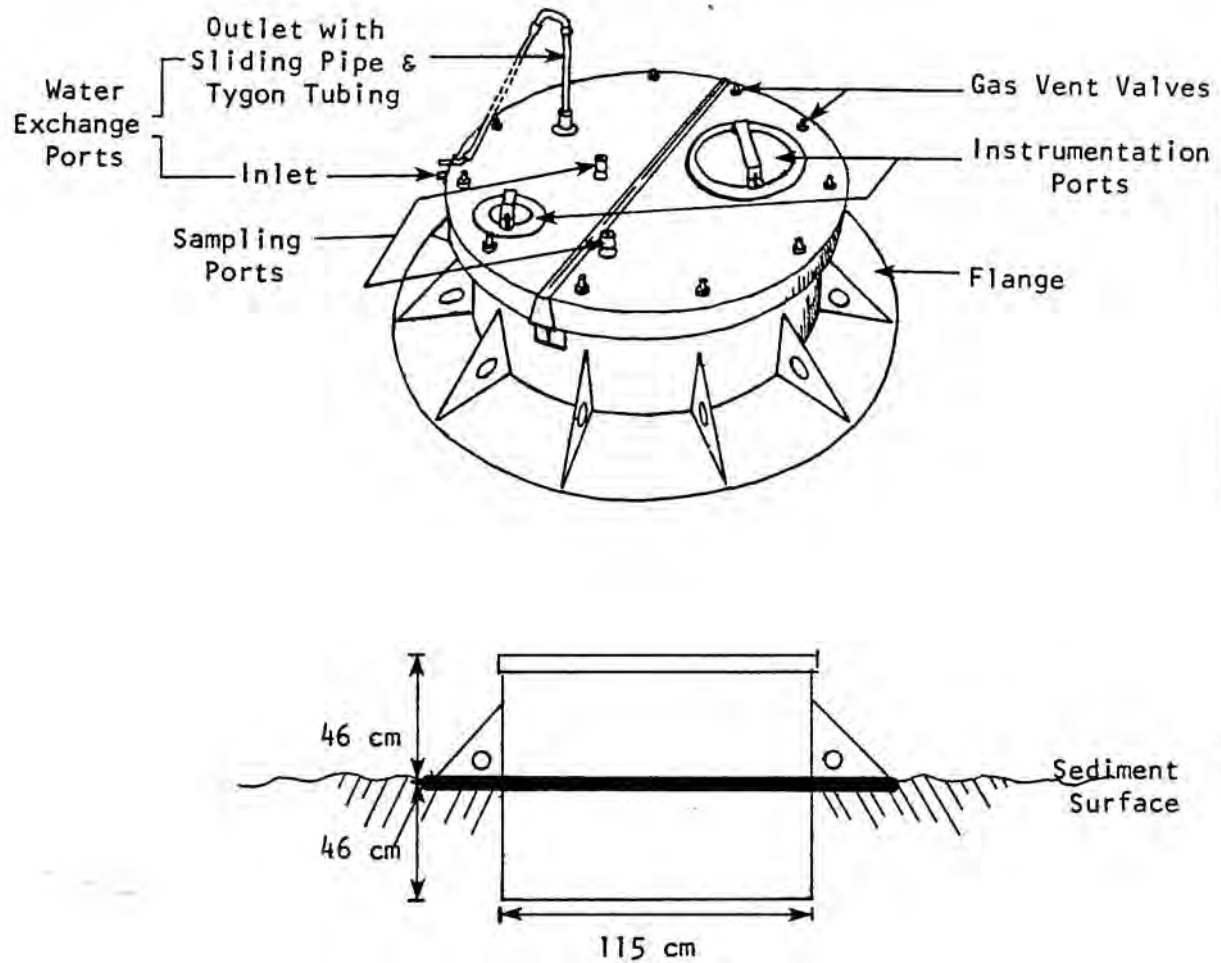
Appendix FT 2300
Tables, Figures and Forms

Figure FT 2300-1 Typical SOD Chamber Design

Form FD 9000-8 Field Instrument Calibration Form

Form FD 9000-15 Sediment Oxygen Demand (SOD) Field Measurement Log

Figure 2300-1
***In Situ* Sediment Oxygen Demand Chamber, Typical Configuration**



Form FD 9000-8: FIELD INSTRUMENT CALIBRATION FORM

INSTRUMENT (MAKER/MODEL#) _____ **INSTRUMENT #** _____

PARAMETER: *[check only one]*

☐ TEMPERATURE ☐ CONDUCTIVITY ☐ SALINITY ☐ pH ☐ ORP
☐ TURBIDITY ☐ RESIDUAL Cl ☐ DO ☐ OTHER _____

STANDARDS: [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 _____

Standard B

Standard C

[illegible]

Form FD 9000-15: SEDIMENT OXYGEN DEMAND (SOD) FIELD MEASUREMENT LOG

SURVEY/PROJECT: _____	SAMPLERS: _____					
WATERBODY: _____	TEST SITE: _____ LAT _____ LONG _____					
DISSOLVED OXYGEN / TEMPERATURE METER(S) USED: _____ [Specify the maker, model and serial number of the instrument(s) being used]						
TEST CHAMBER: <i>(draw a diagram of the Sediment Oxygen Demand test chamber indicating the location of the DO/Temp instrumentation port, gas vent valves, sampling ports and water exchange ports)</i>						
R (internal radius) = _____ cm.	H (internal height) = _____ cm.					
MEASUREMENTS $A_n = 10 H$ (DO concentration) Starting Date and Time: _____ Ending Date and Time: _____ $R_n = [A_n - A_{n-1}] / [T_n - T_{n-1}]$						
DATE (yy/mm/dd)	TIME (hr:min)	DO (mg/L)	TEMP (°C)		AMOUNT OF OXYGEN IN CHAMBER (mg/m ²)	RATE OF OXYGEN DEPLETION (mg/m ² /day)
				A₀		
				A₁		
				A₂		
				A₃		
				A₄		
				A₅		
				A₆		
				A₇		
				A₈		
				A₉		
				A₁₀		
REMARKS:						

FT 2400. FIELD MEASUREMENT OF EXPLOSIVE GASES

Use in conjunction with:

- FA 1000 Administrative
- FC 1000 Decontamination
- FD 1000 Documentation Procedures
- FM 1000 Field Mobilization
- FQ 1000 Field Quality Control Requirements
- FS 1000 General Sampling Procedures
- FT 1000 General Field Testing and Measurement

Explosive gas monitoring is required by some FDEP permits. Detector tubes may be used for screening but are not acceptable for quantitative work. The OVA (organic vapor analyzer), the Explosimeter or FID detectors are not recommended either.

1. EQUIPMENT AND SUPPLIES

- 1.1. Field Instrument – Use a combustible gas indicator with catalytic surface oxidation infrared technology for detection. The meter must provide readings in the lower explosive limit (LEL).
- 1.2. Standards- Purchased methane gas standard(s) of known concentration.
- 1.3. Recordkeeping and Documentation Supplies:
 - Field notebook (w/ waterproof paper is recommended) and/or field parameter sheets
 - Indelible pens

2. CALIBRATION AND USE

- 2.1. General Concerns
 - 2.1.1. Calibrate the meter before use. This calibration may take place at the base of operations or in the field. If the calibration is performed at the base of operations, the instrument must be checked prior to use.
 - 2.1.2. Perform all calibrations and calibration verifications in an environment free from toxic or combustible gases, with normal oxygen content.
 - 2.1.3. Interferences/Limitations
 - 2.1.3.1. Vapors from silicone containing materials, gasoline, and sulfur materials may produce lower readings.
 - 2.1.3.2. High humidity (90-100%) reduces sensitivity, and produces erratic behavior including calibration problems.
 - 2.1.3.3. High chlorinated hydrocarbons (tetrachloroethylene) or acid gases (sulfur dioxide) will produce erroneous low readings.

- 2.1.4. **Caution:** Because of the potential for explosion, there should be no open flames or smoking on site and/or near the meter.
- 2.2. Calibration and Field Use
 - 2.2.1. Perform manufacturer's recommended maintenance and check the battery before mobilizing.
 - 2.2.2. Calibrate or verify the calibration of the meter prior to taking sample readings.
 - 2.2.2.1. Zero the instrument in "fresh air" (see section 2.1.2 above).
 - 2.2.2.2. Follow the manufacturer's instructions for calibration. Use a methane gas standard of known concentration equivalent to 25-50% full-scale concentration. Use the acceptance criterion specified for the specific instrument you are using.
- 2.3. Follow the calibration activities specified in FT 1000, section 2.2.
- 3. PREVENTIVE MAINTENANCE: Refer to FT 1000, section 3.
- 4. DOCUMENTATION
 - 4.1. Record all applicable information about standards per FT 1000, section 4.1.
 - 4.2. Record all applicable calibration and calibration verification information per FT 1000, section 4.2.
 - 4.3. Record sample measurement information per FT 1000, section 4.3.

FT 2410. REFERENCES

- 1. U.S. Department of Labor, Occupational Safety & Health Administration, OSHA Technical Manual, Section II: Chapter 3.II.G, www.osha-slc.gov/dts/osta/otm/otm_toc.html.
- 2. U.S. Environmental Protection Agency, Federal Remediation Technologies Roundtable, Field Sampling and Analysis Technologies Matrix and Reference Guide, EPA 542-B-98-002, First Edition, March 1998.
- 3. U.S. Environmental Protection Agency, Solid Waste and Emergency Response, Criteria for Solid Waste Disposal Facilities, A guide for Owners/Operators, EPA/530-SW-91-089, March 1993.

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."

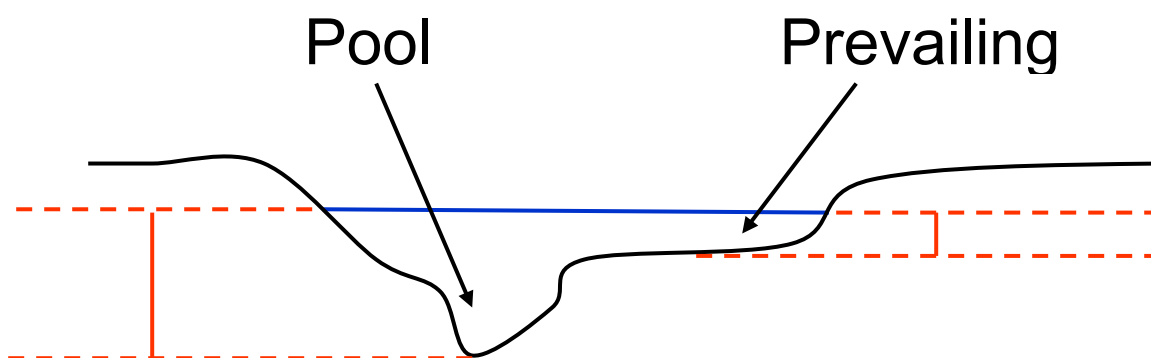
2.4. **Substrate Availability** is the relative spatial abundance of productive habitats present. Refer to the entry on FD 9000-3, as determined from FD 9000-4. A minimum occurrence of two square meters of a particular substrate in the reach is necessary to count that substrate as being "present." Include 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

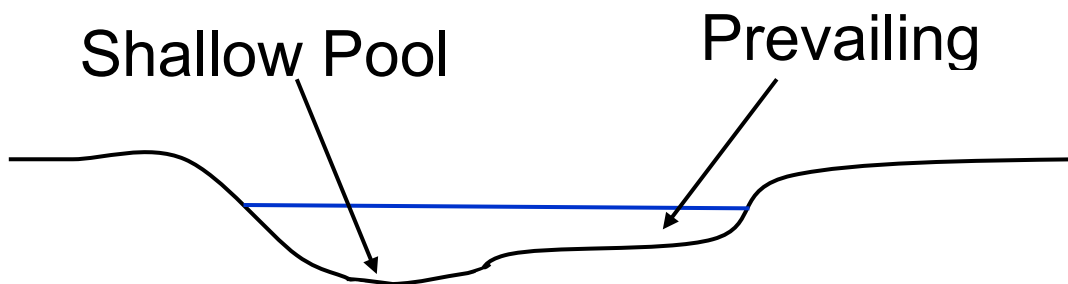
after snags or other material that restrict or enhance the velocity unless this is typical of the majority of the run. Note that in the majority of Florida streams, velocities over 1 m/s are considered unusually high, and should be included in the “poor” category. An exception to this policy would be 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.

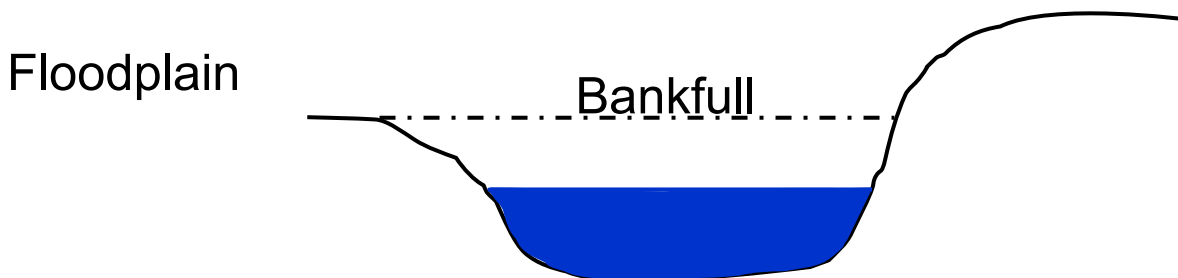
2.8.2. Marginal- An altered system with some sinuosity in stream channel, often developed within the old dredged area, OR some diversity in depth but no pools as defined in 2.6 above. Spoil banks may be visible.

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 []	SILVICULTURE []	FIELD/PASTURE []	AGRICULTURAL []	RESIDENTIAL []	COMMERCIAL []	INDUSTRIAL []	OTHER (SPECIFY) []
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 BACK		TYPICAL WIDTH, DEPTH & VELOCITY [] m wide		TYPICAL VELOCITIES	
ARTIFICIALLY CHANNELIZED ☐ no ☐ recent, ☐ severe some recovery mostly recovered				[] m/s [] m/s [] m/s		7 secs = 0.14 m/s	
ARTIFICIALLY IMPOUNDED ☐ yes more sinuous						6 secs = 0.17 m/s	
HIGH WATER MARK [] + [] = []				[] m deep [] m deep [] m deep		5 secs = 0.20 m/s	
(m above present water level)		(present depth in m)		(m above bed)		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 SLIGHT SEVERE MODERATE SILT SMOTHERING: NONE SLIGHT SEVERE 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				DRAW AERIAL VIEW SKETCH OF HABITATS FOUND IN 100 M SECTION			
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 ST -2 ND ORDER 5 TH -6 TH ORDER 3 RD -4 TH ORDER 7 TH 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 ☐ ☐ ☐ ☐			
				FISH ☐ ☐ ☐ ☐			
				AQUATIC MACROPHYTES ☐ ☐ ☐ ☐			
				IRON/SULFUR BACTERIA ☐ ☐ ☐ ☐			
SAMPLING TEAM:				SIGNATURE:			DATE:

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
Primary Habitat Components Substrate Diversity _____	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
Substrate Availability _____	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
Water Velocity _____	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
Habitat Smothering _____ ----- Primary Score _____	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
Secondary Habitat Components Artificial Channelization _____	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
Bank Stability Right Bank _____ Left Bank _____	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
Riparian Buffer Zone Width Right Bank _____ Left Bank _____	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
Riparian Zone Vegetation Quality Right Bank _____ Left Bank _____ ----- Secondary Score _____	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: _____

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:									
PARAMETER	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 ☐					
HYDROLOGY																					
Color	Very clear, uncolored water (benthic sampling appropriate) ☐					Water somewhat tannin stained (benthic sampling appropriate) ☐					Dark, discolored water (water color 20 PCU or higher) ☐					Visibility extremely reduced due to high color ☐					
	Optimal					Suboptimal					Marginal					Poor					
Secchi ☐	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 VOB	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Vegetation Quality ☐	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	
Stormwater Inputs ☐	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	
Bottom Substrate Quality ☐	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	
Lakeside Adverse Human Alternations ☐	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	
Upland Buffer Zone ☐	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	
Adverse Watershed Land Use ☐	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:

ANALYSIS DATE:	ANALYST:	SIGNATURE:

Department of Environmental Protection Standard Operating Procedures for Laboratory Activities

DEP-SOP-002/01



**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)**

LD 1000. LABORATORY DOCUMENTATION

1. INTRODUCTION: Adhere to these documentation requirements in support of the laboratory procedures described in the related DEP SOPs indicated below.
2. SCOPE AND APPLICABILITY: Use these SOPs only for the indicated laboratory component operations. These SOPs apply to documentation procedures *not* specified in the NELAC Quality Systems document.

LD 2000. (RESERVED)

LD 3000. (RESERVED)

LD 4000. (RESERVED)

LD 5000. (RESERVED)

LD 6000. (RESERVED)

LD 7000. DOCUMENTATION OF BIOLOGICAL LABORATORY PROCEDURES

1. Document the following items for the indicated SOPs found in LQ 1000 – LQ 7420, Laboratory Quality Control and LT 7000 – LT 7500, Determination of Biological Indices.
 - 1.1. Record the minimum information summarized in the following SOPs. Refer to the corresponding LQ- or LT-series SOP for any chronological requirements for documentation sequence.
 - 1.2. Also refer to applicable portions of FD 1000 – FD 1300, FD 3000, FD 5420 and FD 7000 for additional documentation requirements.
2. Use these SOPs only for the indicated laboratory component operations. These SOPs apply to laboratory procedures *not* specified in the NELAC Quality Systems document.

LD 7100. Documentation of Laboratory Procedures for Determination of Biological Indices

LD 7110. REQUIRED DOCUMENTATION FOR LABORATORY PROCEDURES FOR BIORECON DETERMINATION (LT 7100)

- Sample receipt or log-in record
- Site, sample identification number, STORET station number, sample type, replicate number and date collected
- Tally of the number of each taxon

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- Name of any organism encountered in the laboratory for the first time
- Individual taxon names
- Numbers of each taxon counted
- Number of individual organisms counted
- Data entry into the Florida Statewide Biological Database (DEP staff only)
- Method and notes for counting and collapsing taxonomic data
- Collapsed taxa list
- Index calculations per LT 7100, section 5:
 - Long-lived taxa score
 - Sensitive taxa score
 - Taxa richness (total taxa)
 - Number of Ephemeroptera taxa
 - Number of Trichoptera taxa
 - Number of clinger taxa
- BioRecon index metrics and evaluation as scored per Tables LT 7100-1, LT 7100-2 and LT 7100-3

**LD 7120. REQUIRED DOCUMENTATION FOR LABORATORY PROCEDURES FOR STREAM
CONDITION INDEX (SCI) DETERMINATION (LT 7200)**

- Laboratory sample receipt or log-in record
- Site, sample identification number, STORET station number, sample type, replicate number and date collected
- Identification of sample collectors
- Total number of organisms sorted from each selected grid tray aliquot
- Number of grids, squares and aliquots selected and sorted (e.g., 8 grids out of 24 total sample grids)
- Date of sorting completion
- Total number of mounted microscope slides, mounting date for each slide, unique label identification for each slide and identification of mouter(s) for each slide for all sorted samples
- Total number of individuals for each taxon for each of the 150-organism aliquots
- Name of any organism removed from the sorted sample for reference collection
- Name of each taxon identified for each of the 150-organism aliquots
- Total number of taxa identified for each of the 150-organism aliquots
- Total number of individual organisms identified for each of the 150-organism aliquots
- Data entry into the Florida Statewide Biological Database (DEP staff only)

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- Method and notes for counting and collapsing taxonomic data for each of the 150-organism aliquots
- Collapsed taxa list for each of the 150-organism aliquots
- Index calculations per LT 7200, section 5 for each of the 150-organism aliquots:
 - Long-lived taxa
 - Sensitive taxa
 - % Very tolerant taxa
 - Taxa richness (total taxa)
 - Number of Ephemeroptera taxa
 - Number of Trichoptera taxa
 - % Dominant taxa
 - Number of Tanytarsini
 - Number of clinger taxa
 - % Filter feeders
- SCI metrics and evaluation as scored per Tables LT 7200-1 and LT 7200-2 for each of the 150-organism aliquots
- Final SCI score (average of 2 aliquots)
- Label identification of archived vials of sorted organisms linked to sample identification data required in this section
- Label identification of archived mounted slides (midges/worms/mites) linked to sample identification data required in this section

**LD 7130. REQUIRED DOCUMENTATION FOR LABORATORY PROCEDURES FOR LAKE
CONDITION INDEX (LCI) DETERMINATION (LT 7300)**

- Laboratory sample receipt or log-in record
- Site, sample identification number, STORET station number, sample type, replicate number and date collected
- Identification of sample collectors
- Total number of organisms sorted from each selected grid tray aliquot
- Number of grids, squares and aliquots selected and sorted (e.g., 8 grids out of 24 total sample grids)
- Date of sorting completion
- Total number of mounted microscope slides, mounting date for each slide, unique label identification for each slide and identification of mounter(s) for each slide for all sorted samples
- Total number of individuals for each taxon
- Name of any organism removed from the sorted sample for reference collection

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- Name of each taxon identified
- Total number of taxa identified
- Total number of individual organisms identified
- Data entry into the Florida Statewide Biological Database (DEP staff only)
- Method and notes for counting and collapsing taxonomic data
- Collapsed taxa list
- Shannon-Weaver Diversity Index score per LT 7300, section 5.1
- Hulbert Index score per LT 7300, section 5.2
- LCI metrics scores per LT 7300, section 5.3:
 - LCI Taxa Score component
 - LCI EOT Taxa Score component
 - LCI % EOT Score component
 - LCI % Diptera Score component
 - LCI SWDI Score component
 - LCI HI Score component
 - LCI score
- Label identification of archived vials of sorted organisms linked to sample identification data required in this section
- Label identification of archived mounted slides (midges/worms/mites) linked to sample identification data required in this section

**LD 7140. REQUIRED DOCUMENTATION FOR LABORATORY PROCEDURES FOR LAKE
VEGETATION INDEX (LVI) DETERMINATION (LT 7500)**

- Laboratory sample receipt or log-in record
- Site, sample identification number (e.g., STORET station number, sample type, replicate number and date collected)
- Identification of sample collectors
- Total number of taxa identified from each selected section
- Name of each taxon identified from each selected section
- Total number of taxa identified from each selected section
- Total number of individual organisms identified from each selected section
- Data entry into the Florida Statewide Biological Database (DEP staff only)
- LVI metrics scores per LT 7500, section 5 for each selected section
 - % native taxa
 - % invasive taxa

- % sensitive taxa
- Dominant C of C
- LVI score for each selected section
- Final LVI score (average of the 4 selected sections)

LD 7200. Documentation of Laboratory Quality Control for Biological Community Analysis

The following sections summarize required documentation items for the indicated biological laboratory quality control procedures.

LD 7210. REQUIRED DOCUMENTATION OF QUALITY CONTROL FOR ALGAL IDENTIFICATION

- Initial demonstration of proficiency for each analyst per LQ 7110
 - Similarity values and % correct identifications for both soft algae and diatoms
 - Notes regarding new analyst training to correct proficiency of identifications
 - Results of senior staff QC re-analysis of samples analyzed by newly proficient analysts
- On-going quality control information per LQ 7120
 - Identification of all wet samples or slides re-analyzed as QC samples
 - Results of all QC sample analyses including taxa, counts and similarity values
 - Results of analyst training to correct proficiency of identifications
 - Results of any sample re-analyses due to QC failures
- Results of quarterly consistency identifications per LQ 7130
 - Names of analysts participating in consistency identifications
 - Identity of QC samples chosen for consistency identifications
 - Results of consensus identifications for the QC samples
 - % correct identifications for each analyst
 - Corrective actions performed per consistency exercise results
 - Cumulative taxa list derived from consistency identification exercises
- Corrective quality control information per LQ 7140
 - Names of participating analysts
 - Identity of samples chosen as QC samples
 - Results of all analyses of QC samples performed by each analyst
 - Results of intra-sample comparisons of the QC analyses
 - Corrective actions performed

LD 7220. (RESERVED)

LD 7230. REQUIRED DOCUMENTATION OF QUALITY CONTROL FOR MACROINVERTEBRATE TAXONOMIC IDENTIFICATION

LD 7231. *Required Documentation of Quality Control for Macroinvertebrate Sorting (LQ 7410)*

- Total organisms as defined in LQ 7410, section 1.4
- QC organisms as defined in LQ 7410, section 1.4
- Original field sample identification
- Subsample aliquot identifications
- Cumulative sorting efficiency for each analyst

LD 7232. *Required Documentation of Quality Control for Macroinvertebrate Taxonomic Identification and Enumeration (LQ 7420)*

1. DOCUMENTATION OF QUALITY CONTROL FOR WET AND SLIDE-MOUNTED ENUMERATIONS

- 1.1. Single-analyst cumulative identification error rate for total number of organisms identified
- 1.2. Single-analyst cumulative identification error rate for total number of taxa identified
- 1.3. Identification of original field sample or subsample QC-checked (*QC sample*, as defined in LQ 7420, section 3.1)
- 1.4. Results for each original field sample or subsample, including number of organisms identified for each taxon
- 1.5. Results for each corresponding QC sample, including number of organisms identified for each taxon
- 1.6. Name of taxonomist identifying original sample or subsample
- 1.7. Name of taxonomist performing the QC sample analysis
- 1.8. Date of each original field sample or subsample analysis
- 1.9. Date of each QC sample analysis
- 1.10. Additional comments associated with the QC check, including noted discrepancies and resolutions with the original field sample or subsample enumeration

2. DOCUMENTATION FOR DEP TAXONOMIC QC ROUND-ROBIN SAMPLES

Document the following for all data generated under the DEP Taxonomic Round-Robin program (see LQ 7400, section 1.3).

- 2.1. Record relevant information for round-robin sample enumerations per section 1 above.
- 2.2. Retain all correspondence, data sheets, resolutions concerning discrepant results and all reports of results associated with round-robin samples.

- 2.3. Document and retain all correspondence and associated records for any corrective actions implemented pursuant to round-robin results.

LD 7300. References (*RESERVED*)

LD 8000. (RESERVED)

LQ 1000. LABORATORY QUALITY CONTROL

1. INTRODUCTION: Use these procedures to support the sampling efforts described in the respective FS-series DEP SOPs as well as for related laboratory procedures described in the LT-series DEP SOPs indicated below.
2. SCOPE AND APPLICABILITY: Use these SOPs only for the indicated sampling efforts and supporting laboratory component operations. These SOPs apply to quality control procedures *not* specified in the NELAC Quality Systems document.

LQ 2000. (RESERVED)

LQ 3000. (RESERVED)

LQ 4000. (RESERVED)

LQ 5000. (RESERVED)

LQ 6000. (RESERVED)

LQ 7000. QUALITY CONTROL FOR BIOLOGICAL COMMUNITY ANALYSIS

The following DEP SOP sections specifically apply to activities performed using FS 7000 – FS 7400 and LT 7100 – LT 7500 as indicated, but may also be used for variations of these procedures used to produce other macroinvertebrate taxonomic data submitted to DEP. In addition, see LD 7200, Documentation for Biological Laboratory Quality Control.

LQ 7100. Laboratory Quality Control for Algal Identification

Perform these quality control procedures when analyzing samples collected per FS 7200.

1. GENERAL REQUIREMENTS: Perform the following quality control activities for all taxonomic identifications.
 - 1.1. Maintain copies of appropriate taxonomic identification keys
 - 1.2. Meet an initial demonstration of proficiency
 - 1.3. Perform QC procedures listed below

LQ 7110. INITIAL DEMONSTRATION OF PROFICIENCY

Perform these quality control procedures to insure a new analyst has achieved a minimum proficiency of Algal identification.

1. GENERAL REQUIREMENTS:

- 1.1. Achieve 60% correct at the genus level for soft algae or 60% correct at the species level for Diatoms in the Consistency Identifications procedure (LQ 7130). A recommended target level of 80% correct is suggested.
- 1.2. The new analyst should re-identify a minimum of 10 samples previously identified by a proficient analyst.
2. Perform the following criteria with re-identified samples.
 - 2.1. Sample selection and preparation
 - 2.1.1. Samples to be re-identified for wet identification should have less than 40% diatoms in the original ID.
 - 2.1.2. Samples to be re-identified for wet identification or diatom identification should not be samples with very low densities or taxa counts in the original ID or samples that were “problem” samples in the original ID such as very dirty samples. These samples are difficult to achieve agreement on due to factors other than analyst proficiency.
 - 2.1.3. If the sample is identified using a settling chamber (e.g., Utermohl, Sedgewick Rafter, or Palmer-Maloney) and the integrity of the sample cannot be preserved long enough for a second identification to occur, the second analyst will prepare and settle a new aliquot of sample. Be sure to use the same dilution or concentration as the first analyst. If possible, use a counting chamber with the same cell depth as the first analyst. Identify and enumerate to the same counting endpoint (i.e., number of units or number of fields) as the first analyst.
 - 2.1.4. If the sample is identified using a semi-permanent or permanent slide, use the same permanent slide mount for the re-identification.
 - 2.2. Sample analysis
 - 2.2.1. After the new analyst has re-analyzed a sample, insure at least the targeted similarity (e.g., Bray-Curtis Similarity Index) was achieved.
 - 2.2.1.1. If the similarity cutoff is not met, combine taxa in the sample to the generic level. The goal of combining taxa to the generic level is to determine if the new analyst requires further training to differentiate algal units to species as compared to genus.
 - 2.2.1.2. If the QC has passed at the generic but not the specific level, compare the taxa lists from the two analysts. If there are differences in level of identification of a given taxon, target additional training to bring the analysts to the same level of identification. An inexperienced analyst may identify a taxon to a higher level than an experienced analyst. Pinpointing those taxa makes targeting additional training more effective and less time consuming.
 - 2.2.2. Continue with re-identifications until 10 samples have been successfully re-identified.
 - 2.2.3. After 10 re-identifications have been successfully completed, the newly-proficient analyst should have 10% of samples re-identified by another analyst until an additional 10 samples have successfully passed the similarity cutoff. The analyst should then have 5% of samples re-identified as outlined in LQ 7120.

LQ 7120. ONGOING QUALITY CONTROL

Perform these quality control procedures to insure analyst maintain a minimum proficiency of Algal identification.

1. Perform the following criteria with ongoing quality control samples.

1.1. Sample selection and preparation

1.1.1. When 20 samples of a particular type of sample have been analyzed, ask another analyst who also performs that type of identification to randomly choose a sample from the list.

1.1.2. Divide samples into four categories: freshwater periphyton, freshwater phytoplankton, marine periphyton, and marine phytoplankton.

1.1.3. If the sample is identified using a settling chamber (e.g., Utermohl, Sedgewick Rafter, or Palmer-Maloney) and the integrity of the sample cannot be preserved long enough for a second identification to occur, the second analyst will prepare and settle a new aliquot of sample. Be sure to use the same dilution or concentration as the first analyst. If possible, use a counting chamber with the same cell depth as the first analyst. Identify and enumerate to the same counting endpoint (i.e. number of units or number of fields) as the first analyst.

1.1.4. If the sample is identified using a semi-permanent or permanent slide, use the same permanent slide mount for the re-identification

1.2. Sample analysis

1.2.1. The QC analyst will identify the selected sample and compare the taxonomic identifications and unit counts.

1.2.2. If the analyst does not obtain the target similarity value (e.g., Bray-Curtis Similarity Index), then corrective action is required.

1.3. Corrective Action

1.3.1. If the similarity cutoff is not met, combine taxa in the sample to the generic level. The goal of combining taxa to the generic level is to determine if the analyst requires further training to differentiate algal units to species as compared to genus.

1.3.1.1. If the similarity of the sample passes the cutoff the QC has been successfully passed at the generic level.

1.3.2. If the QC has passed at the generic but not the specific level, compare the taxa lists from the two analysts. If there are differences in level of identification of a given taxon, target additional training to bring the analysts to the same level of identification.

1.3.3. If the QC does not pass at any level of comparison (genus vs. species), the sample must be re-identified by both analysts. Perform the following steps along with LQ 7140 to pinpoint taxa and/or counts that are problematic.

1.3.3.1. Compare the differences between taxa list. Those taxa contributing the highest percentage of the dissimilarity between samples should be examined to determine the source of the discrepancy (count, level of identification, etc.). All taxa contributing 5% or more of the total inter-sample dissimilarity should be examined.

1.3.3.2. If the sample passed the QC at some level, this list can be used to pinpoint areas where additional training is needed. If the sample did not pass the

QC at any level, this list should be reviewed and identifications corrected, and the sample should be re-identified by both analysts.

1.3.4. Re-identifications of any QC sample should be put through the steps outlined in this SOP to determine if the re-identification passed QC standards and if problem areas have been corrected.

LQ 7130. CONSISTENCY IDENTIFICATIONS

Perform these quality control procedures to insure that multiple analysts maintain a minimum comparability of algal identification. This procedure tests the ability of multiple analysts to correctly and consistently identify a single organism. Laboratories with only one analyst are not required to routinely perform this procedure, but are encouraged to do so with external analysts.

1. Perform the following criteria with consistency identifications.

1.1. Sample selection and preparation

1.1.1. Once a quarter, all analysts doing a particular type of identification participate in an internal consistency exercise.

1.1.2. The sample chosen for this quarterly exercise should be one that has not been analyzed previously.

1.1.3. The sample can be scanned by the group to ensure that it has enough taxa to complete the exercise.

1.1.4. Rotate samples chosen for this procedure through samples from periphyton (qualitative and quantitative) and phytoplankton.

1.1.5. A minimum of 50 specimens per quarter must be identified.

1.2. Sample analysis

1.2.1. Each analyst takes a turn choosing one specimen to identify.

1.2.2. Without discussion, each analyst writes down his or her identification of the chosen specimen, identifying the specimen to the lowest level of which they are capable.

1.2.3. After everyone has identified the specimen, the analysts compare identifications and discuss any differences before moving on to the next specimen.

1.2.4. Once a consensus is reached, the “correct” identification is noted on the bench sheet.

1.2.4.1. “Correct” is the best identification as agreed upon by the group.

1.2.4.2. In some cases, it may be agreed that the most correct answer is to back up to a higher taxonomic level such as genus or family.

1.2.5. If a consensus cannot be reached, the analysts will note the lowest level at which they agree as the “correct” identification. These taxa are tracked so that those occurring more than once may be submitted to outside experts for resolution.

1.2.6. All identifications are compared in order to calculate percentages of incorrect IDs, correct IDs, and IDs that differ only in the level of taxonomy. The results of this comparison are used to identify areas where additional training is needed, outside verification is needed, or better references are needed. For each exercise, the target minimum goal is 60%.

1.2.7. If 60% of taxa are not identified correctly by an analyst, results should be re-examined to identify the source of the problem. Adjustments, further training and/or outside consultation may be required.

1.2.7.1. Compare microscopes and adjustments to assure that all equipment is working properly.

1.2.7.2. Level of identification (genus or species) as a source of misidentification should be rectified with additional training, or with standardization of level of identification, as appropriate.

1.2.7.3. Consistency identifications are an opportunity for all analysts to share their expertise with each other.

1.2.7.4. Perform the procedures in LQ 7140 to pinpoint where differences between analysts are occurring.

1.2.8. A cumulative list of taxa identified in consistency exercises will be kept. A combination of new and previously-identified taxa should be included in each consistency exercise, if possible. The purpose of keeping track of taxa examined is to ensure that a wide range of taxa are used in QA consistency exercises over time.

LQ 7140. CORRECTIVE QUALITY CONTROL EXERCISES

Perform these quality control procedures if re-identifications are consistently falling below the minimum target for similarity. This exercise is designed to assess differences among analysts or sample aliquots due to sample processing that might introduce bias.

1. Perform the following criteria ongoing quality control samples.

1.1. Sample selection and preparation

1.1.1. A person not participating in the exercise should choose and code three samples for analysis.

1.1.2. Samples should be of the same general type (phytoplankton, periphyton, etc.), but different samples may be used for diatom and soft algae analysis if they are identified via separate analyses.

1.1.3. Diatom samples should be chosen from those with high diatom abundance; soft algae samples should be chosen from those with high soft algae abundance. This can be determined with a preliminary scan of some sample material using the inverted microscope.

1.1.4. Analysts will not be told the identity of any sample analyzed in this exercise until the exercise is completed. The analyst will be told the type of sample (periphyton, phytoplankton, etc.) as this will determine how the sample is prepped and analyzed.

1.1.5. This exercise is performed separately for diatom and soft algae taxonomists if different analysts perform the two types of identification.

1.1.6. For each sample, prepare one slide or counting chamber and label it in such a way that the identity of the sample is undisclosed.

1.1.7. The person setting up the exercise should retain a list of the identity of the samples.

1.2. Sample analysis

1.2.1. Each analyst identifies each of the three samples twice for a total of six analyses per analyst. Record each analysis (identifications and counts) on a separate QC data sheet labeled by sample code and analysis number.

1.2.1.1. Perform analyses on each of the three samples before performing the second analysis of the three samples.

1.2.1.2. Do not refer to the first analysis of the same sample when performing the second analysis. Each analysis is designed to be independent.

1.2.2. After analysis of the duplicate samples, insure the similarity is at least the targeted minimum similarity.

1.2.2.1. There are 15 pair-wise similarity comparisons for each sample identified twice by three analysts.

1.2.2.2. If all intra-sample similarities are greater than the targeted minimum similarity, the intra-sample similarity portion of this procedure has been passed.

1.2.3. If the similarity cutoff is not met, combine taxa in the sample to the generic level. The goal of combining taxa to the generic level is to determine if the analyst requires further training to differentiate algal units to species as compared to genus.

1.2.4. If the intra-sample similarities are greater than the targeted minimum similarity, the QC has been successfully passed at the generic level.

1.2.5. If the intra-sample similarities do not pass the similarity cutoff at any level, stop the exercise and determine what taxa contribute most to the differences between counts.

1.2.6. Those taxa contributing the highest percentage of the dissimilarity between samples should be examined to determine the source of the discrepancy (count, level of identification, etc.). All taxa contributing 5% or more of the total inter-sample dissimilarity should be examined.

LQ 7200. (Reserved)

LQ 7300. Laboratory Quality Control for Macrophyte Taxonomic Identification

1. GENERAL REQUIREMENTS: Perform the following quality control activities for all taxonomic identifications.

- 1.1. Maintain copies of appropriate taxonomic identification keys
- 1.2. Establish and maintain a current reference specimen collection.
- 1.3. Retain extramural experts to verify identifications.

LQ 7310. LAKE VEGETATION INDEX (OPTIONAL)

Perform these quality assurance procedures to insure taxonomist maintain a minimum proficiency for macrophyte identification. This procedure is optional and can be used as additional quality control in conjunction with the annual Lake Vegetation Index (LVI) consistency test described in FA 4330

1. QUALITY CONTROL FREQUENCY:

- 1.1. Perform the following quality control procedure for 5% of all original field samples with a minimum of 1 per year.
- 1.2. Calculate and retain cumulative performance data for each taxonomist.
2. QUALITY CONTROL ACCEPTANCE CRITERIA
 - 2.1. The target single-analyst cumulative correct identification rate is 90% of the total number of individual taxa (10% cumulative error rate).
 - 2.2. Verify a minimum of 30 distinct taxa per analyst per year.
 - 2.3. Verifying taxonomists must have a 90% cumulative correct identification rate.
3. QUALITY CONTROL PROCEDURE
 - 3.1. Randomly identify a sample for QC check before performing the actual sampling. Then, complete section 3.2, Field Verification below. Complete the laboratory verification (section 3.3) only if it is impractical to perform a field exercise (for example, if only 1 taxonomist is available). *The selected sample is defined as a QC sample.*
 - 3.2. Field Verification
 - 3.2.1. Two independent taxonomists perform the LVI as described in FS 7310 on the same 4 sections of the same lake. Return unknowns to laboratory for identification as described in the method. Be sure to keep each taxonomist's unknowns separate.
 - 3.2.2. Compare the Lake Vegetation Index Data Sheets of both taxonomists. If there is a disagreement with an identification, consult with the original taxonomist until a consensus is reached, utilizing additional experts as warranted.
 - 3.2.3. Record the identification of the field sample, the date of the QC check and the name of the taxonomist performing the QC check.
 - 3.3. Laboratory Verification
 - 3.3.1. Perform FS 7310 Lake Vegetation Index. NOTE: Collect and return to the laboratory all taxa that were identified in the field on the Lake Vegetation Index Data Sheet, Form FD 9000-7 (*i.e.*, recorded as being present) along with all unknowns.
 - 3.3.2. Have a second taxonomist identify all the taxa in the QC sample to the lowest practical taxonomic level.
 - 3.3.3. Record the presence of each taxon on the Lake Vegetation Index Data Sheet (Form FD 9000-7).
 - 3.3.4. Record the identification of the original field sample, the date of the QC check and the name of the taxonomist performing the QC check.
 - 3.3.5. Obtain the original Lake Vegetation Index Data Sheet (Form FD 9000-7) and compare with the data obtained from the QC check above. If there is a disagreement with an identification, consult with the original taxonomist until a consensus is reached, utilizing additional experts as warranted.
 - 3.4. Record all taxonomic discrepancies and comments associated with the QC check for the original field sample.
 - 3.5. Calculate and retain cumulative performance data for each taxonomist, per the criteria in section 2 above.

LQ 7400. Laboratory Quality Control for Macroinvertebrate Taxonomic Identification

Perform these quality control procedures, as applicable, when using LT 7100 – LT 7300.

1. GENERAL REQUIREMENTS: Perform the following quality control activities for all taxonomic identifications.

- 1.1. Establish and maintain a current type specimen collection.
- 1.2. Retain extramural experts to verify identifications.
- 1.3. Participate in the DEP Taxonomic Quality Control Round Robin program. Participation is required for all taxonomists generating data to be entered into the DEP Statewide Biological Database (SBIO).

LQ 7410. LABORATORY QUALITY CONTROL FOR MACROINVERTEBRATE SORTING

1. Perform the following quality control check on all samples sorted in the laboratory for LT 7200 (Stream Condition Index) and LT 7300 (Lake Condition Index).

- 1.1. After sorting all organisms from aliquots of an original field sample or subsample, separately retain the material remaining from each of the sorted aliquots for quality control (QC) checking.
- 1.2. Have a second taxonomist randomly select one of the sorted aliquots and perform a QC check for sorting efficiency by examining the aliquot and retrieving and counting any organisms found.
- 1.3. After all organisms sorted from the original field sample or subsample have been counted and identified, record the total number of organisms found in the sample or subsample and the total number found in all QC checks. Determine the sorting efficiency according to the formula in section 1.4 below.
- 1.4. Calculate the sorting efficiency for the sample or subsample using the following formula:

$$\text{Sorting efficiency (\%)} = [Total\ organism - QC\ organisms] \div Total\ organisms \times 100$$

Where:

Total organisms $\equiv$ Total number of organisms counted (sorted) in the sample or subsample plus QC organisms

QC organisms $\equiv$ Total number of organisms counted (sorted) in the QC check(s) for the aliquot(s)

- 1.5. Perform the sorting efficiency QC check (sections 1.1 – 1.3 above) for 10% of all aliquots processed for each original field sample or subsample.
2. Record the sorting efficiency for each analyst.
- 2.1. The target control limit for *cumulative* sorting efficiency is 95% as calculated in section 1.4 above. Take precautionary measures when single-analyst cumulative sorting efficiency falls below 95%.
 - 2.2. Take corrective action when single-analyst *cumulative* sorting efficiency falls below 90% as calculated in section 1.4 above.

LQ 7420. LABORATORY QUALITY CONTROL FOR MACROINVERTEBRATE TAXONOMIC IDENTIFICATION

Use the QC procedures in this section for all wet identifications and for all slide-mounted identifications of midges, worms and mites.

1. QUALITY CONTROL FREQUENCY: Perform the following quality control procedure for 5% of all original field samples or subsamples processed and enumerated.
2. QUALITY CONTROL ACCEPTANCE CRITERIA
 - 2.1. The target single-analyst cumulative correct identification rate is 95% of the total number of individual organisms and 95% of taxa identified in all samples or subsamples enumerated by the analyst (5% cumulative error rate).
 - 2.2. Similarly, control performance for analysts enumerating organisms for subgroups of taxonomic specialty according to the same criteria above.
3. QUALITY CONTROL PROCEDURE
 - 3.1. Randomly select 5% of the processed and enumerated original field samples or subsamples for QC checking. *The selected samples or subsamples are defined as QC samples.*
 - 3.2. Have a second taxonomist identify the organisms in the QC samples to the lowest practical taxonomic level using the most appropriate taxonomic key for each taxonomic group.
 - 3.3. Record the name and number of individual organisms identified for each taxon enumerated in the QC sample.
 - 3.3.1. Record the identification of the original field sample or subsample checked, the date of the QC check and the name of the taxonomist performing the QC check.
 - 3.4. Obtain the original field sample or subsample enumeration data and compare with the data obtained from the QC check above. If there is a disagreement with an identification, consult with the original taxonomist until a consensus is reached, utilizing additional experts as warranted.
 - 3.5. Record all taxonomic discrepancies and comments associated with the QC check for the original field sample or subsample.
 - 3.6. Calculate and retain cumulative performance data for each taxonomist according to each area of taxonomic proficiency, per the criteria in section 2 above.

LQ 8000. REFERENCES (RESERVED)

LT 7000. DETERMINATION OF BIOLOGICAL INDICES

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
- FS 7000 Biological Community Sampling
- FT 1000 General Field Testing and Measurement
- FT 3000 Aquatic Habitat Characterization
- LD 7000 Documentation of Biological Laboratory Procedures
- LQ 7000 Quality Control for Biological Community Analysis

LT 7100. Biorecon Determination

1. DEFINITION: Biological Reconnaissance (Biorecon) is a rapid community based biological assessment of stream health using benthic macroinvertebrates sampled via four sweeps of a D-frame dipnet, with organisms (excluding Oligochaeta, Chironomidae, and Acarina) identified to the lowest practical taxonomic level.

2. SAMPLING

- 2.1. Perform physical/chemical characterization and habitat mapping according to FT 3001.
- 2.2. Perform a habitat assessment according to FT 3100.
- 2.3. Conduct Rapid Bioassessment (Biorecon) sampling according to FS 7410.
- 2.4. Sort the organisms in the field according to FS 7410.

3. LABORATORY ANALYSES

3.1. Laboratory Verification of Field Identifications (Modified from American Public Health Association, *Standard Methods for the Examination of Water and Wastewater*, 10500 C)

3.1.1. Equipment and Supplies

- Dissecting microscope
- Identification references
- Forceps
- Petri dishes (100 x 15 mm or 60 x 15 mm) or other appropriate containers

- Laboratory counter (optional)
- Macroinvertebrate Bench Sheet (may vary from lab to lab)
- Pen

3.1.2. Methods

3.1.2.1. First, empty the contents of the vial into an appropriate container (100-mm diameter petri dish).

3.1.2.2. You may choose to separate the organisms into like groups. To do this, place the groups into smaller (60-mm diameter) individual petri dishes or group the animals within the larger dish.

3.1.2.3. Use the dissecting microscope to identify the organisms to the lowest practical taxonomic level, with the following exception. For the BioRecon procedure, do not identify Oligochaeta, Chironomidae, and Acarina below class, family, and order, respectively. See LT 7900 for guidance concerning “lowest practical taxonomic level” for the remaining groups of organisms. Use the most appropriate identification reference for each group. Enumerate organisms concurrently, and then place them back into the labeled vial with the forceps. Remove the animals as you count them in order to avoid counting any of them twice. It will take some time until sufficient experience with identification procedures and references is gained. In addition to the identification manuals, maintain a reference collection that can be used to compare specimens and facilitate identification. After using a dichotomous key to arrive at the name of an unknown organism, check the organism’s geographic range, habitat preferences, and morphological diagnosis to confirm that the identification is correct. Do not identify an organism by simply flipping through some pictures and assigning a name based on a superficial resemblance. Another taxonomist will recheck sample identifications according to LQ 7000.

3.1.2.4. If a large number of one or a few taxa are present, use a laboratory counter to keep a running total to facilitate the enumeration process. You may temporarily label counters to avoid mistakes. If you do not use a counter, tally the number of each taxon on your bench sheet.

3.1.2.5. If an organism is encountered in your laboratory for the first time, remove it and place it in an individual vial for inclusion in the reference collection. Make a note of this on the bench sheet, so that it can be located in the future, if necessary.

3.1.2.6. Record the individual taxon names on your bench sheet. Organisms are also enumerated during this process, and their numbers recorded on the bench sheet.

3.1.2.7. Follow proper Taxonomic Quality Assurance procedures (see LQ 7000).

4. DATA REDUCTION

4.1. For DEP staff only, enter all data into SBIO (the Florida Statewide Biological Database).

4.2. Follow the counting and collapsing procedures listed below. Keep a record of the original taxa list and the resulting collapsed list.

4.2.1. When combining biological data (taxa and counts), the number of taxa may become artificially inflated by the incorporation of the same taxon under different names and by counting high-level identifications (family or genus). An erroneously high taxa count creates additional anomalies among metrics involving these counts, such as the number of Ephemeroptera and Trichoptera taxa.

4.2.2. Collapse all taxa to the lowest practical taxonomic level.

4.2.3. Collapse taxa further, which follows the “Upward Collapsing” of Taxa (i.e., Preparation for Index Calculations) procedure listed in the *Statewide Biological Database Manual*, Florida Department of Environmental Protection.

As an example, see the following species list:

Conchapelopia sp. (2)
Helopelopia sp. (4)
Dicrotendipes simpsoni (21)
Dicrotendipes modestus (1)
Dicrotendipes sp. (20)
Hyalella azteca (20)
Planorbella sp. (1)

7 taxa and 69 individuals

Upward collapsing, however, will combine *Conchapelopia* and *Helopelopia* as synonyms, and will apportion the individuals from *Dicrotendipes* sp. to the two identified species of that genus, resulting in:

Conchapelopia sp. (6)
Dicrotendipes simpsoni (40)
Dicrotendipes modestus (2)
Hyalella azteca (20)
Planorbella sp. (1)

5 taxa and 69 individuals

Note that if “*Dicrotendipes* sp.” had represented a distinct species level entity with no available or known name, it would have properly been entered as “*Dicrotendipes* sp. 14 Epler” or a similar name, and would then not have been combined. Collapsing will also take place at other taxonomic levels: family level identifications will combine with generic level identifications, species will combine with subspecies, etc.

5. INDEX CALCULATION

Perform the following calculations based on collapsed data as outlined in Section 4.2.

5.1. Calculate and record the long-lived taxa score according to the list below (based on Fore, 2007 with minor modifications). Use the taxonomic order, family, and genus (or species) name of each taxon to calculate long-lived taxa richness. Taxonomic synonyms present in the current Florida data base are also shown as additional information. Long-lived taxa require more than one year to complete their life cycles.

Order	Family	Genus	Species (Long-lived)	Synonyms
Decapoda			All families, genera and species	
Basommatophora	Lymnaeidae	<i>Fossaria</i>	All species	
Mesogastropoda	Ampulariidae	<i>Pomacea</i>	All species	
Veneroida	Corbiculidae	<i>Corbicula</i>	All species	
Unionoida	Unionidae		All genera and species	

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Order	Family	Genus	Species (Long-lived)	Synonyms
Odonata	Aeshnidae	<i>Basiaeschna</i>	<i>Basiaeschna janata</i>	
		<i>Boyeria</i>	All species	
	Cordulegastridae		All species	
	Gomphidae	<i>Gomphus</i>	All species	
Odonata		<i>Haegenius</i>	All species	<i>Gomphurus</i>
		<i>Progomphus</i>	All species	
	Libellulidae	<i>Macromia</i>	All species	
		<i>Somatochlora</i>	All species	
Odonata		<i>Tetragoneuria</i>	All species	<i>Epithec</i>
	Petaluridae	<i>Tachopteryx</i>	<i>Tachopteryx thoreyi</i>	
Plecoptera	Pteronarcidae	<i>Pteronarcys</i>	All species	
	Leuctridae		All genera and species	
	Peltoperlidae	<i>Tallaperla</i>	<i>Tallaperla cornelia</i>	
	Perlidae	<i>Acroneuria</i>	All species	
		<i>Agnetina</i>	<i>Agnetina annulipes</i>	
		<i>Eccopectura</i>	<i>Eccopectura xanthenes</i>	
		<i>Neoperla</i>	All species	
		<i>Paragnetina</i>	All species	
	Perlodidae	<i>Clioperla</i>	<i>Clioperla clio</i>	
		<i>Perlinella</i>	<i>Perlinella drymo</i>	
			<i>Perlinella ephyre/zwicky</i>	
		<i>Isoperla</i>	<i>Isoperla orata</i>	
Megaloptera	Corydalidae		All genera and species	
Trichoptera	Brachycentridae	<i>Brachycentrus</i>	<i>Brachycentrus americanus</i>	<i>Oligoplectrum americanum</i>
		<i>Micrasema</i>	All species	
	Calamoceratidae	<i>Heteroplectron</i>	<i>Heteroplectron americanum</i>	
	Hydropsychidae	<i>Diplectrona</i>	<i>Diplectrona modesta</i>	
		<i>Macrostemum</i>	<i>Macrostemum carolina</i>	<i>Macronema carolina</i> <i>Macronemum carolina</i>
	Lepidostomidae	<i>Lepidostoma</i>	All species	
				<i>Alepomyia</i> <i>Alepomyiodes</i> <i>Arcadopsyche</i> <i>Atomyia</i> <i>Jenortha</i> <i>Mormomyia</i> <i>Neuropsyche</i> <i>Nosopus</i>

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Order	Family	Genus	Species (Long-lived)	Synonyms
Trichoptera				<i>Notiopsyche</i> <i>Olemira</i> <i>Oligopsyche</i> <i>Phanopsyche</i> <i>Pristosilo</i> <i>Athripsodes</i>
	Leptoceridae	<i>Ceraclea</i>	All species	
	Limnephilidae	<i>Ironoquia</i> <i>Pycnopsyche</i>	<i>Ironoquia punctatissima</i> All species	
	Molannidae	<i>Molanna</i>	All species	
	Phryganeidae	<i>Banksiola</i> <i>Ptilostomis</i> <i>Agrypnia</i>	<i>Banksiola concatenata</i> <i>Ptilostomis postica</i> <i>Agrypnia vestita</i>	<i>Neuronia concatenata</i> <i>Neuronia postica</i>
	Psychomyiidae	<i>Lype</i>	<i>Lype diversa</i>	
	Rhyacophilidae	<i>Rhyacophila</i>	All species	
	Uenoidae	<i>Neophylax</i>	All species	

5.2. Calculate and record the sensitive taxa score according to the list below (based on Fore, 2007 with minor modifications). These taxa are identified as sensitive to human disturbance. Synonyms in the current Florida database are also included as additional information.

Order	Family	Genus	Taxon (sensitive)	Synonyms
Acariformes	Lebertiidae	<i>Lebertia</i>	All species	
Amphipoda	Crangonyctidae	<i>Crangonyx</i>	<i>Crangonyx</i>	
Coleoptera	Elmidae	<i>Ancyronyx</i>	<i>Ancyronyx variegatus</i>	
		<i>Gonielmis</i>	All species	
		<i>Macronychus</i>	All species	
Diptera	Chironomidae	<i>Microtendipes</i>	All species	
		<i>Parametriocnemus</i>	All species	
		<i>Polypedilum</i>	<i>Polypedilum aviceps</i>	
		<i>Rheocricotopus</i>	All species	
		<i>Stempellinella</i>	All species	
		<i>Tanytarsus</i>	<i>Tanytarsus sp. d epler</i>	
		<i>Tanytarsus</i>	<i>Tanytarsus sp. m epler</i>	
		<i>Tribelos</i>	<i>Tribelos jucundum</i>	
		<i>Hemerodromia</i>	<i>Hemerodromia</i>	
			All genera and species	
Ephemeroptera	Baetidae	<i>Acerpenna</i>	<i>Acerpenna pygmaea</i>	<i>Baetis pygmaeus</i>

Order	Family	Genus	Taxon (sensitive)	Synonyms
Isopoda	Ephemerellidae	<i>Caecidotea</i>	All genera and species	<i>Asellus</i>
	Heptageniidae		All genera and species	
	Leptophlebiidae		All genera and species	
	Leptohyphidae		All genera and species	
	Asellidae		<i>Caecidotea</i>	
	Libellulidae		All species	
			All families, genera and species	
	Hydropsychidae		All species	
	Leptoceridae		All species	
	Philopotamidae		<i>Chimarra</i>	
Trichoptera	Psychomyiidae	<i>Lype</i>	<i>Lype diversa</i>	

5.3. Tally the numbers for taxa richness (total taxa), Ephemeroptera taxa, and Trichoptera taxa.

5.4. Refer to Merritt and Cummins, An Introduction to the Aquatic Insects of North America to determine the number of clinger taxa. For clinger taxa, include only those taxa whose sole habit is listed as "clinger".

5.5. Evaluate and record the biological metrics according to the scoring system in Tables LT 7100-1, 7100-2 and 7100-3.

LT 7110. REFERENCES

1. Merritt, R.W., and Cummins, K.W., An Introduction to the Aquatic Insects of North America, Third Edition, 1996.
2. Fore, L., R.B. Frydenborg, D. Miller, T. Frick, D. Whiting, J. Espy, and L. Wolfe. Development and Testing of Biomonitoring Tools for Macroinvertebrates in Florida Streams. Florida Department of Environmental Protection, 2007.
3. American Public Health Association, American Water Works Association, Water Pollution Control Federation, SM10500C, Standard Methods for the Examination of Water and Wastewater, 20th Edition, 1999.

Appendix LT 7100
Tables, Figures and Forms

Table LT 7100-1

Table LT 7100-2

Table LT 7100-3

Table LT 7100-1

BioRecon metric name and range of metric values used to assign a score of 0 (indicating degraded condition) to 1 (indicating minimal disturbance) by region. Metric values higher or lower than the listed range were assigned a score of 0 or 1 as appropriate. Bold values indicate scoring ranges that differ from the same SCI metric.

BioRecon metric	Northeast	Panhandle	Peninsula
Total taxa	14–37	16–49	11–36
Ephemeroptera taxa	0–3.5	0–12	0–5
Trichoptera taxa	0–6.5	0–7	0–7
Long-lived taxa	0–6	0–10	0–7
Clinger taxa	0–7	0–15.5	0–8
Sensitive taxa	0–11	0–19	0–9

Table LT 7100-2

BioRecon metric scoring formulae for converting metric values to a metric score ranging from 0 to 1. In each equation, 'X' stands for the raw metric value. For calculated values >1, score equals 1; for calculated values <0, score equals 0.

BioRecon metric	Northeast	Panhandle	Peninsula
Total taxa	$(X-14)/23$	$(X-16)/33$	$(X-11)/25$
Ephemeroptera taxa	$X / 3.5$	$X / 12$	$X / 5$
Trichoptera taxa	$X / 6.5$	$X / 7$	$X / 7$
Long-lived taxa	$X / 6$	$X / 10$	$X / 7$
Clinger taxa	$X / 7$	$X / 15.5$	$X / 8$
Sensitive taxa	$X / 11$	$X / 19$	$X / 9$

1. Check that none of the metric scores are >1 or <0. If so, change the scores to 0 or 1 as appropriate.
2. Sum the metric scores; check that the sum is between 0 and 6.
3. Divide the sum of scores by 0.6. This is a correction factor to change the BioRecon range from 0–6 to 0–10.

Table LT 7100-3

Categorical descriptions and range of index values for the BioRecon index. Square brackets indicate a value is included in the range; round brackets indicate a value is not included.

BioRecon	Index range
<u>1 sample</u>	
Category 1 ("exceptional")	[7–10]
Category 2 ("healthy")	[4–7)
Category 3 ("impaired")	[0–4)

LT 7200. Stream Condition Index (SCI) Determination

1. DEFINITION: The SCI is a community-based biological assessment of stream health using benthic macroinvertebrates sampled via 20 sweeps of a D-frame dip net, with organisms identified to the lowest practical taxonomic level.

2. SAMPLING

2.1. Perform physical/chemical characterization and habitat mapping according to FT 3001.

2.2. Perform a habitat assessment according to FT 3100.

2.3. Conduct SCI D-frame dip net sampling according to FS 7420.

2.4. See the SCI Primer for additional information about sampling (LT 7210, section 6, below).

3. LABORATORY ANALYSES

3.1. Sample Preparation

3.1.1. Equipment and Supplies

- Waterproof paper
- Permanent marker
- U.S. No. 30 mesh sieve
- Ethanol-filled squeeze bottle (80%)
- Pan marked with a grid of 24 5-cm squares (gridded pan)
- Random number table
- 250-mL glass jar
- Dissecting microscope
- Compound microscope
- 100 x 15 mm petri dish or other appropriate container
- Forceps
- Vials for picked organisms (1 or 2 dram)
- Laboratory counter
- Macroinvertebrate Bench Sheet (may vary from lab to lab)
- Discard bucket
- Lighted magnifier
- Ruler
- Lab coat

- Latex gloves
- Properly fitted respirator
- Safety glasses

3.1.2. Methods

3.1.2.1. Make two labels to go into each of the vials of picked bugs that clearly identify the sample. This could include information such as the sample identification number, station identification, date sampled, and replicate number.

3.1.2.2. Include the entire sample in this reduction and homogenization process.

3.1.2.3. Place sample material into a U.S. No. 30 mesh sieve over a discard bucket. Empty the contents of the sample into the sieve slowly, making sure not to lose any of the sample material. The formalin should go through the sieve and collect in the bucket. Once the sample is finished draining, pour the waste formalin into the proper container. Follow proper safety protocols (personal protective equipment, ventilation and handling) when handling samples preserved with formalin.

3.1.2.4. Gently rinse the sample material with tap water. Pull out large twigs, leaves, plants, etc., and place into a gridded pan. Wash fine debris (silt, mud) through the (U.S. No. 30 mesh) sieve. Repeat steps 3.1.2.3 and 3.1.2.4 until the entire sample from all the jugs has been processed. Visually inspect large debris (leaves, plants, twigs) held in the pan for animals before discarding. This inspection is best accomplished by observing it with a lighted magnifier. Randomly place found organisms into the gridded pan with the rest of the unpicked sample.

3.1.2.5. Thoroughly mix the sample so that a homogeneous distribution of organisms is achieved in the detrital matrix. Place the sieved sample in a labeled, gridded pan. Each 5-cm square should have a pre-assigned number (1-24). Liquid present in the sample should be sufficiently reduced to prevent material from shifting among squares during the sorting process. There are 24 total 5-cm squares in a standard pan. If the sample is small and does not cover all 24 squares, spread it out across a number of squares that is divisible by three (e.g., 18, 12, 21). Use a straightedge to delineate the edges of a grid while removing the sample.

3.1.2.6. Randomly select eight separate squares (or 1/3 of the total grids). A random number table is recommended. Remove the contents of these squares, in their entirety, and place in another labeled, gridded tray. Thoroughly mix the sample in the second tray so that a homogeneous distribution of organisms is achieved in the detrital matrix. Use a straightedge to delineate the edges of a grid while removing the sample.

3.1.2.7. Randomly select one square from the second tray, remove the contents of this square in its entirety, and place it into a third container (such as a gridded tray or Petri dish). After selecting your square, you may need to add some ethanol or water (in addition to a cover) to the trays to prevent them from drying out.

3.1.2.8. The intent of this step is to achieve a final target count of 150 (with an acceptable range of 140-160) organisms. **Note that if the correct counting range can not be achieved, the calculation of a reliable final score is diminished.** Randomly select an aliquot (any fraction of the square; for example, $\frac{1}{4}$, $\frac{1}{8}$, etc.),

remove its contents, and place it in a separate, labeled container. Divide this aliquot further, if necessary, to achieve the target number of organisms.

3.1.2.9. Place the container under a dissecting scope set at low power (approximately 7x or 10x). In a deliberate, systematic manner, pick every organism from the final aliquot and place it into an alcohol-filled vial (clearly identified as per section 3.1.2.1). Keep a running total of the number of organisms picked. When started, finish sorting this aliquot in its entirety.

3.1.2.10. Save the container (petri dish) until you have ten (10), and have a co-worker recheck them as described in LQ 7000. After a container has been checked, you may discard the material in the remaining containers.

3.1.2.11. If you have not reached the minimum count of 140 organisms, repeat steps 3.1.2.7-3.1.2.10. Use whatever size aliquot is necessary in order to reach the target count of organisms.

3.1.2.12. If you have exceeded the maximum count of 160 organisms, randomly sub sample 150 organisms. This may be accomplished by placing the organisms into a Petri dish that has been subdivided evenly into 16 squares. With the aid of a dissecting microscope, remove and discard any terrestrial organisms, pieces of worms and other organisms without heads. If still not within the target range, randomly select a square in the Petri dish and remove **all** the organisms in that square. Repeat this process until you have the target number of individuals.

3.1.2.13. If you have not reached the minimum target count of 150 (with an acceptable range of 140-160) after completely sorting the previous square from 3.1.2.7, go back to the second tray, randomly select a new square, and continue steps 3.1.2.8-3.1.2.12 until the target count has been obtained. If an obvious organism is observed but its grid number was not selected and no examples of that organism were present in the grids that were selected, you may note that organism as qualitatively observed. Do not include the organism in the analysis.

3.1.2.14. Record the number of squares, grids and aliquots selected (e.g., 8/24, 2/12, 1/4) to enable conversion to total abundance present in the original sample. Failure to record the number of squares and grids selected (out of the total possible) compromises the usefulness of the data. Save any remaining material in the third container and the remaining squares from the second tray in separate air-tight containers until both portions have been completely processed. This material may be necessary if the target counts fall below the acceptable range during the identification process.

3.1.2.15. Return to the tray in step 3.1.2.6 and without re-homogenizing repeat the entire process from steps 3.1.2.7-3.1.2.14 to obtain a second 150 (with acceptable range of 140-160) count. Place the organisms in a second vial.

3.1.2.16. If the entire sample is processed, and there are insufficient individuals for both (or one) of the aliquots to achieve the minimum of 140 organisms, this indicates an extremely unusual condition, either an environmental stressor (e.g., toxicity, lack of habitat, desiccation, etc.) or sampling error (e.g., sampling during flood conditions). **If this occurs, a final Stream Condition Index score should not be calculated, and the "X" qualifier should be used during reporting. "X" means there were insufficient individuals present in the sample, suggesting an extreme environmental stressor or sampling error.**

3.1.2.17. Record the date the sorting of the sample is completed.

3.2. Slide Preparation (Based on Beckett, D.C. and Lewis, P.A. 1982. An efficient procedure for slide mounting of larval Chironomidae. Trans. Amer. Microsc. Soc. 101: 96-99; Epler, J. 1992, Identification manual for the larval Chironomidae (Diptera) of Florida; and Pluchino, E. 1984, Guide to the common water mite genera of Florida.)

3.2.1. Equipment and Supplies

- Dissecting microscope
- 25 x 75 mm glass microscope slides
- 12-mm and 18-mm diameter round #0 or #1 cover slips
- Transparent tape and razor blade
- Pencil
- Forceps or needle
- 1 N KOH
- Mounting medium (CMC-10)

3.2.2. Methods

3.2.2.1. Prepare the slides for labeling. This task is most easily accomplished by lining up several slides with long ends together and applying a row of transparent tape to the right side of each slide. Usually, three slides are left taped together until organisms are mounted. Use a razor blade to separate the slides during the identification process.

3.2.2.2. Label each slide so it can be uniquely identified. For example, write the sample number, sample date, and abbreviated site information on each slide label with a soft pencil. Other station identifiers along with the total number of slides, the initials of the mounter, and the date mounted can be written on a small piece of paper and attached to the tray on which the slides are placed to dry. This is often helpful when identifying the organisms.

3.2.2.3. Place a drop of CMC on the slide for each organism you are mounting. An excess of CMC may be used, which will help to form a seal around the cover slip when it is pressed down. Mount three midges/worms per slide, under separate 12-mm cover slips. In the case of very large specimens, mount two per slide under separate 18-mm cover slips.

3.2.2.4. Using a needle or forceps, place the specimen in the CMC, ventral side up if it is a midge or mite.

3.2.2.5. Using forceps, place the cover slip over the specimen.

3.2.2.6. Using forceps or the eraser of a pencil, press the cover slip onto the specimen. Apply sufficient pressure to spread the mandibles and labrum. At this point, you may also orient the specimen by pushing or pressing the cover slip in various ways. Be careful not to break the cover slip, as the pressure required to flatten the specimen may be great. Mounting of aquatic mites requires more CMC along with a greater amount of pressure. Make sure you use enough of both. Otherwise, air will accumulate under the cover slip and the necessary structures will not be visible. Mites can be soaked in 1N KOH for softening before mounting.

3.2.2.7. Set the slides aside to dry; it may take 1 to 2 days for the slides to dry completely. Recheck the labels on the slides to make sure that each one has the correct sample number.

3.3. Organism Identification (Modified from *Standard Methods 10500C*)

3.3.1. Equipment and Supplies

- Dissecting microscope
- Compound microscope
- Identification references
- Forceps
- Vials (1- or 2-dram)
- Petri dishes (100 x 15 mm or 60 x 15 mm) or Syracuse watch glasses
- Laboratory counter (optional)
- Microscope slides
- 12-mm diameter cover slips
- Macroinvertebrate Bench Sheet (may vary from lab to lab)
- Pen
- Pencil

• Methods

3.3.1.1. Sort and process samples according to section 3.1. Make permanent slide mounts of worms and midges according to section 3.2 when needed.

3.3.1.2. Identify organisms other than worms, midges, and aquatic mites with a dissecting microscope, unless higher magnification is needed. Make permanent slide mounts of worms, midges, and water mites as necessary from the 150-organism sample.

3.3.1.3. You may choose to separate the organisms into like groups. To do this, place the groups into smaller (60-mm diameter) individual petri dishes or Syracuse watch glasses, or group the animals within the larger dish.

3.3.1.4. Identify the organisms to the lowest practical taxonomic level, using the most appropriate identification reference for each group. See LT 7900 for guidance concerning "lowest practical taxonomic level". Enumerate organisms concurrently, and then place them back into the labeled vial with the forceps. Remove the animals as you count them in order to avoid counting any of them twice. It will take some time until sufficient experience with identification procedures and references is gained. In addition to the identification manuals, maintain a reference collection that can be used to compare specimens and facilitate identification. After using a dichotomous key to arrive at the name of an unknown organism, check the organism's geographic range, habitat preferences, and morphological diagnosis to confirm that the identification is correct. Do not identify an organism by simply flipping through some pictures and assigning a name based on a superficial resemblance. Another taxonomist will recheck sample identifications according to LQ 7000.

3.3.1.5. If a large number of one or a few taxa are present, use a laboratory counter to keep a running total to facilitate the enumeration process. Temporarily label counters to avoid mistakes. If you do not use a counter, tally the number of each taxon on your bench sheet.

3.3.1.6. If an organism is encountered in your laboratory for the first time, remove it and place it in an individual vial for inclusion in the reference collection. Make a note of this on the bench sheet, so that it can be located in the future, if necessary.

3.3.1.7. A compound microscope is required to identify worms, midges, and aquatic mites. Sometimes, parts of other organisms (e.g., mayfly labrums, etc.) must be mounted for proper identification. Most midges and mites can be recognized at 400x (40x objective and 10x eyepiece). Prepare specimens from these groups according to section 3.2.

3.3.1.8. If the structures that must be observed cannot be seen, use a 100x oil immersion objective. This procedure will give a magnification of 1000x.

3.3.1.9. Identify the specimens to the lowest practical taxonomic level. See LT 7900 for guidance concerning "lowest practical taxonomic level". Write the organism name or code directly on the slide label. If the specimen has no head or belongs to a group not classified as a benthic macroinvertebrate (e.g., nematode), draw a horizontal line through the slide label to indicate that it will not be counted. Specimens that are missing their heads are not counted. This situation will most often be encountered with the worms, as the heads are difficult to discern under the dissecting microscope when the pieces are mounted.

3.3.1.10. Record the individual taxon names and enumerate the organisms for each taxon on your bench sheet. Use of the laboratory counter will facilitate this operation, especially where large numbers of individuals are present.

3.3.1.11. Tally the number of organisms identified.

3.3.1.12. Follow proper Taxonomic Quality Assurance procedures (see LQ 7000).

4. DATA REDUCTION

4.1. For DEP staff, enter all data into SBIO (the Florida Statewide Biological Database).

5. INDEX CALCULATION

Perform the following calculations based on collapsed data as outlined in LT 7100, Section 4.2.

5.1. Calculate and record the biological metrics for long-lived and sensitive taxa according to LT 7100, Sections 5.1 and 5.2, respectively.

5.2. Calculate and record the % very tolerant taxa according to the taxa list below (based on Fore, 2007 with minor modifications). These taxa are identified as very tolerant to human disturbance. Synonyms in the current Florida database are also included as additional information.

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LT 7000 Determination of Biological Indices

Order	Family	Genus	Taxon (very tolerant)	Synonyms
Basommatophora	Ancylidae	<i>Hebetancylus</i>	<i>Hebetancylus excentricus</i>	
		<i>Laevapex</i>	All species	
	Physidae	<i>Physella</i>	All species	
	Planorbidae		All genera and species	
Coleoptera	Haliplidae	<i>Peltodytes</i>	All species	
Diptera	Chironomidae	<i>Larsia</i>	All species	
		<i>Chironomus</i>	All species	<i>Tendipes</i> , <i>Chaetolabis</i>
		<i>Cladopelma</i>	<i>Cladopelma</i>	
		<i>Cricotopus</i>	All species	
		<i>Cryptochironomus</i>	All species	
		<i>Dicrotendipes</i>	<i>Dicrotendipes modestus</i> <i>Dicrotendipes neomodestus</i>	
		<i>Glyptotendipes</i>	All species	
		<i>Goeldichironomus</i>	All species	
		<i>Kiefferulus</i>	<i>Kiefferulus</i>	
			<i>Polypedilum beckae</i>	<i>Asheum beckae</i>
		<i>Polypedilum</i>		<i>Pedionomus beckae</i>
			<i>Polypedilum illinoiense</i> grp.	<i>Polypedilum illnoense</i>
		<i>Polypedilum</i>	<i>Polypedilum tritum</i>	<i>Chironomus tritum</i>
		<i>Tanypus</i>	All species	<i>Pelopia</i>
Diptera	Chironomidae	<i>Tanytarsus</i>	<i>Tanytarsus</i> sp. f epler	
		Stratiomyidae	<i>Odontomyia</i>	<i>Eulalia</i>
		Tipulidae	<i>Tipula</i>	<i>Nippotipula</i> <i>Playttipula</i> <i>Yamatotipula</i>
Haplotaxida	Naididae	<i>Bratislavia</i>	<i>Bratislavia unidentata</i>	
		<i>Dero</i>	All species	
		<i>Nais</i>	<i>Nais communis</i> complex	<i>Nais communis</i> <i>Nais elinguis</i> <i>Nais pardalis</i> <i>Nais variabilis</i>
Haplotaxida	Naididae	<i>Pristina</i>	<i>Pristina synclites</i>	

Order	Family	Genus	Taxon (very tolerant)	Synonyms
	Tubificidae	<i>Haber</i> <i>Limnodrilus</i>	<i>Haber speciosus</i> All species	<i>Camptodrilus</i>
Heteroptera	Mesoveliidae		All genera and species	
Hoplonemertea	Tetrastemmatidae	<i>Prostoma</i>	All species	
Lepidoptera	Pyralidae		All genera and species	
Lumbriculida	Lumbriculidae	<i>Lumbriculus</i>	All species	
Odonata	Libellulidae	<i>Pachydiplax</i>	All species	
	Coenagrionidae	<i>Argia</i> <i>Enallagma</i> <i>Ischnura</i>	<i>Argia sedula</i> <i>Enallagma cardenium</i> All species	<i>Enallagma coecum</i> <i>Anomalagrion</i>
Mesogastropoda	Hydrobiidae	<i>Pyrgophorus</i>	<i>Pyrgophorus platyrachis</i>	<i>Pyrogophorus platyrachis</i>
	Thiaridae	<i>Melanoides</i>	All species	
Rhynchobdellida	Glossiphoniidae		All genera and species	

5.3. Tally the numbers for taxa richness (total taxa), Ephemeroptera taxa, Trichoptera taxa, % Dominance, and % Tanytarsini.

5.4. Refer to Merritt and Cummins, An Introduction to the Aquatic Insects of North America to determine the number of clinger taxa and % filter feeders. For clinger taxa, include only those taxa whose sole habit is listed as “clinger”.

5.5. Evaluate and record the biological metrics according to the scoring system in Tables LT 7200-1, 7200-2 and 7200-3. See the SCI Primer (LT 7210, section 6, below).

LT 7210. REFERENCES

1. Beckett, D.C. and Lewis, P.A., An Efficient Procedure for Slide Mounting of Larval Chironomidae, Trans. Amer. Microsc. Soc. V. 101, pp. 96-99, 1982.
2. Epler, J., Identification Manual for the Larval Chironomidae (Diptera) of Florida, 1992.
3. Pluchino, E., Guide to the Common Water Mite Genera of Florida, 1984.
4. Merritt, R.W., and Cummins, K.W., An Introduction to the Aquatic Insects of North America, Third Edition, 1996.

5. Fore, L., R.B. Frydenborg, D. Miller, T. Frick, D. Whiting, J. Espy, and L. Wolfe.
Development and Testing of Biomonitoring Tools for Macroinvertebrates in Florida Streams.
Florida Department of Environmental Protection, 2007.
6. "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

Appendix LT 7200
Tables, Figures and Forms

LT 7200-1

SCI metric scoring formulae for converting metric values to a metric score ranging from 0 to 10. In each equation, 'X' stands for the raw metric value; "ln" stands for the natural log.

SCI metric	Northeast	Panhandle	Peninsula
Total taxa	$10 * (X-16)/26$	$10 * (X-16)/33$	$10 * (X-16)/25$
Ephem. taxa	$10 * X /3.5$	$10 * X /6$	$10 * X /5$
Trichoptera taxa	$10 * X /6.5$	$10 * X /7$	$10 * X /7$
% Filterer	$10 * (X-1)/41$	$10 * (X-1)/44$	$10 * (X-1)/39$
Long-lived taxa	$10 * X /3$	$10 * X /5$	$10 * X /4$
Clinger taxa	$10 * X /9$	$10 * X /15.5$	$10 * X /8$
% Dominance	$10 - (10 * [(X-10)/44])$	$10 - (10 * [(X-10)/33])$	$10 - (10 * [(X-10)/44])$
% Tanytarsini	$10 * [\ln(X + 1) /3.3]$	$10 * [\ln(X + 1) /3.3]$	$10 * [\ln(X + 1) /3.3]$
Sensitive taxa	$10 * X /11$	$10 * X /19$	$10 * X /9$
% Very tolerant	$10 - (10 * [\ln(X + 1)/4.4])$	$10 - (10 * [\ln(X + 1)/3.6])$	$10 - (10 * [\ln(X + 1)/4.1])$

1. Follow Steps 2-5 for each of the two 150 aliquots. If there are less than two aliquots, stop at Step 1 and report a null result with a qualifier of "X" ("too few to calculate").
2. Determine the bioregion for the sample and calculate each of the 10 SCI metrics using the appropriate equation in the table above. Based on reference site community similarity, three SCI Bioregions have been established for Florida: the Panhandle, the Northeast, and the Peninsula. Note: The SCI is not calibrated for Ecoregion 76, the Southern Florida Coastal Plain, where few natural streams exist. 3. Change any of the resulting individual SCI metrics score that are >10 to 10 and any that are <0 to 0.
4. Sum the 10 SCI metric scores; check that the sum is between 0 and 90. If it is not, verify that the correct equations were used.
5. Divide the sum of scores by 0.9. Do not round the result to get the aliquot score.
6. Average the two aliquot scores from step 5 and round to the nearest integer (decimal portions <.50 round down; >=.50 round up). This value will be reported as the final score with an "A" qualifier (for "averaged value").
7. Use Table 7200-2 to assign a category to the result calculated in Step 6.

Table LT 7200-2

Category names, ranges of values for SCI, and example descriptions of biological conditions typically found for that category. Narrative metric descriptions are not used to score metrics, rather they describe values associated with a range of index values. The SCI 2004 category name is listed only for translating 2004 to 2007 category names and should not be used as an interpretation of SCI scores.

SCI Score	SCI 2007 Category Name	SCI 2004 Category Name (for reference only)	Example Description
68–100	Category 1 (“exceptional”)	“Good”	Higher diversity of taxa than for Category 2, particularly for Ephemeroptera and Trichoptera; several more clinger and sensitive taxa than found in Category 2; high proportion for Tanytarsini; few individuals in the dominant taxon; very tolerant individuals make up a very small percentage of the assemblage.
48–67	Category 2 (“healthy”)	“Fair”	Diverse assemblage with 30 different species found on average; several different taxa each of Ephemeroptera, Trichoptera, and long-lived and, on average, 5 unique clinger and 6 sensitive taxa routinely found; small increase in dominance by a single taxon relative to Category 1; very tolerant taxa represent a small percentage of individuals, but noticeably increased from Category 1.
35–47	Category 2 (“healthy”)	“Poor”	Diverse assemblage with 30 different species found on average; several different taxa each of Ephemeroptera, Trichoptera, and long-lived and, on average, 5 unique clinger and 6 sensitive taxa routinely found; small increase in dominance by a single taxon relative to Category 1; very tolerant taxa represent a small percentage of individuals, but noticeably increased from Category 1.
0–34	Category 3 (“impaired”)	“Poor” or “Very Poor”	Note: any score of 35 and above is not impaired using the current interpretation categories. Notable loss of taxonomic diversity; Ephemeroptera, Trichoptera, long-lived, clinger, and sensitive taxa uncommon or rare; half the number of filterers than expected; assemblage dominated by a tolerant taxon; very tolerant individuals represent a large proportion of the individuals collected.

LT 7300. Lake Condition Index (LCI) Determination

1. DEFINITION: The LCI is a community based biological assessment of lake health using benthic macroinvertebrates sampled via 12 deployments of an Ekman or petite Ponar dredge, with organisms identified to the lowest practical taxonomic level.
2. SAMPLING
 - 2.1. Perform physical/chemical characterization according to FT 3001.
 - 2.2. Perform a habitat assessment according to FT 3200.
 - 2.3. Conduct dredge sampling according to FS 7460.
3. LABORATORY ANALYSES
 - 3.1. Prepare the sample according to LT 7200, section 3.1.
 - 3.2. Prepare slides according to LT 7200, section 3.2.
 - 3.3. Identify the organisms according to LT 7200, section 3.3.
4. DATA REDUCTION
 - 4.1. For DEP staff, enter all data into the Florida Statewide Biological Database.
 - 4.2. Follow the counting and collapsing procedures listed in LT 7100 section 4.2.1-4.2.3.
 - 4.2.1. Keep a record of the original taxa list and the resulting collapsed list.
5. INDEX CALCULATION
 - 5.1. Calculate and record the Shannon-Weaver Diversity Index (SWDI) score according to the following definition: *The Shannon-Weaver Diversity Index is the negative summation (from $i = 1$ to s) of $(n_i/N) \log_2 n_i/N$, where s is the number of species in a sample, N is the total number of individuals in a sample, and n_i is the total number of individuals in species.*
 - 5.2. Calculate and record the Hulbert Index (HI) score according to the list below.

$$\text{Hulbert Index} = (\# \text{ in Class A} \times 2) + \# \text{ in Class B}$$

Class A (2 points per taxon)

Hexagenia spp.
Ceratotina truncona (= *Polycentropus flavus*)
Orthotrichia spp.
Oxyethira spp.
Oecetis spp.
Palaemonetes paludosus
Chaoborus albatrus
Pagastiella spp.
Paralauterborniella nigrohalteralis
Pseudochironomus devinctus
Djalmabatista pulcher
Nilothauma spp.
Clinotanytus spp.
Stictochironomus devinctus
Cryptotendipes spp.
Ablabesmyia spp.

Class B (1 point per taxon)

Caenis spp.

Gammarus spp.
Hyalella azteca
Gomphus spp.
Aphylla williamsoni
Pachydiplax longipennis
Nectopsyche spp.
Byssanodonta cubensis (= *Eupera cubensis*)
Corbicula fluminea (= *C. manilensis*)
Unionidae
Campelema spp.
Procladius spp.
Polypedilum halterale group (= *P. digitifer*, *P. griseopunctatum*, *P. halterale*, and *P. simulans*)
Polypedilum illinoense group (= *P. illinoense*, *P. ophioides*, and several undescribed species)
Nimbecera pinderi (= *Tanytarsus limnetica*)
Einfeldia spp.

5.3. Calculate and record the solutions to formulae 5.3.1-5.3.6 below.

5.3.1. Taxa Score = $\text{MIN}(100, 100 \times \# \text{ Taxa} / 30.5)$

5.3.2. EOT (Ephemeroptera + Odonata + Trichoptera) Taxa Score = $\text{MIN}(100, 100 \times \# \text{ EOT Taxa} / 5.2)$

5.3.3. % EOT Score = $\text{MIN}(100, 100 \times \% \text{ EOT} / 34.4)$

5.3.4. % Diptera Score = $\text{MIN}(100, 100 \times (100 - \% \text{ Diptera}) / (100 - 13.6))$

5.3.5. SWDI Score = $\text{MIN}(100, 100 \times \text{SWDI} / 4.39)$

5.3.6. HI Score = $\text{MIN}(100, 100 \times \text{HI} / 17.4)$

5.4. Determine the LCI score by calculating the mean of the above six scores (5.3.1-5.3.6). Record the LCI score.

Appendix LT 7300
Tables, Figures and Forms

LT 7400. Algal Sensitivity Index Determination (*RESERVED*)

LT 7500. Lake Vegetation Index (LVI) Determination

1. **DEFINITION:** The LVI is a multimetric, community based biological assessment of lake health using aquatic plants. Macrophytes are identified to the lowest practical taxonomic level. The LVI procedure and calculations are described in "Fore, Leska S., Assessing the Biological Condition of Florida Lakes: Development of the Lake Vegetation Index (LVI), 2007."

2. SAMPLING

- 2.1. Perform physical/chemical characterization according to FT 3001.
- 2.2. Perform a lake habitat assessment according to FT 3200.
- 2.3. Conduct macrophyte survey according to FS 7310.

3. LABORATORY ANALYSES

- 3.1. Prepare unknowns for herbarium identification by an independent taxonomist or verification by a consulting botanist as voucher specimens.
- 3.2. Identify and record the correct names of the unknown specimens on the Lake Vegetation Index Data Sheet.
- 3.3. Follow quality assurance requirements addressed in FA 4330 and LQ 7310.

4. DATA REDUCTION

- 4.1. For DEP staff, enter all data into the Florida Statewide Biological Database.

5. INDEX CALCULATION

- 5.1. Calculate the % native taxa in a single sampling unit (pie slice) by dividing the number of native taxa by the total number of taxa in that sampling unit. Nativity status is determined by the Institute for Systematic Botany and is listed in Table 7500-1.
- 5.2. Calculate the % invasive taxa in a single sampling unit (pie slice) by adding the number of FLEPPC Category I and II taxa and then dividing by the total number of taxa in that sampling unit. Category I and II lists are maintained by FLEPPC, the Florida Exotic Pest Plant Council, and are listed in Table 7500-1.
- 5.3. Calculate the % sensitive taxa in a single sampling unit by summing the number of taxa with a C of C (Coefficient of Conservatism) score ≥ 7 and then dividing by the total number of taxa in that sampling unit. Refer to Table 7500-1 for a list of C of C scores.
- 5.4. Calculate the Dominant C of C for a single sampling unit by inserting the C of C for the dominant taxon or the average C of C for the 2 co-dominant taxa. If no dominant taxon was identified, this metric will be null, not zero. Refer to Table 7500-1 for a list of C of C scores.
- 5.5. Calculate the metrics according to the following table. If any result is less than zero, replace with zero, if a score is greater than 1, replace with 1. Make sure you use the correct equation for % sensitive taxa and dominant C of C, depending on the region in which the lake was located.

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Metric	5th %tile	95th %tile	Scoring rule
% Native taxa	54%	98%	$(x - 54)/44$
% Invasive taxa	0%	36%	$1 - (x/36)$
% Sensitive taxa			
North	0%	37%	$x/37$
South	0%	24%	$x/24$
Dominant C of C			
North	0	7.2	$x/7.2$
South	0	5.8	$x/5.8$

5.6. Average the results for the metrics within an individual sampling unit and multiply by 100. Note that you divide by 3 instead of 4 if the dominant (or co-dominant) C of C was not available. The result of this calculation must be between 0 and 100.

5.7. Average the LVI's determined for all the sampling units (four units are sampled) to calculate the final LVI score for the lake.

5.8. Evaluate the LVI according to the scoring system in the table below.

Aquatic life use category	LVI Range	Description
Category 1 "exceptional"	78–100	Nearly every macrophyte present is a species native to Florida, invasive taxa typically not found. About 30% of taxa present are identified as sensitive to disturbance and most taxa have C of C values >5.
Category 2 "healthy"	38–77	About 85% of macrophyte taxa are native to Florida; invasive taxa present. Sensitive taxa have declined to about 15% and C of C values average about 5.
Category 3 "impaired"	0–37	About 70% of macrophyte taxa are native to Florida. Invasive taxa may represent up to 1/3 of total taxa. Less than 10% of the taxa are sensitive and C of C values of most taxa are <4.

LT 7510. References

1. Fore, L. 2007. Assessing the Biological Condition of Florida Lakes: Development of the Lake Vegetation Index (LVI)
2. Institute for Systematic Botany website - <http://www.plantatlas.usf.edu/>
3. Florida Exotic Pest Plant Council website - <http://www.fleppc.org/>

Appendix LT 7500
Tables, Figures and Forms

Table 7500-1 Plant Attributes for LVI Calculation

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Table 7500-1 Plant Attributes for LVI Calculation

Scientific Name	C of C	Nativity	FLEPPC
Acalypha gracilens	3.29	Native	
Acer barbatum	7.7	Native	
Acer rubrum	4.65	Native	
Acer saccharinum	6.89	Native	
Acrostichum danaeifolium	5.79	Native	
Aeschynomene americana	2.47	Native	
Aeschynomene indica	0.49	Exotic	
Agalinis filifolia	6.69	Native	
Agalinis linifolia	7.04	Native	
Agalinis obtusifolia	6.5	Native	
Agarista populifolia	7.7	Native	
Albizia julibrissin	0	Exotic	Cat 1
Alternanthera philoxeroides	0	Exotic	Cat 2
Alternanthera sessilis	0.11	Exotic	
Alternanthera tenella	0	Exotic	
Amaranthus blitum	0	Exotic	
Amaranthus spinosus	0.04	Exotic	
Ambrosia artemisiifolia	0.95	Native	
Ammannia coccinea	5.06	Native	
Ammannia latifolia	4.55	Native	
Amorpha fruticosa	4.31	Native	
Ampelopsis arborea	3.25	Native	
Amphicarpum floridanum	5.7	Native	
Amphicarpum muhlenbergianum	5.7	Native	
Andropogon glomeratus	3.9	Native	
Andropogon gyrans stenophyllus	5	Native	
Andropogon liebmanii	6.13	Native	
Andropogon virginicus	3.44	Native	
Annona glabra	6.21	Native	
Apios americana	3.85	Native	
Aristida affinis	8.23	Native	
Aristida lanosa	8.73	Native	
Aristida palustris	8.54	Native	
Aristida patula	4.85	Native	
Aristida purpurascens	5.58	Native	
Aristida stricta	8.67	Native	
Aronia arbutifolia	5.2	Native	
Arundinaria gigantea	5.25	Native	
Arundo donax	0	Exotic	
Asclepias lanceolata	6.73	Native	
Aster carolinianus	3.93	Native	
Aster dumosus	2.53	Native	
Aster elliottii	6.76	Native	

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Table 7500-1 Plant Attributes for LVI Calculation

Scientific Name	C of C	Nativity	FLEPPC
Aster pilosus	2.38	Native	
Aster subulatus	5.74	Native	
Aster tortifolius	4.62	Native	
Axonopus affinis	1.89	Native	
Axonopus furcatus	2.12	Native	
Azolla caroliniana	1.81	Native	
Baccharis angustifolia	4.2	Native	
Baccharis glomeruliflora	6.12	Native	
Baccharis halimifolia	2.53	Native	
Bacopa caroliniana	5.31	Native	
Bacopa inominata	7.48	Native	
Bacopa monnieri	4.49	Native	
Bidens alba	1	Native	
Bidens laevis	7.19	Native	
Bidens mitis	6.31	Native	
Bidens pilosa	1.64	Exotic	
Bigelowia nudata	7.59	Native	
Blechnum serrulatum	7.15	Native	
Boehmeria cylindrica	5.91	Native	
Boltonia diffusa	4.96	Native	
Brachiaria mutica	0	Exotic	Cat 1
Brasenia schreberi	8.79	Native	
Burmannia capitata	8.13	Native	
Cabomba caroliniana	5.07	Native	
Callicarpa americana	3.2	Native	
Callistemon viminalis	0	Exotic	
Campsis radicans	2.53	Native	
Canna flaccida	6.75	Native	
Caperonia castaneifolia	4.94	Native	
Caperonia palustris	0.52	Exotic	
Cardamine pensylvanica	4.42	Native	
Carex alata	4.27	Native	
Carex albolutescens	3.47	Native	
Carex comosa	1.5	Native	
Carex fissa	3.9	Native	
Carex gigantea	5.07	Native	
Carex glaucescens	4.7	Native	
Carex longii	2.25	Native	
Carex lurida	4.29	Native	
Carex stipata	4.46	Native	
Carex verrucosa	7.97	Native	
Carex walteriana	4	Native	

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Table 7500-1 Plant Attributes for LVI Calculation

Scientific Name	C of C	Nativity	FLEPPC
Carphephorus odoratissimus	6.93	Native	
Carpinus caroliniana	6.5	Native	
Carya aquatica	6.64	Native	
Cassia	1.46	Unknown	
Cassytha filiformis	3.34	Native	
Casuarina equisetifolia	0	Exotic	Cat 1
Catalpa bignonioides	3.27	Native	
Celtis laevigata	5.08	Native	
Centella asiatica	1.92	Native	
Centella erecta	1.92	Native	
Cephalanthus occidentalis	6.99	Native	
Ceratophyllum demersum	4.16	Native	
Ceratopteris pteridoides	2.67	Native	
Ceratopteris thalictroides	2.93	Exotic	
Chamaecyparis thyoides	7.09	Native	
Chara	3.9	Native	
Chasmanthium laxum	7.37	Native	
Chenopodium album	0.78	Exotic	
Chenopodium ambrosioides	0.59	Exotic	
Chrysobalanus icaco	5.63	Native	
Chrysoma pauciflosculosa	4.4	Native	
Chrysopsis mariana	3.7	Native	
Cinnamomum camphora	0	Exotic	Cat 1
Cirsium nuttallii	3.08	Native	
Cladium jamaicense	9.04	Native	
Clethra alnifolia	5.63	Native	
Cliftonia monophylla	5.63	Native	
Coelorachis rugosa	8.91	Native	
Coelorachis tuberculosa	10	Native	
Colocasia esculenta	0	Exotic	Cat 1
Commelina	2	Unknown	
Commelina diffusa	2.02	Exotic	
Commelina erecta	2	Native	
Conoclinium coelestinum	4.37	Native	
Conyza canadensis	1.01	Native	
Coreopsis gladiata	4	Native	
Coreopsis leavenworthii	3.43	Native	
Coreopsis tinctoria	0.9	Native	
Cortaderia selloana	0	Exotic	
Crinum americanum	8.67	Native	
Crotalaria pallida	0	Exotic	
Crotalaria spectabilis	0	Exotic	
Cuphea carthagenensis	1.92	Exotic	
Cynodon dactylon	0.29	Exotic	

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Table 7500-1 Plant Attributes for LVI Calculation

Scientific Name	C of C	Nativity	FLEPPC
Cyperus alternifolius	0	Exotic	Cat 2
Cyperus articulatus	6.64	Native	
Cyperus brevifolius	1.42	Native	
Cyperus compressus	2.74	Native	
Cyperus croceus	1.3	Native	
Cyperus difformis	0	Exotic	
Cyperus distinctus	5	Native	
Cyperus erythrorhizos	2.89	Native	
Cyperus esculentus	0	Exotic	
Cyperus flavescens	2.17	Native	
Cyperus globulosus	1.3	Native	
Cyperus haspan	5.68	Native	
Cyperus involucratus	0	Exotic	Cat 2
Cyperus iria	1.69	Exotic	
Cyperus lanceolatus	2.04	Exotic	
Cyperus lecontei	2.33	Native	
Cyperus ligularis	1.55	Native	
Cyperus odoratus	4.25	Native	
Cyperus papyrus	0.31	Exotic	
Cyperus polystachyos	1.56	Native	
Cyperus prolifer	0	Exotic	Cat 2
Cyperus retrorsus	1.79	Native	
Cyperus rotundus	0	Exotic	
Cyperus strigosus	4.49	Native	
Cyperus surinamensis	2.03	Native	
Cyperus virens	5.7	Native	
Cyrtilla racemiflora	5.2	Native	
Decodon verticillatus	7.8	Native	
Desmodium triflorum	0.43	Exotic	
Dichanthelium commutatum	7.57	Native	
Dichanthelium erectifolium	7.39	Native	
Dichanthelium laxiflorum	6.79	Native	
Dichanthelium scabriusculum	7.15	Native	
Dichromena colorata	6.18	Native	
Dichromena latifolia	6.62	Native	
Digitaria bicornis	0	Exotic	
Digitaria ciliaris	1.3	Native	
Digitaria serotina	1.39	Native	
Diodia virginiana	4.96	Native	
Dioscorea bulbifera	0	Exotic	Cat 1
Diospyros virginiana	5.76	Native	
Drosera brevifolia	8.21	Native	
Drosera capillaris	7.09	Native	
Drosera filiformis	6.5	Native	
Drosera intermedia	8.23	Native	

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Table 7500-1 Plant Attributes for LVI Calculation

Scientific Name	C of C	Nativity	FLEPPC
Drymaria cordata	2.72	Native	
Dulichium arundinaceum	7.31	Native	
Echinochloa colona	0.24	Exotic	
Echinochloa crusgalli	0.22	Exotic	
Echinochloa muricata	6.01	Native	
Echinochloa walteri	3.36	Native	
Eclipta alba	3.22	Native	
Eclipta prostrata	3.22	Native	
Egeria densa	0.49	Exotic	
Eichhornia crassipes	0	Exotic	Cat 1
Eleocharis acicularis	3.4	Native	
Eleocharis atropurpurea	5.69	Native	
Eleocharis baldwinii	2.82	Native	
Eleocharis cellulosa	7.8	Native	
Eleocharis confervoides	4	Native	
Eleocharis elongata	6.97	Native	
Eleocharis equisetoides	9.1	Native	
Eleocharis flavescens	2.1	Native	
Eleocharis interstincta	7.8	Native	
Eleocharis melanocarpa	1.83	Native	
Eleocharis microcarpa	5.78	Native	
Eleocharis montana	3.17	Native	
Eleocharis montevidensis	5.2	Native	
Eleocharis olivacea	1.4	Native	
Eleocharis quadrangulata	2.5	Native	
Eleocharis robbinsii	8	Native	
Eleocharis vivipara	3.81	Native	
Elephantopus elatus	2.72	Native	
Eleusine indica	0	Exotic	
Eragrostis atrovirens	1.58	Exotic	
Eragrostis elliottii	4.14	Native	
Eragrostis spectabilis	3.44	Native	
Erechtites hieracifolia	1.37	Native	
Erechtites hieraciifolia	1.37	Native	
Erianthus giganteus	6.34	Native	
Erigeron quercifolius	3.31	Native	
Eriocaulon compressum	7.5	Native	
Eriocaulon decangulare	7.5	Native	
Eriocaulon lineare	6	Native	
Eriocaulon ravenelii	5.9	Native	
Eupatorium capillifolium	0.83	Native	
Eupatorium compositifolium	2.72	Native	
Eupatorium leptophyllum	4.94	Native	
Eupatorium mikanioides	5.08	Native	
Eupatorium mohrii	6.87	Native	
Eupatorium perfoliatum	5.85	Native	

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Table 7500-1 Plant Attributes for LVI Calculation

Scientific Name	C of C	Nativity	FLEPPC
Eupatorium recurvans	6.87	Native	
Eupatorium serotinum	3.43	Native	
Eustachys petraea	1.93	Native	
Euthamia caroliniana	3.25	Native	
Euthamia minor	1.64	Native	
Euthamia tenuifolia	3.25	Native	
Euthamia tenuifolia tenuifolia	3.25	Native	
Fatsia japonica	0	Exotic	
Ficus aurea	3.38	Native	
Ficus microcarpa	0	Exotic	Cat 1
Fimbristylis autumnalis	2.17	Native	
Fimbristylis castanea	4.92	Native	
Fimbristylis dichotoma	3.55	Native	
Fimbristylis miliacea	1.95	Exotic	
Fraxinus americana	5.27	Native	
Fraxinus caroliniana	5.21	Native	
Froelichia floridana	3.21	Native	
Fuirena breviseta	7.6	Native	
Fuirena pumila	5.92	Native	
Fuirena scirpoidea	6.5	Native	
Fuirena squarrosa	2.67	Native	
Galium pilosum	4.77	Native	
Galium tinctorium	5.08	Native	
Galium uniflorum	5.8	Native	
Gaylussacia dumosa	5.44	Native	
Gelsemium sempervirens	3.9	Native	
Gomphrena serrata	0.87	Exotic	
Gordonia lasianthus	9.03	Native	
Gratiola pilosa	6.63	Native	
Gratiola ramosa	6.87	Native	
Habenaria repens	4.58	Native	
Hedyotis corymbosa	2.31	Exotic	
Helianthus floridanus	5.85	Native	
Hibiscus coccineus	5.45	Native	
Hibiscus furcellatus	3.89	Native	
Hibiscus grandiflorus	6.86	Native	
Hieracium	5.2	Unknown	
Hydrilla verticillata	0	Exotic	Cat 1
Hydrochloa caroliniensis	4.79	Native	
Hydrocotyle	2	Native	
Hydrocotyle ranunculoides	2.75	Native	
Hydrocotyle umbellata	1.92	Native	
Hydrolea corymbosa	5.85	Native	
Hydrolea quadrivalvis	2	Native	

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Table 7500-1 Plant Attributes for LVI Calculation

Scientific Name	C of C	Nativity	FLEPPC
Hygrophila polysperma	0	Exotic	Cat 1
Hymenachne amplexicaulis	0	Exotic	Cat 1
Hypericum brachyphyllum	7.55	Native	
Hypericum chapmanii	5.8	Native	
Hypericum cistifolium	6.32	Native	
Hypericum fasciculatum	7.27	Native	
Hypericum gymnanthum	4.75	Native	
Hypericum hypericoides	5.44	Native	
Hypericum lissophloeus	7.56	Native	
Hypericum mutilum	4.04	Native	
Hypericum myrtifolium	6.56	Native	
Hypericum reductum	5	Native	
Hypericum tetrapetalum	6.38	Native	
Hypoxis	7.15	Native	
Hyptis alata	4.58	Native	
Ilex cassine	7.66	Native	
Ilex coriacea	3.1	Native	
Ilex glabra	5.85	Native	
Ilex myrtifolia	5.7	Native	
Ilex opaca	4.55	Native	
Ilex vomitoria	3	Native	
Imperata cylindrica	0	Exotic	Cat 1
Ipomoea aquatica	0	Exotic	Cat 1
Ipomoea carnea fistulosa	0	Exotic	Cat 2
Ipomoea indica	1.23	Native	
Ipomoea quamoclit	0.26	Exotic	
Ipomoea sagittata	6.42	Native	
Iris hexagona	6.97	Native	
Iris pseudacorus	0	Exotic	
Itea virginica	7.09	Native	
Iva frutescens	5.08	Native	
Iva microcephala	4.68	Native	
Juncus abortivus	2	Native	
Juncus acuminatus	2.25	Native	
Juncus coriaceus	8.51	Native	
Juncus effusus	3.25	Native	
Juncus elliotii	3.11	Native	
Juncus marginatus	3.65	Native	
Juncus megacephalus	5.7	Native	
Juncus polycephalus	4.96	Native	
Juncus repens	6.91	Native	
Juncus roemerianus	7.09	Native	
Juncus scirpoides	4.33	Native	
Juniperus siliciola	6.25	Native	
Juniperus virginiana	6.25	Native	

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Table 7500-1 Plant Attributes for LVI Calculation

Scientific Name	C of C	Nativity	FLEPPC
Justicia ovata	8.88	Native	
Kosteletzkya virginica	7.49	Native	
Kummerowia striata	0	Exotic	
Kyllinga brevifolia	1.42	Native	
Kyllinga pumila	1.38	Native	
Lachnanthes caroliana	3.76	Native	
Lachnocaulon anceps	7.15	Native	
Lachnocaulon beyrichianum	9.18	Native	
Lachnocaulon minus	7.97	Native	
Lechea cernua	8.67	Native	
Leersia hexandra	5.61	Native	
Lemna minor	3.77	Native	
Leptochloa fascicularis	4.55	Native	
Leucothoe racemosa	9.44	Native	
Ligustrum sinense	0	Exotic	Cat 1
Limnobium spongia	4.79	Native	
Limnophila sessiliflora	0	Exotic	Cat 2
Lindernia anagallidea	5.57	Native	
Lindernia crustacea	0.27	Exotic	
Lindernia grandiflora	3.6	Native	
Lipocarpha maculata	4.55	Native	
Liquidambar styraciflua	5.56	Native	
Lobelia glandulosa	6.03	Native	
Lobelia paludosa	8.08	Native	
Ludwigia alata	5.85	Native	
Ludwigia alternifolia	6.24	Native	
Ludwigia arcuata	5.32	Native	
Ludwigia decurrens	6.76	Native	
Ludwigia erecta	2.55	Native	
Ludwigia grandiflora	1.44	Exotic	
Ludwigia hexapetala	1.43	Exotic	
Ludwigia lanceolata	6.15	Native	
Ludwigia leptocarpa	3.47	Native	
Ludwigia linearis	5.72	Native	
Ludwigia linifolia	7.04	Native	
Ludwigia maritima	5.85	Native	
Ludwigia microcarpa	4.81	Native	
Ludwigia octovalvis	4.09	Native	
Ludwigia palustris	4.77	Native	
Ludwigia peploides	2.33	Native	
Ludwigia peruviana	0.62	Exotic	Cat 1
Ludwigia pilosa	6.99	Native	
Ludwigia repens	5.2	Native	
Ludwigia sphaerocarpa	2.5	Native	
Ludwigia suffruticosa	6.23	Native	

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Table 7500-1 Plant Attributes for LVI Calculation

Scientific Name	C of C	Nativity	FLEPPC
Ludwigia virgata	6.73	Native	
Luziola fluitans	4.79	Native	
Lycopodiella alopecuroides	5.27	Native	
Lycopodium alopecuroides	5.75	Native	
Lycopodium appressum	7.89	Native	
Lycopus americanus	3.17	Native	
Lycopus amplexans	2.88	Native	
Lycopus rubellus	6.75	Native	
Lycopus virginicus	3.67	Native	
Lygodium japonicum	0	Exotic	Cat 1
Lygodium microphyllum	0	Exotic	Cat 1
Lyonia ferruginea	8.39	Native	
Lyonia fruticosa	5.93	Native	
Lyonia ligustrina	8.67	Native	
Lyonia lucida	7.06	Native	
Lyonia mariana	4.8	Native	
Lythrum alatum	3.55	Native	
Lythrum lineare	3.82	Native	
Macroptilium lathyroides	0.41	Exotic	
Magnolia grandiflora	4.36	Native	
Magnolia virginiana	9.44	Native	
Mayaca fluviatilis	8.45	Native	
Melaleuca quinquenervia	0	Exotic	Cat 1
Melanthra nivea	6.07	Native	
Melia azedarach	0	Exotic	Cat 2
Melinis repens	0	Exotic	Cat 1
Melochia corchorifolia	2.24	Exotic	
Melothria pendula	3.31	Native	
Micranthemum glomeratum	5.85	Native	
Micranthemum umbrosum	5.66	Native	
Micromeria brownei	6.34	Native	
Mikania scandens	1.95	Native	
Mimosa pigra	0	Exotic	Cat 1
Mitchella repens	7.37	Native	
Mitreola petiolata	5.41	Native	
Mollugo verticillata	1.3	Exotic	
Muhlenbergia capillaris	5.43	Native	
Murdannia keisak	2.34	Exotic	
Murdannia nudiflora	1.42	Exotic	
Musa sapientum	0	Exotic	
Musa sapientum paradisiaca	0	Exotic	
Myrica cerifera	3.82	Native	
Myriophyllum aquaticum	0.98	Exotic	
Myriophyllum heterophyllum	4.77	Native	

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Table 7500-1 Plant Attributes for LVI Calculation

Scientific Name	C of C	Nativity	FLEPPC
Myriophyllum laxum	5.85	Native	
Myriophyllum pinnatum	5.85	Native	
Myriophyllum spicatum	0	Exotic	Cat 2
Najas filifolia	8.45	Native	
Najas gracillima	3	Native	
Najas guadalupensis	5.07	Native	
Najas marina	7.15	Native	
Najas minor	3.64	Exotic	
Nasturtium officinale	2.93	Exotic	
Nelumbo lutea	6.26	Native	
Nitella	7.28	Native	
Nuphar	4.64	Native	
Nuphar advena	4.64	Native	
Nymphaea mexicana	8.61	Native	
Nymphaea odorata	6.99	Native	
Nymphoides aquatica	6.09	Native	
Nyssa sylvatica biflora	9.04	Native	
Orontium aquaticum	8.39	Native	
Osmunda cinnamomea	6.44	Native	
Osmunda regalis	8.04	Native	
Ostrya virginiana	5.91	Native	
Oxalis corniculata	1.37	Native	
Oxypolis filiformis	8.69	Native	
Panicum abscissum	9.22	Native	
Panicum anceps	4.61	Native	
Panicum chamaelonche	7.69	Native	
Panicum dichotomiflorum	4.96	Native	
Panicum dichotomum	5.61	Native	
Panicum ensifolium	6.5	Native	
Panicum erectifolium	7.39	Native	
Panicum hemitomon	5.82	Native	
Panicum hians	6.63	Native	
Panicum maximum	0	Exotic	Cat 2
Panicum repens	0	Exotic	Cat 1
Panicum rigidulum	5.47	Native	
Panicum scabriusculum	7.15	Native	
Panicum spretum	6.63	Native	
Panicum tenerum	8.67	Native	
Panicum verrucosum	6.83	Native	
Panicum virgatum	5.44	Native	
Parthenocissus quinquefolia	3.43	Native	
Paspalidium geminatum	6.36	Native	
Paspalum acuminatum	1.06	Exotic	
Paspalum conjugatum	3.84	Exotic	
Paspalum dilatatum	4.33	Exotic	

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Table 7500-1 Plant Attributes for LVI Calculation

Scientific Name	C of C	Nativity	FLEPPC
Paspalum distichum	5.54	Native	
Paspalum floridanum	6.11	Native	
Paspalum laeve	5.79	Native	
Paspalum monostachyum	9.8	Native	
Paspalum notatum	0.14	Exotic	
Paspalum praecox	6.5	Native	
Paspalum repens	6.69	Native	
Paspalum setaceum	3.44	Native	
Paspalum urvillei	0	Exotic	
Passiflora incarnata	2.89	Native	
Peltandra	7.31	Native	
Peltandra virginica	7.31	Native	
Pennisetum	2.79	Exotic	
Pennisetum purpureum	0	Exotic	Cat 1
Persea borbonia	8.02	Native	
Persea borbonia humilis	7.43	Native	
Persea palustris	8.31	Native	
Phlebodium aureum	6.85	Native	
Phragmites australis	4.39	Exotic	
Phragmites communis	4.39	Exotic	
Phyla nodiflora	1.92	Native	
Phyllanthus urinaria	0.22	Exotic	
Physalis	2.04	Native	
Phytolacca americana	2.09	Native	
Pinus echinata	2.78	Native	
Pinus elliotii	4.21	Native	
Pinus glabra	5	Native	
Pinus palustris	4.77	Native	
Pinus taeda	5.34	Native	
Pistia stratiotes	0	Exotic	Cat 1
Platanus occidentalis	4.36	Native	
Pluchea camphorata	3	Native	
Pluchea foetida	6.65	Native	
Pluchea longifolia	5.85	Native	
Pluchea odorata	4.96	Native	
Pluchea rosea	5.45	Native	
Poinsettia cyathophora	1.57	Native	
Polygala cymosa	7.67	Native	
Polygala rugelii	8.17	Native	
Polygonella gracilis	4.77	Native	
Polygonum densiflorum	5.32	Native	
Polygonum hirsutum	8.17	Native	
Polygonum hydropiperoides	4.02	Native	
Polygonum lapathifolium	1.95	Exotic	

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Table 7500-1 Plant Attributes for LVI Calculation

Scientific Name	C of C	Nativity	FLEPPC
Polygonum meisnerianum	3	Native	
Polygonum meisnerianum beyrichianum	3	Native	
Polygonum punctatum	4.02	Native	
Polygonum virginianum	2.75	Native	
Polypogon monspeliensis	1	Exotic	
Polypremum procumbens	1.71	Native	
Pontederia cordata	5.38	Native	
Pontederia rotundifolia	0	Exotic	
Portulaca amilis	0.87	Exotic	
Potamogeton diversifolius	7.15	Native	
Potamogeton illinoensis	6.64	Native	
Potamogeton pectinatus	7.8	Native	
Potamogeton pusillus	7.8	Native	
Proserpinaca palustris	5.85	Native	
Proserpinaca pectinata	5.5	Native	
Prunus caroliniana	4.03	Native	
Prunus serotina	3.9	Native	
Psilocarya nitens	5.2	Native	
Psilocarya scirpoides	3.29	Native	
Pteridium aquilinum	3.9	Native	
Pteris tripartita	0.27	Exotic	
Ptilimnium capillaceum	2.73	Native	
Quercus laurifolia	5.14	Native	
Quercus nigra	4.14	Native	
Quercus virginiana	4.85	Native	
Rhexia alifanus	4.6	Native	
Rhexia cubensis	7.22	Native	
Rhexia mariana	5.5	Native	
Rhexia nashii	7.8	Native	
Rhexia nuttallii	7.93	Native	
Rhexia petiolata	7.9	Native	
Rhexia virginica	3.8	Native	
Rhodomyrtus tomentosa	0	Exotic	Cat 1
Rhus copallinum	3.65	Native	
Rhynchelytrum repens	0	Exotic	Cat 1
Rhynchospora baldwinii	6.44	Native	
Rhynchospora caduca	7.61	Native	
Rhynchospora cephalantha	6.19	Native	
Rhynchospora chalarocephala	1.88	Native	
Rhynchospora corniculata	4.43	Native	
Rhynchospora curtissii	3.75	Native	
Rhynchospora debilis	7.8	Native	
Rhynchospora divergens	5.53	Native	
Rhynchospora fascicularis	5.92	Native	

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Table 7500-1 Plant Attributes for LVI Calculation

Scientific Name	C of C	Nativity	FLEPPC
Rhynchospora fernaldii	4.77	Native	
Rhynchospora filifolia	8.13	Native	
Rhynchospora globularis	3.45	Native	
Rhynchospora inundata	7.25	Native	
Rhynchospora microcarpa	5.29	Native	
Rhynchospora microcephala	6.5	Native	
Rhynchospora nitens	5.2	Native	
Rhynchospora perplexa	5.2	Native	
Rhynchospora pleiantha	4.63	Native	
Rhynchospora pusilla	7.54	Native	
Rhynchospora rariflora	8.63	Native	
Rhynchospora scirpoides	5.43	Native	
Rhynchospora tracyi	9.03	Native	
Rhynchospora wrightiana	7.8	Native	
Ricciocarpus natans	1	Native	
Richardia scabra	0	Exotic	
Ricinus communis	0	Exotic	Cat 2
Rorippa nasturtium-aquaticum	2.93	Exotic	
Rorippa teres	4.2	Native	
Rosa palustris	6.01	Native	
Rubus argutus	3.56	Native	
Rubus cuneifolius	3.9	Native	
Rubus trivialis	2.6	Native	
Rumex	2.23	Unknown	
Rumex crispus	0	Exotic	
Ruppia maritima	7.24	Native	
Sabal palmetto	4.85	Native	
Sabatia brevifolia	7.8	Native	
Sabatia campanulata	4.4	Native	
Sabatia grandiflora	7.09	Native	
Saccharum giganteum	6.34	Native	
Sacciolepis indica	0.92	Exotic	
Sacciolepis striata	5.35	Native	
Sagittaria filiformis	6.76	Native	
Sagittaria graminea	5.53	Native	
Sagittaria isoetiformis	5.8	Native	
Sagittaria kurziana	9.75	Native	
Sagittaria lancifolia	4.96	Native	
Sagittaria latifolia	6.5	Native	
Sagittaria stagnorum	7.24	Native	
Sagittaria subulata	5	Native	
Salix babylonica	0	Exotic	
Salix caroliniana	2.95	Native	
Salix eriocephala	4	Native	
Salix floridana	9	Native	
Salvinia minima	2.03	Exotic	

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Table 7500-1 Plant Attributes for LVI Calculation

Scientific Name	C of C	Nativity	FLEPPC
Sambucus canadensis	1.48	Native	
Samolus	5.67	Native	
Sapium sebiferum	0	Exotic	Cat 1
Sarcostemma clausum	3.81	Native	
Saururus cernuus	7.33	Native	
Schinus terebinthifolius	0	Exotic	Cat 1
Schizachyrium scoparium	5.44	Native	
Schoenolirion albiflorum	9.1	Native	
Scirpus americanus	6.5	Native	
Scirpus californicus	6.01	Native	
Scirpus cubensis	3.77	Exotic	
Scirpus cyperinus	3.5	Native	
Scirpus pungens	4	Native	
Scirpus validus	5.55	Native	
Scleria baldwinii	8.67	Native	
Scleria georgiana	8.78	Native	
Scleria reticularis	6.79	Native	
Scleria triglomerata	6.74	Native	
Scoparia dulcis	2.36	Native	
Senna obtusifolia	1.01	Exotic	
Senna occidentalis	0.37	Exotic	
Serenoa repens	7.03	Native	
Sesbania drummondii	1.8	Native	
Sesbania herbacea	1.5	Native	
Sesbania punicea	0	Exotic	Cat 2
Sesbania vesicaria	1.44	Native	
Setaria geniculata	3.4	Native	
Setaria magna	3.25	Native	
Setaria parviflora	3.4	Native	
Sida rhombifolia	1.65	Native	
Smilax auriculata	3.96	Native	
Smilax bona-nox	3.78	Native	
Smilax glauca	2.7	Native	
Smilax laurifolia	4	Native	
Smilax pumila	6.01	Native	
Solanum americanum	1.16	Native	
Solanum carolinense	2.13	Native	
Solanum tampicense	0	Exotic	Cat 1
Solanum viarum	0	Exotic	Cat 1
Solidago canadensis	2.45	Native	
Solidago elliotii	2.57	Native	
Solidago fistulosa	4.49	Native	
Solidago latissimifolia	7.45	Native	

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Table 7500-1 Plant Attributes for LVI Calculation

Scientific Name	C of C	Nativity	FLEPPC
Solidago leavenworthii	2.73	Native	
Solidago sempervirens	4.36	Native	
Solidago stricta	5.49	Native	
Solidago tortifolia	6.96	Native	
Sorghastrum secundum	7.73	Native	
Sorghum bicolor	0.11	Exotic	
Sparganium americanum	6.5	Native	
Spartina alterniflora	7.94	Native	
Spartina bakeri	5.98	Native	
Spartina patens	5.23	Native	
Spermacoce assurgens	3.09	Native	
Sphagnum	7.43	Native	
Spilanthes americana	7.08	Native	
Spirodela polyrhiza	2.95	Native	
Spirodela punctata	0.25	Exotic	
Sporobolus domingensis	2.47	Native	
Sporobolus indicus	0.99	Exotic	
Steinchisma hians	6.63	Native	
Stenotaphrum secundatum	1.57	Native	
Stillingia aquatica	8.32	Native	
Stillingia sylvatica	7.3	Native	
Syngonanthus flavidulus	6.93	Native	
Syzygium cumini	0	Exotic	Cat 1
Taxodium	7.2	Native	
Taxodium ascendens	7.21	Native	
Taxodium distichum	7.21	Native	
Teucrium canadense	6.44	Native	
Thalia geniculata	7.12	Native	
Thelypteris dentata	1.62	Exotic	
Thelypteris interrupta	6.74	Native	
Thelypteris palustris pubescens	5.31	Native	
Thespesia populnea	0	Exotic	Cat 1
Tilia americana	5.55	Native	
Toxicodendron radicans	1.44	Native	
Toxicodendron vernix	6.64	Native	
Tradescantia zebrina	0	Exotic	
Triadenum virginicum	8.16	Native	
Triadenum walteri	7.92	Native	
Trifolium	1.49	Unknown	
Tripsacum dactyloides	6.03	Native	
Typha	0.8	Native	
Typha domingensis	0.59	Native	

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Table 7500-1 Plant Attributes for LVI Calculation

Scientific Name	C of C	Nativity	FLEPPC
Typha latifolia	1.6	Native	
Ulmus americana	7.68	Native	
Uniola paniculata	6.43	Native	
Urena lobata	0	Exotic	Cat 2
Utricularia biflora	6.37	Native	
Utricularia cornuta	7.46	Native	
Utricularia fibrosa	6.37	Native	
Utricularia floridana	6.34	Native	
Utricularia foliosa	6.44	Native	
Utricularia gibba	6.37	Native	
Utricularia inflata	5.85	Native	
Utricularia juncea	6.24	Native	
Utricularia obtusa	6.37	Native	
Utricularia olivacea	3.33	Native	
Utricularia purpurea	6.5	Native	
Utricularia radiata	6.01	Native	
Utricularia resupinata	5.46	Native	
Utricularia subulata	7.23	Native	
Vaccinium corymbosum	5.63	Native	
Vaccinium darrowii	7.15	Native	
Vaccinium elliotii	4	Native	
Vaccinium myrsinites	5.64	Native	
Vallisneria americana	6.99	Native	
Verbena bonariensis	0.56	Exotic	
Verbena brasiliensis	0.35	Exotic	
Viburnum nudum	5.55	Native	
Vigna luteola	2.31	Native	
Viola lanceolata	5.32	Native	
Viola primulifolia	6.11	Native	
Vitis aestivalis	2.48	Native	
Vitis rotundifolia	1.18	Native	
Websteria confervoides	4	Native	
Wedelia trilobata	0	Exotic	Cat 2
Wolffiella	4.37	Native	
Woodwardia areolata	7.68	Native	
Woodwardia virginica	6.5	Native	
Xanthosoma sagittifolium	0	Exotic	Cat 2
Xyris ambigua	6.43	Native	
Xyris baldwiniana	6.97	Native	
Xyris brevifolia	7.2	Native	
Xyris caroliniana	6.14	Native	
Xyris difformis	7.5	Native	
Xyris elliotii	6.69	Native	

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Table 7500-1 Plant Attributes for LVI Calculation

Scientific Name	C of C	Nativity	FLEPPC
Xyris fimbriata	7.08	Native	
Xyris flabelliformis	7.43	Native	
Xyris jupicai	3.51	Native	
Xyris platylepis	5.32	Native	
Xyris smalliana	7.8	Native	
Zingiber	0	Unknown	
Zizania aquatica	6.69	Native	
Zizaniopsis miliacea	6.21	Native	

LT 7600. Reserved

LT 7700. Reserved

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LT 7900. Taxonomic Effort for Freshwater Macroinvertebrate Identifications

The table below is intended to provide guidance on defining lowest practical taxonomic level for freshwater taxa. Identify organisms at least to this level unless specified by another method (e.g., the Biorecon procedure specifies a reduced taxonomic effort for worms, mites and midges). Recommended taxonomic references are available on the DEP Bureau of Laboratories website.

Table LT 7900-1

Phylum	Class	Order	Family	Genus	Species	ID Level
Annelida	Branchiobdellida					Order
Annelida	Hirudinea					Genus
Annelida	Hirudinea	Rhynchobdellida	Glossiphoniidae	Gloiobdella	elongata	Species
Annelida	Hirudinea	Rhynchobdellida	Glossiphoniidae	Helobdella		Species
Annelida	Oligochaeta					Species
Annelida	Oligochaeta	Tubificida	Naididae	Dero	digitata complex	Complex
Annelida	Oligochaeta	Tubificida	Naididae	Nais	communis complex	Complex
Arthropoda	Arachnida	Acariformes				Genus
Arthropoda	Arachnida	Oribatida				Order
Arthropoda	Hexapoda	Coleoptera				Genus
Arthropoda	Hexapoda	Coleoptera	Chelonariidae			Family
Arthropoda	Hexapoda	Coleoptera	Chrysomelidae			Family
Arthropoda	Hexapoda	Coleoptera	Curculionidae			Family
Arthropoda	Hexapoda	Coleoptera	Dryopidae			Family
Arthropoda	Hexapoda	Coleoptera	Elmidae			Genus
Arthropoda	Hexapoda	Coleoptera	Elmidae	Ancyronyx	variegatus	Species
Arthropoda	Hexapoda	Coleoptera	Elmidae	Dubiraphia	vittata	Species
Arthropoda	Hexapoda	Coleoptera	Elmidae	Gonielmis	dietrichi	Species
Arthropoda	Hexapoda	Coleoptera	Elmidae	Macronychus	glabratus	Species
Arthropoda	Hexapoda	Coleoptera	Elmidae	Microcylloepus	pusillus	Species
Arthropoda	Hexapoda	Coleoptera	Elmidae	Oulimnius	latiusculus	Species
Arthropoda	Hexapoda	Coleoptera	Elmidae	Promoresia		Species

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Phylum	Class	Order	Family	Genus	Species	ID Level
Arthropoda	Hexapoda	Coleoptera	Gyrinidae	Gyretes	iricolor	Species
Arthropoda	Hexapoda	Coleoptera	Hydrophilidae	Derallus	altus	Species
Arthropoda	Hexapoda	Coleoptera	Hydrophilidae	Dibolocelus	ovatus	Species
Arthropoda	Hexapoda	Coleoptera	Hydrophilidae	Helobata	lavalis	Species
Arthropoda	Hexapoda	Coleoptera	Hydrophilidae	Helobata	striata	Species
Arthropoda	Hexapoda	Coleoptera	Hydrophilidae	Hydrobiomorpha	castus	Species
Arthropoda	Hexapoda	Coleoptera	Hydrophilidae	Hydrobius	tumidus	Species
Arthropoda	Hexapoda	Coleoptera	Hydrophilidae	Sperchopsis	tessellatus	Species
Arthropoda	Hexapoda	Coleoptera	Noteridae	Suphis	inflatus	Species
Arthropoda	Hexapoda	Coleoptera	Staphylinidae			Family
Arthropoda	Hexapoda	Collembola				Order
Arthropoda	Hexapoda	Diptera				Genus
Arthropoda	Hexapoda	Diptera	Ceratopogonidae			Family
Arthropoda	Hexapoda	Diptera	Ceratopogonidae	Atrichopogon		Genus
Arthropoda	Hexapoda	Diptera	Ceratopogonidae	Dasyhelea		Genus
Arthropoda	Hexapoda	Diptera	Ceratopogonidae	Palpomyia/bezzia	grp.	Genus
Arthropoda	Hexapoda	Diptera	Chironomidae			Genus
Arthropoda	Hexapoda	Diptera	Chironomidae	Ablabesmyia		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Ablabesmyia	(Karelia) grp.	group
Arthropoda	Hexapoda	Diptera	Chironomidae	Ablabesmyia	rhamphe grp.	group
Arthropoda	Hexapoda	Diptera	Chironomidae	Alotanypus		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Antillocladius		Genus
Arthropoda	Hexapoda	Diptera	Chironomidae	Apedilum	elachista	Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Apsectrotanypus		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Brillia		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Conchapelopia	Thienemannimyia grp.	group
Arthropoda	Hexapoda	Diptera	Chironomidae	Cricotopus	bicinctus	Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Cricotopus	sylvestris grp.	group
Arthropoda	Hexapoda	Diptera	Chironomidae	Cricotopus	trifascia	Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Cricotopus or Orthocladius		Genus gr.
Arthropoda	Hexapoda	Diptera	Chironomidae	Demicryptochironomus		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Dicrotendipes		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Djalmabatista		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Einfeldia		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Endotribelos	hesperium	Species

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Phylum	Class	Order	Family	Genus	Species	ID Level
Arthropoda	Hexapoda	Diptera	Chironomidae	Eukiefferiella		group
Arthropoda	Hexapoda	Diptera	Chironomidae	Fittkauimyia		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Glyptotendipes	paripes	Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Goeldichironomus		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Guttipelopia		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Hayesomyia	Thienemannimyia grp.	group
Arthropoda	Hexapoda	Diptera	Chironomidae	Helopelopia	Thienemannimyia grp.	group
Arthropoda	Hexapoda	Diptera	Chironomidae	Heterotrissocladius		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Krenopelopia		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Labrundinia		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Larsia		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Lauterborniella		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Meropelopia	Thienemannimyia grp.	group
Arthropoda	Hexapoda	Diptera	Chironomidae	Microtendipes		group
Arthropoda	Hexapoda	Diptera	Chironomidae	Monopelopia		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Natarsia		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Nilotanytus		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Orthocladius		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Orthocladius		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Parachironomus		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Paracladopelma		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Parakiefferiella	coronata	Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Paralauterborniella		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Paratanytarsus	dissimilis	Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Paratendipes		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Pentaneura		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Phaenopsectra		Group
Arthropoda	Hexapoda	Diptera	Chironomidae	Polypedilum		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Psectrotanytus	dyari	Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Pseudochironomus		Genus
Arthropoda	Hexapoda	Diptera	Chironomidae	Rheocricotopus		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Rheopelopia	Thienemannimyia grp.	group
Arthropoda	Hexapoda	Diptera	Chironomidae	Rheotanytarsus	exiguus grp.	group
Arthropoda	Hexapoda	Diptera	Chironomidae	Robackia		Species

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Phylum	Class	Order	Family	Genus	Species	ID Level
Arthropoda	Hexapoda	Diptera	Chironomidae	Saetheria	sp.A	Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Stelechomyia		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Stempellinella		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Synorthocladius		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Tanypus		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Tanytarsus		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Thienemannimyia grp.		group
Arthropoda	Hexapoda	Diptera	Chironomidae	Tribelos		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Tvetenia		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Unniella		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Xenochironomus		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Xylotopus		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Zavreliella		Species
Arthropoda	Hexapoda	Diptera	Chironomidae	Zavreliomyia		Genus
Arthropoda	Hexapoda	Diptera	Corethrellidae			Genus
Arthropoda	Hexapoda	Diptera	Culicidae			Genus
Arthropoda	Hexapoda	Diptera	Dixidae			Genus
Arthropoda	Hexapoda	Diptera	Dolichopodidae			Family
Arthropoda	Hexapoda	Diptera	Empididae			Genus
Arthropoda	Hexapoda	Diptera	Ephydriidae			Family
Arthropoda	Hexapoda	Diptera	Muscidae			Family
Arthropoda	Hexapoda	Diptera	Psychodidae			Genus
Arthropoda	Hexapoda	Diptera	Ptychopteridae			Genus
Arthropoda	Hexapoda	Diptera	Sciaridae			Family
Arthropoda	Hexapoda	Diptera	Sciomyzidae			Family
Arthropoda	Hexapoda	Diptera	Simuliidae			Genus
Arthropoda	Hexapoda	Diptera	Stratiomyidae			Genus
Arthropoda	Hexapoda	Diptera	Tabanidae			Genus
Arthropoda	Hexapoda	Diptera	Thaumaleidae			Genus
Arthropoda	Hexapoda	Diptera	Tipulidae			Genus
Arthropoda	Hexapoda	Ephemeroptera				Species
Arthropoda	Hexapoda	Ephemeroptera	Caenidae			Genus
Arthropoda	Hexapoda	Ephemeroptera	Ephemerellidae			Genus
Arthropoda	Hexapoda	Ephemeroptera	Leptophlebiidae			Family/ Genus
Arthropoda	Hexapoda	Ephemeroptera	Ephemeridae	Hexagenia		Genus
Arthropoda	Hexapoda	Ephemeroptera	Heptageniidae			Species

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Phylum	Class	Order	Family	Genus	Species	ID Level
Arthropoda	Hexapoda	Ephemeroptera	Oligoneuriidae	Isonychia		Genus
Arthropoda	Hexapoda	Hemiptera	Hemiptera			Genus
Arthropoda	Hexapoda	Homoptera	Homoptera			Order
Arthropoda	Hexapoda	Hymenoptera				Order
Arthropoda	Hexapoda	Lepidoptera				Family
Arthropoda	Hexapoda	Megaloptera				Species
Arthropoda	Hexapoda	Odonata				Species
Arthropoda	Hexapoda	Odonata	Gomphidae			Genus
Arthropoda	Hexapoda	Odonata	Gomphidae	Hagenius	brevistylus	Species
Arthropoda	Hexapoda	Odonata	Libellulidae	Libellula		Genus
Arthropoda	Hexapoda	Odonata	Coenagrionidae			Genus
Arthropoda	Hexapoda	Odonata	Coenagrionidae	Argia	sedula	Species
Arthropoda	Hexapoda	Odonata	Coenagrionidae	Enallagma		Genus
Arthropoda	Hexapoda	Odonata	Coenagrionidae	Enallagma	cardenium	Species
Arthropoda	Hexapoda	Odonata	Coenagrionidae	Ischnura		Genus
Arthropoda	Hexapoda	Plecoptera	Plecoptera			Species
Arthropoda	Hexapoda	Plecoptera	Capniidae			Genus
Arthropoda	Hexapoda	Plecoptera	Leuctridae			Genus
Arthropoda	Hexapoda	Plecoptera	Nemouridae	Amphinemura		Genus
Arthropoda	Hexapoda	Plecoptera	Perlidae	Perlesta		Genus
Arthropoda	Hexapoda	Plecoptera	Perlodidae			Genus
Arthropoda	Hexapoda	Plecoptera	Perlodidae	Isoperla	orata	Species
Arthropoda	Hexapoda	Plecoptera	Perlodidae	Clioperla	clio	Species
Arthropoda	Hexapoda	Plecoptera	Taeniopterygidae			Genus
Arthropoda	Hexapoda	Trichoptera				Species
Arthropoda	Hexapoda	Trichoptera	Dipseudopsidae			Genus
Arthropoda	Hexapoda	Trichoptera	Hydropsychidae	Cheumatopsyche		Genus
Arthropoda	Hexapoda	Trichoptera	Hydropsychidae	Hydropsyche		Genus
Arthropoda	Hexapoda	Trichoptera	Hydroptilidae			Genus
Arthropoda	Hexapoda	Trichoptera	Lepidostomatidae			Genus
Arthropoda	Hexapoda	Trichoptera	Limnephilidae			Genus
Arthropoda	Hexapoda	Trichoptera	Limnephilidae	Ironoquia	punctatissima	Species
Arthropoda	Hexapoda	Trichoptera	Philopotamidae			Genus
Arthropoda	Hexapoda	Trichoptera	Polycentropodidae			Genus
Arthropoda	Malacostraca	Amphipoda				Genus
Arthropoda	Malacostraca	Amphipoda	Hyalellidae	Hyalella	azteca	Species

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LT 7000 Determination of Biological Indices

Phylum	Class	Order	Family	Genus	Species	ID Level
Arthropoda	Malacostraca	Amphipoda	Talitridae			Family
Arthropoda	Malacostraca	Decapoda				Genus
Arthropoda	Malacostraca	Decapoda	Atyidae			Family
Arthropoda	Malacostraca	Decapoda	Cambaridae			Genus
Arthropoda	Malacostraca	Decapoda	Palaemonidae			Genus
Arthropoda	Malacostraca	Isopoda	Asellidae			Genus
Arthropoda	Malacostraca	Isopoda	Munnidae			Family
Arthropoda	Malacostraca	Isopoda	Munnidae	Uromunna	reynoldsi	Species
Arthropoda	Malacostraca	Isopoda	Oniscidae			Family
Arthropoda	Malacostraca	Isopoda	Sphaeromatidae			Family
Arthropoda	Malacostraca	Mysidacea				Family
Cnidaria	Hydrozoa	Hydroida	Hydridae	Hydra		Genus
Ectoprocta	Phylactolaemata	Plumatellida	Plumatellidae	Plumatella		Genus
Ectoprocta		Ectoprocta	Ectoprocta			Phylum
Entoprocta		Loxosomatida	Urnatellidae	Urnatella		Genus
Mollusca	Bivalvia					Genus
	Bivalvia	Veneroida	Corbiculidae	Corbicula	fluminea	species
Mollusca	Gastropoda					Genus
Mollusca	Gastropoda	Basommatophora	Anclidae	Hebetancylus	excentricus	Species
Mollusca	Gastropoda	Basommatophora	Lymnaeidae			Family
Mollusca	Gastropoda	Basommatophora	Physidae			Genus
Mollusca	Gastropoda	Basommatophora	Planorbidae			Species
Mollusca	Gastropoda	Basommatophora	Planorbidae	Gyraulus		Species
Mollusca	Gastropoda	Mesogastropoda	Hydrobiidae			Genus
Mollusca	Gastropoda	Mesogastropoda	Hydrobiidae	Pyrgophorus	platyrachis	Species
Mollusca	Gastropoda	Mesogastropoda	Pilidae			Species
Mollusca	Gastropoda	Mesogastropoda	Pleuroceridae			Genus
Mollusca	Gastropoda	Mesogastropoda	Thiaridae			Species
Mollusca	Gastropoda	Mesogastropoda	Viviparidae			Genus
Mollusca	Gastropoda	Mesogastropoda	Viviparidae	Viviparus	georgianus	Species
Nemertea		Nemertea				Phylum
Nemertea		Hoplonemertea	Tetrastemmatidae	Prostoma		Genus
Platyhelminthes		Tricladida				Order
Porifera						Phylum

APPENDIX H – TABLE

TABLE 1
Sample Locations, Analytical Methods, Holding Times, Preservation, and Container Requirements
Vacant County Parcel - SWC SW 1st Street and SW 1st Avenue - Lake Butler, Union County, Florida

Parameter(s)	Method(s)	Sample IDs	Location	Sample Type/Depth	Number of Samples	QA/QC Sample	Container	Preservation		Holding Time	Sample Volume
								Temperature	Chemical		
Groundwater											
VOC	EPA 8260	MW-1 through MW-4	See Figure 4 in Appendix A	Groundwater at a depth between 5 and 15 BGS	8	1 duplicate, 1 rinsate, 1 field, 1 trip*	VOA Glass	4°C	HCl to pH <2	14 days	3 x 40 mL
SVOC	EPA 8270		See Figure 4 in Appendix A		6	1 duplicate, 1 rinsate	Amber Glass	4°C	None	7 days E / 40 days A	1 L
TRPH	FL PRO		See Figure 4 in Appendix A		6	1 duplicate, 1 rinsate	Amber Glass	4°C	HCl	7 days E / 40 days A	100 mL
Lead	EPA 6010		See Figure 4 in Appendix A		6	1 duplicate, 1 rinsate	Plastic or Glass	4°C	HNO ₃ to pH <2	28 Days	250 mL

Notes: Sample containers will be provided by Eurofins, Tampa, Florida
VOC - Volatile Organic Compounds
SVOC - Semi-Volatile Organic Compounds
TRPH - Total Recoverable Petroleum Hydrocarbons
Hold Time: E - Extraction, A - Analyze
* One trip blank per sample cooler will be provided by the laboratory
MW - Monitoring Well
SB - Soil Boring
BGS - Below Ground Surface
mL - milliliter, L - liter, oz - ounce, C - celcius, HCl -

**APPENDIX I – U.S. EPA REGION 4 BROWNFIELDS SITE-SPECIFIC QAPP
CHECKLIST**

USEPA REGION 4 BROWNFIELDS QAPP REVIEW CHECKLIST

QAPP Title: Site-Specific Quality Assurance Project Plan Addendum No. 2A for Phase II Environmental Site Assessment Activities at the West Main Street Property

Cooperative Agreement Recipient: Union County, Florida

Grant Number: BF-02D29322-0

QAPP Preparer: Jeff Ferretti / PPM Consultants, Inc. (PPM)

QAPP Date: October 15, 2024

Transmittal Date: October 15, 2024

DAO Reviewer: Ms. Alyssa Kuhn

*This is **not** an exhaustive list of requirements and is not intended as guidance for developing a QAPP. Refer to the Preparation of Quality Assurance Project Plans for EPA Brownfields Projects in the Southeast for comprehensive requirements.

**For DAOs, mark each element in the right-hand column with one of the following abbreviations:

P = Present & Acceptable; **NP** = Not Present; **I** = Incomplete; **NA** = Not Applicable

ELEMENT	Page Number & Paragraph	EPA Use
A1. Title and Approval Sheet	P. 1-2, Lines 1-79	
Title (Including CAR's name and revision #)	P. 1, Lines 1-6	
Grant Number	P. 1, Line 12	
Name of organization that prepared the QAPP	P. 1, Lines 23-28	
Dated signature of approving officials: printed names, titles, organizations, date, and signatures	P. 2, Lines 38-66	
Other signatures, as needed	N/A	
A2. Table of Contents	P. 3-4, Lines 80-136	
A3. Distribution List	P. 5-6, Lines 137-179	
A4. Project/Task Organization	P. 6-7, Lines 181-205	
Key individuals, technical disciplines, and responsibilities	P. 6, Lines 183-201. Section A4 of the Generic QAPP	
Organizational chart/table depicting lines of authority and reporting responsibilities	P. 7, Lines 204-205. Appendix A, Figure 1	
A5. Problem Definition/Background	P. 7-10, Lines 207-324	
Clearly state the problem or decision to be resolved	P. 7, Lines 209-228	
Provide historical and background information	P. 8-10, Lines 232-318	
A6. Project/Task Description	P. 10-12, Lines 326-401	
List measurements to be made	P. 11, Lines 342-364	
Cite applicable technical, regulatory, or program-specific quality standards, criteria, and/or objectives	P. 11-12, Lines 366-401	
Note special personnel or equipment requirements	P. 10, Line 348-349	
Provide work schedule	Appendix A, Figure 5	
Note required project and QA records/reports	N/A	
A7. Quality Objectives and Criteria for Measurement Data	P. 12-17, Lines 403-558	

ELEMENT	Page Number & Paragraph	EPA Use
State project objectives and limits, both qualitatively and quantitatively	P. 13-16, Lines 406-543	
State and characterize measurement quality objectives to applicable action levels or criteria	P. 17, Lines 546-558	
A8. Special Training /Certification	P. 17, Lines 560-573	
State trainings, date of trainings, expirations, and where applicable records are maintained	P. 17, Lines 562-573	
A9. Documentation and Records	P. 17, 575-588	
List information and records to be included for this project	Section A9 of the Generic QAPP	
State requested lab turnaround time	Section A9 of the Generic QAPP	
Give retention time and location for records and reports	Section A9 of the Generic QAPP	
B1. Sampling Process Design and Site Figures	P. 18, Lines 592-620	
Type and number of samples required	P. 18, Lines 599-604	
Sampling design and rationale	P. 18, Lines 599-604	
Sampling locations and frequency	P. 18, Lines 599-604	
Sample matrices	P. 18, Lines 601-603	
Classification of each measurement parameter as either critical or needed for information only	P. 18, Lines 616-620	
Describe/list SOPs used to characterize and dispose of IDW	NA	
B2. Sampling and Analytical Procedures	P. 18-20, Lines 622-670	
Describe the sampling methods and procedures or cite the specific SOPs to be used to guide the sample collection	P. 18-20, Lines 624-670	
Describe how problems (lost samples, broken equipment, etc.) will be resolved and documented	See Section B2 of Generic QAPP	
If SOPs are referenced, include a table listing all field sampling SOPs that will be used. Include the title of SOP, date, revision number and organization that wrote the SOP. Describe any modifications to the SOPs that are necessary for your project.	See Appendix G	
B3. Sample Handling and Custody	P. 20, Lines 672-676	
Sample handling requirements	P. 20, Lines 674-676, See Section B3 of Generic QAPP and Appendix E	
Chain-of-custody procedures	P. 20, Lines 674-6764, See Section B3 of Generic QAPP and Appendix E	
B4. Analytical Methods and Requirements	P. 20, Lines 678-684	

ELEMENT	Page Number & Paragraph	EPA Use
Identify the extraction, digestion, analytical methodologies to be followed	P. 20, Lines 680-684, See Section B2 of Generic QAPP and Appendix F	
Specify the turnaround time for hardcopy/electronic laboratory data deliverables	P. 20, Line 682, See Section B2 of Generic QAPP and Appendix F	
Provide the laboratory SOPs as appropriate	See Section B2 of Generic QAPP and Appendix F	
Identify the individual(s) responsible for overseeing the analysis and implementing corrective actions	See Appendix F	
B5. Field Quality Control Requirements	P. 20, Lines 686-691	
Design the field QC program that will be routinely performed, and provide a corresponding field sampling QC table in the QAPP	P. 20, Lines 688-691, and Appendix H	
Include field duplicate samples for each matrix and parameter, trip blanks for VOC samples, temperature blanks, and QA/QC samples as necessary	P. 20, Lines 689-691, and Appendix H	
B6. Laboratory Quality Control Requirements	P. 21, Lines 693-695	
Determine the laboratory QC data to be routinely included with the laboratory's data package, and provide a corresponding laboratory analytical QC table.	See Appendix E	
B7. Field Equipment Calibration and Corrective Action	P. 21, Lines 697-699	
If contained in SOPs, reference that appendix in this section of the QAPP. Otherwise, provide a field equipment calibration table for the types of field equipment routinely used	See Section B7 of Generic QAPP	
Discuss the corrective actions taken in the field when the control limits are not met	See Section B7 of Generic QAPP	
B8. Laboratory Equipment Calibration and Corrective Action	P. 21, Lines 701-703	
If contained in laboratory SOPs, reference that appendix in this section. Otherwise, provide a laboratory equipment calibration table for each analytical method	See Section B8 of Generic QAPP and Appendix E	
Note responsible individuals	See Section B8 of Generic QAPP	
B9. Analytical Sensitivity and Project Criteria	P. 21, Lines 705-710	
Provide an analytical method sensitivity and project criteria table for the analytical methods that will be routinely performed	See Appendix E	
If the laboratory provides only one analytical method limit, note in the table whether it is the MDL or the QL/RL that is being reported	See Section B9 of Generic QAPP and Appendix E	
B10. Data Management and Documentation	P. 21, Lines 712-716	

ELEMENT	Page Number & Paragraph	EPA Use
Describe standard record-keeping, data storage, and retrieval requirements for digital and hard copies of field data, laboratory data, and manipulated data; Include any checklists used for data management	See Section B10 of Generic QAPP	
Describe the control mechanism for detecting and correcting errors, and ensuring accuracy	See Section B10 of Generic QAPP	
Include the name, title, and organization of the person(s) responsible for these activities	See Section B10 of Generic QAPP	
C1. Assessments and Corrective Actions	P. 21, Lines 718-720	
Assessments/oversight that will be performed and frequency	See Section C1 of Generic QAPP	
The person(s) responsible for performing the assessments/oversight, and where the results will be documented	See Section C1 of Generic QAPP	
Identify who will receive the assessment/oversight report; who will be responsible for dealing with corrective actions; and follow up on assessments/oversight	See Section C1 of Generic QAPP	
C2. Project Reports	P. 21, Lines 722-724	
Identify the types of reports that will be routinely generated	See Section C2 of Generic QAPP	
Provide a detailed description of the contents of project final reports to establish expectations between report preparer and client	See Section C2 of Generic QAPP	
D1. Field Data Evaluation	P. 21, Lines 726-728	
Describe the final data evaluation process that will be routinely performed on the field data	See Section D1 of Generic QAPP	
Indicate how the results of the evaluation will be documented, and what will be presented the final report(s). Indicate the position(s) of the person(s) who will be performing the field data evaluation	See Section D1 of Generic QAPP	
D2. Laboratory Data Evaluation	P. 22, Lines 729-731	
Describe the final data evaluation process that will be routinely performed on the laboratory data	See Section D2 of Generic QAPP	
Perform a completeness check of the laboratory data package to ensure it is compliant with the requirements in the QAPP	See Section D2 of Generic QAPP	
Document the presence or absence of any problems with the data, and note any relevant sample data that may be impacted.	See Section D2 of Generic QAPP	
Evaluate the field QC sample results including data qualifiers for sample results	See Section D2 of Generic QAPP	
D3. Evaluating Data in Terms of User Needs	P. 22, Lines 733-740	
Describe the overall project evaluation process that will be routinely performed to determine the usability of the data, update the conceptual site model, and determine if the objectives of the project have been met	Appendix E	

ELEMENT	Page Number & Paragraph	EPA Use
Tabulate the field sample data together with the state/federal standards for presentation in the final report	See Section D3 of Generic QAPP	
Using the summary tables and graphical presentations, evaluate the usability of the individual field sample results at the parameter level. Document any limitations	See Section D3 of Generic QAPP	
Document observations, trends, anomalies, or data gaps that may exist. Evaluate how the results have impacted the conceptual site model, and if the objectives of the project have been met. Draw conclusions and recommendations from all the information	See Section D3 of Generic QAPP	

Final QAPP disposition:

___ *Approved, no comments*

___ *Approved with comments, resubmittal **not** required*

___ *Conditionally approved, comments must be addressed, resubmittal required*

___ *Not approved, comments must be addressed, resubmittal required*

References

EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5, March 2001, EPA/240/B-01/003,
Guidance for Quality Assurance Project Plans, EPA QA/G-5, December 2002, EPA/240/R-02/009
(Available from EPA's Website: <http://www.epa.gov/quality>)