

Superfund Records Center  
SITE: Industri-Plex  
BREAK: 2.7  
OTHER: 35268

**Toxicological Surface Water,  
Sediments Sampling and  
Fish Sampling Work Plan and  
Quality Assurance Project Plan  
For the Industri-Plex Site  
Woburn, Massachusetts**

***Prepared For:***

Industri-Plex Site  
Remedial Trust

***Prepared By:***

Menzie-Cura & Associates, Inc.  
One Courthouse Lane, Suite Two  
Chelmsford, Massachusetts 01824

July 7, 1999

**MENZIE • CURA & ASSOCIATES, INC.**

One Courthouse Lane, Suite Two • Chelmsford, Massachusetts 01824 • Phone 978/453-4300 Fax 978/453-7260

**Toxicological Surface Water,  
Sediments Sampling and  
Fish Sampling Work Plan and  
Quality Assurance Project Plan  
For the Industri-Plex Site  
Woburn, Massachusetts**

***Prepared For:***

Industri-Plex Site  
Remedial Trust

***Prepared By:***

Menzie-Cura & Associates, Inc.  
One Courthouse Lane, Suite Two  
Chelmsford, Massachusetts 01824

July 7, 1999

**MENZIE • CURA & ASSOCIATES, INC.**

One Courthouse Lane, Suite Two • Chelmsford, Massachusetts 01824 • Phone 978/453-4300 Fax 978/453-7260

**Toxicological Surface Water,  
Sediments Sampling and  
Fish Sampling Work Plan and  
Quality Assurance Project Plan  
For the Industri-Plex Site  
Woburn, Massachusetts**

***Prepared For:***

Industri-Plex Site  
Remedial Trust

***Prepared By:***

Menzie-Cura & Associates, Inc.  
One Courthouse Lane, Suite Two  
Chelmsford, Massachusetts 01824

July 7, 1999

**Final Quality Assurance Project Plan  
Industri-Plex Site  
Woburn, Massachusetts**

**Distribution List:**

- 1) Joseph F. LeMay, P.E.  
U.S. EPA, Region 1 - New England
- 2) Charles A. Menzie  
Menzie-Cura & Associates, Inc.
- 3) Susan D. Chapnick, M.S.  
New Environmental Horizons, Inc.
- 4) Bruce Yare  
Solutia, Inc.
- 5) Andy Beliveau  
U.S. EPA, Region 1
- 6) Patti Tyler  
U.S. EPA, Region 1
- 7) Ken Finkelstein  
U.S. EPA, Region 1 - New England/ NOAA
- 8) Ms. Anna Mayor  
MADEP - Bureau of Waste Sites Cleanup
- 9) Steve Mierzykowski  
U.S. Fish and Wildlife Service
- 10) Gordon Bullard  
TTNUS

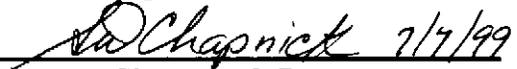
---

Signature & Date



---

Signature & Date



---

Signature & Date

---

Signature & Date

---

Signature & Date

---

Signature & Date

## TABLE OF CONTENTS

		<b>Sections</b>	<b>Pages</b>
<b>1.0</b>	<b>PROJECT DESCRIPTION</b>	<b>1</b>	<b>1</b>
1.1	Geographic Area	1	3
1.2	Past Data Collection Activity/Current Status	1	3
1.2.1	Phase 1 and Phase 2 Remedial Investigations	1	3
1.2.2	Ground-Water/Surface-Water Investigation Plan (GSIP) Phase 1 Remedial Investigation (RI)	1	4
1.2.3	Ground-Water/Surface-Water Investigation Plan (GSIP) Phase 2 Remedial Investigation (RI)	1	5
1.3	Project Objectives and Scope	1	5
1.3.1	The Ecological Reconnaissance Field Survey	1	6
1.3.2	The Main Sampling Program	1	7
1.3.3	Project Reporting Limits	1	8
<b>2.0</b>	<b>PROJECT ORGANIZATION AND RESPONSIBILITY</b>	<b>2</b>	<b>1</b>
<b>3.0</b>	<b>QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA</b>	<b>3</b>	<b>1</b>
3.1	Level of Quality Control Effort	3	2
3.1.1	Field Blanks	3	2
3.1.2	Method Blanks	3	2
3.1.3	Laboratory or Matrix Duplicates	3	2
3.1.4	Matrix Spikes and Matrix Spike Duplicates	3	3
3.1.5	Laboratory Control Sample/Standard Reference Material	3	3
3.1.6	Surrogate Spikes	3	4
3.1.7	Laboratory Calibration Check Samples	3	4
3.2	Precision	3	4
3.2.1	Field Precision Objectives	3	4
3.2.2	Laboratory Precision Objectives	3	4
3.3	Accuracy	3	5
3.3.1	Survey Results of Freeze-Drying Sedimentson Accuracy of Chemical Data	3	5
3.3.2	Field Accuracy Objectives	3	6
3.3.3	Laboratory Accuracy Objectives	3	7
3.4	Sensitivity - Reporting Limit Requirements	3	7

## TABLE OF CONTENTS

	<b>Sections</b>	<b>Pages</b>
3.5	Completeness	3 8
3.5.1	Field Completeness Objectives	3 8
3.5.2	Laboratory Completeness Objectives	3 8
3.6	Representativeness	3 9
3.6.1	Measures to Ensure Representativeness of Field Data	3 9
3.6.2	Measures to Ensure Representativeness of Laboratory Data	3 9
3.7	Comparability	3 9
3.7.1	Measures to Ensure Comparability of Field Data	3 9
3.7.2	Measures to Ensure Comparability of Laboratory Data	3 9
<b>4.0</b>	<b>ECOLOGICAL ASSESSMENT FIELD SAMPLING PLAN</b>	<b>4 1</b>
4.1	Study Area	4 1
4.2	Field Sampling Rationale and Sampling Locations	4 1
4.2.1	Reconnaissance Survey Objectives and Results	4 2
4.2.2	Main Sampling Program	4 3
4.2.3	Sample Locations	4 4
4.3	Surface Water Sampling	4 7
4.3.1	Water Sample Collection	4 7
4.3.2	Water Sample Analytes, Containers, and Shipment Requirements	4 8
4.3.3	Supporting Measurements for Surface Water Quality	4 8
4.4	Sediment Sampling	4 10
4.4.1	Sediment Sample Collection	4 10
4.4.2	Sediment Sample Analytes, Containers, and Shipment Requirements	4 12
4.5	Benthic Invertebrate Sample Collection	4 12
4.5.1	Benthic Invertebrate Collection for Tissue Analysis	4 12
4.5.2	Benthic Invertebrate Collection for Community Evaluation	4 18
4.5.3	Assessment of Habitat Conditions at Benthic Sampling Locations	4 18
4.6	Sediment Toxicity Tests	4 19

## TABLE OF CONTENTS

	<b>Sections</b>	<b>Pages</b>
4.7	Vegetation Sample Collection	4 20
4.7.1	Collection of Emergent Vegetation	4 20
4.7.2	Collection of Submergent Vegetation	4 21
4.8	Fish Sample Collection	4 22
4.8.1	Collection of Fish and Fish Habitat Assessment	4 23
4.8.2	Fish Collection for Tissue Analysis	4 24
<b>5.0</b>	<b>SAMPLE CUSTODY</b>	<b>5 1</b>
5.1	Field Chain of Custody Procedures	5 1
5.1.1	Field Procedures	5 1
5.1.2	Field Logbooks/Documentation	5 2
5.1.3	Transfer of Custody and Shipment Procedures	5 3
5.2	Laboratory Chain of Custody Procedures	5 4
5.3	Final Evidence Files Custody Procedures	5 4
<b>6.0</b>	<b>CALIBRATION PROCEDURES AND FREQUENCY</b>	<b>6 1</b>
6.1	Field Instruments/Equipment	6 1
6.2	Laboratory Instruments	6 1
<b>7.0</b>	<b>ANALYTICAL PROCEDURES</b>	<b>7 1</b>
7.1	Field Analytical Procedures	7 1
7.2	Laboratory Analytical Procedures	7 2
7.2.1	Sediment and Surface Water Methods	7 2
7.2.2	Biota Methods – Chemical Analysis of Benthic Invertebrates, Fish, and Vegetation	7 3
7.2.3	Biota Methods – Benthic Invertebrate Community Composition	7 4
7.2.4	Biota Methods – Fish Processing and Filleting	7 4
7.2.5	Sediment Toxicity Methods	7 4
<b>8.0</b>	<b>INTERNAL QUALITY CONTROL CHECKS</b>	<b>8 1</b>
8.1	Field Measurements	8 1
8.2	Laboratory Analysis	8 1
8.2.1	Calibration Criteria	8 1
8.2.2	Blanks	8 2

## TABLE OF CONTENTS

	<b>Sections</b>	<b>Pages</b>
8.2.3 Matrix Spikes and Matrix Spike Duplicates	8	3
8.2.4 Surrogate Spikes	8	3
8.2.5 Laboratory Control Samples and Standard Reference Material	8	3
8.2.6 Cleanup Check Samples	8	4
8.2.7 Laboratory Duplicates	8	4
8.2.8 Retention Time Window Determination	8	4
<b>9.0 DATA REDUCTION, VALIDATION, AND REPORTING</b>	<b>9</b>	<b>1</b>
9.1 Data Reduction	9	1
9.1.1 Field Data Reduction Procedures	9	1
9.1.2 Laboratory Data Reduction Procedures	9	1
9.2 Data Validation	9	2
9.2.1 Procedures Used to Validate Field Data	9	2
9.2.2 Procedures Used to Validate Laboratory Data	9	2
9.3 Data Reporting	9	3
9.3.1 Field Data Reporting	9	3
9.3.2 Laboratory Data Reporting	9	3
<b>10.0 PERFORMANCE AND SYSTEM AUDITS</b>	<b>10</b>	<b>1</b>
10.1 Field Performance and System Audits	10	1
10.1.1 Internal Field Audit Responsibilities, Frequency, and Procedures	10	1
10.1.2 External Field Audit Responsibilities, Frequency, and Procedures	10	1
10.2 Laboratory Performance and System Audits	10	2
10.2.1 Internal Laboratory Audit Responsibilities, Frequency, and Procedures	10	2
10.2.2 External Laboratory Audit Responsibilities, Frequency, and Procedures	10	2
<b>11.0 PREVENTIVE MAINTENANCE</b>	<b>11</b>	<b>1</b>
11.1 Field Instrument Preventative Maintenance	11	1
11.2 Laboratory Instrument Preventative Maintenance	11	1
11.2.1 Inductively Coupled Plasma Spectroscopy	11	1
11.2.2 Gas Chromatograph Instruments	11	2

## TABLE OF CONTENTS

	<b>Sections</b>	<b>Pages</b>
11.2.3	Thermometers	11 2
11.2.4	Analytical Balances	11 2
<b>12.0</b>	<b>SPECIFIC ROUTINE PROCEDURES TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS</b>	<b>12 1</b>
12.1	Precision Assessment	12 1
12.2	Accuracy Assessment	12 1
12.3	Completeness Assessment	12 2
12.4	Overall Assessment of Environmental Data	12 3
12.5	Reconciliation with Data Used to Assess Precision, Accuracy, Representativeness, Completeness, Comparability for Quality Objectives Measurement	12 4
<b>13.0</b>	<b>CORRECTIVE ACTIONS</b>	<b>13 1</b>
13.1	Field Sample Collection	13 1
13.2	Laboratory Analysis	13 2
<b>14.0</b>	<b>QUALITY ASSURANCE REPORTS TO MANAGEMENT</b>	<b>14 1</b>

## TABLE OF CONTENTS

### List of Tables

Table 1-1	Summary of Data Collection Activities from Three Previous Investigations at the Industri-Plex Site, Woburn, Massachusetts
Table 1-2	Analytical Parameters for Sediment Samples in Support of the Ecological and Human Health Risk Assessments
Table 1-3	Analytical Parameters for Surface Water Samples in Support of the Ecological and Human Health Risk Assessments
Table 1-4	Analytical Parameters for Biota Samples in Support of the Ecological and Human Health Risk Assessments
Table 1-5.	Semivolatile Organic Analytical Parameters and Reporting Limits in Support of the Ecological Risk Assessment
Table 1-6.	Volatile Organic Compound Analytical Parameters and Reporting Limits in Support of the Ecological Risk Assessment
Table 1-7.	Inorganic Analytical Parameters and Reporting Limits in Support of the Ecological Risk Assessment
Table 1-8.	Arsenic Speciation Analytical Parameters and Reporting Limits in Support of the Ecological Risk Assessment
Table 1-9.	Pesticide and PCB Aroclor Analytical Parameters and Reporting Limits in Support of the Ecological Risk Assessment
Table 1-10.	Acid Volatile Sulfides and Simultaneously Extracted Metals Analytical Parameters and Reporting Limits in Support of the Ecological Risk Assessment
Table 1-11a	Ecological Surface Water Risk-Based Concentrations (RBCs)
Table 1-11b	Ecological Sediment and Biota Risk-Based Concentrations (RBCs)
Table 1-12a	Human Health Risk-Based Concentrations (RBCs) for Sediment
Table 1-12b	Human Health Risk-Based Concentrations (RBCs) for Fish Tissue
Table 1-12c	Human Health Risk-Based Concentrations (RBCs) for Surface Water
Table 2-1	Project Team Members
Table 3-1a.	Analytical Laboratory Data Quality Objectives for Precision and Accuracy for Semivolatile Organic Compound Analyses of Surface Water Samples
Table 3-1b.	Analytical Laboratory Data Quality Objectives for Precision and Accuracy for Semivolatile Organic Compound Analyses of Sediment and Biota Samples
Table 3-2.	Analytical Laboratory Data Quality Objectives for Precision and Accuracy for Metals, AVS/SEM, and TOC Analyses
Table 3-3.	Analytical Laboratory Data Quality Objectives for Precision and Accuracy for Volatile Organic Compound Analyses
Table 3-4.	Analytical Laboratory Data Quality Objectives for Precision and Accuracy for Pesticide Analyses
Table 3-5.	Analytical Laboratory Data Quality Objectives for Precision and Accuracy for PCB Aroclor Analyses
Table 3-6.	Summary of QC Sample Types, Criteria, and Corrective Action
Table 4-1.	Locations of the 13 Sampling Stations for Surface Water and Sediment
Table 4-2	Surface Water Samples: Number, Preservation, Container Specification, and Holding Time Requirements in Support of the Environmental Assessment
Table 4-3	Sediment Samples: Number, Preservation, Container Specification, and Holding Time Requirements in Support of the Environmental Assessment

## TABLE OF CONTENTS

Table 4-4	Estimating Sample Size Requirements for Obtaining Sufficient Biomass for Tissue
Table 4-5	Benthic Tissue Analysis Samples: Analysis Number, Sample Preservation, Container Specification, and Holding Time Requirements in Support of the Environmental Assessment
Table 4-6	Samples for Analysis of; Benthic Invertebrate Composition and Abundance: Analysis Number, Sample Preservation, Container Specification, and Holding Time Requirements in Support of the Environmental Assessment
Table 4-7	Samples for Toxicity Tests: Number, Preservation, Container Specification, and Holding Time Requirements in Support of the Environmental Assessment
Table 4-8	Plant Tissue analysis Samples: Number, Preservation, Container Specification, and Holding Time Requirements in Support of the Environmental Assessment
Table 4-9	Fish Tissue Analysis Samples: Number, Preservation, Container Specification, and Holding Time Requirements in Support of the Environmental Assessment
Table 4-10.	Field and Trip Blanks: Preservation, Container Specification, and Holding Time Requirements in Support of the Environmental Assessment
Table 7-1	Field Measurement Methods and Reporting Limits
Table 7-2	Laboratory Methods of analysis of Samples in Support of the Environmental Assessment

## Figures

Figure 4-1	Location of Surface Water and Sediment Stations
Figure 5-1	Chain-of-Custody Record

## Appendices

### Appendix A Reconnaissance Survey

- A-1 Reconnaissance Sampling and Analysis Scheme
- A-2 Ecological Field Reconnaissance Survey and Observations and Pictures
- A-3 Summary of Environmental Reconnaissance Survey Results Chemical Results

### Appendix B Field Sampling and Measurement Standard Operating Procedures (SOPs)

- B-1 Decontamination of Field Equipment
- B-2 Surface Water Sampling
- B-3 Sampling Soft and Fine-Grained Surface Sediments for Chemical Analysis Using an Ekman Grab Sampler
- B-4 Collection of Benthic Macroinvertebrates with a Grab Sampler

## TABLE OF CONTENTS

### Appendices

- B-5 Collection of Epiphytic Invertebrates for Chemical Analysis of Tissue
  - B-5a Habitat Assessment Field Data Sheet
- B-6 Fish Capture Protocols
  - B-6a US Fish & Wildlife Service
  - B-6b Electrofishing
  - B-6c Fish Filleting
- B-7 Macrophyte Sampling
- B-8 Field Measurement SOPs
  - B-8a HE YSI 600XL Multi-Parameter Water Quality Monitor
  - B-8b YSI Incorporated, 600XL Multi-Parameter Water Quality Monitor, Instruction Manual
  - B-8c USEPA Region I Draft Calibration of Field Instruments
  - B-8d Horiba U-10 for Turbidity Measurements

### Appendix C Laboratory Procedures and Specific Analysis SOPs

- C-1 Freeze Drying - Woods Hole Group Environmental Laboratories
- C-2 Chemistry Laboratory-Specific Extraction and Cleanup SOPs for Sediment and Biota - Woods Hole Group Environmental Laboratories
  - C-2a Pressurized Fluid Extraction - Method 3545
  - C-2b Sulfur Cleanup Method - 3660B
  - C-2c Amino- Propyl Cleanup of Tissues and Sediments
  - C-2d GEL Permeation Chromatography (GPC)
  - C-2e Method 8082 – Polychlorinated Biphenyls (PCBs) as Aroclors by Gas Chromatography/Electron Capture Detection (GC/ECD)
  - C-2f Method 8081A – Organochlorine Pesticides by Gas Chromatography/Electron Capture Detection (GC/ECD)
  - C-2g Total Organic Carbon in Soil/Sediment Modified from EPA Method 9060
  - C-2h Determination of Arsenic Species in Water by Hydride Generation Cryogenic Trapping Gas Chromatography Atomic Absorption Spectrophotometry (FGS-022)

## TABLE OF CONTENTS

- C-2i Leaching of Inorganic Arsenic Species from Tissue Samples
- C-3 Sediment Toxicity Testing Protocols Includes 5 Laboratory SOPs From Aquatec Biological Sciences
  - C-3a Amphipod, *Hyaella azteca*, 10-Day Survival and Growth
  - C-3b Amphipod, *Hyaella azteca*, 42-Day Survival and Growth and Reproduction
  - C-3c Midge *Chironomus tentans*, 10-Day Survival and Growth
  - C-3d Midge *Chironomus tentans* Chronic Whole
  - C-3e Reference Toxicant Control Chart *Hyaella azteca* In Potassium Chloride (mg/L)
  - C-3f Reference Toxicant Control Chart *Chironomus tentans* In Potassium Chloride (g/L)
- C-4 Method for Laboratory Sorting and Identification of Macroinvertebrate Sample

## MAPPING OF INDUSTRI-PLEX QAPP ELEMENTS TO EPA QA/R-5 and QA/G-5 QAPP

INDUSTRI-PLEX QAPP ELEMENTS	EPA QA/R-5 and QA/G-5 QAPP ELEMENTS
Title Page with table for approval signatures	A1 Title and Approval Sheet
Distribution List	A3 Distribution List
Table of Contents (TOC)	A2 Table of Contents
1 Project Description	A5 Problem Definition/Background A6 Project/Task Description
2 Project Organization and Responsibility	A4 Project/Task Organization
3 Quality Assurance Objective for Measurement Data	A7 Quality Objectives and Criteria for Measurement Data
4 Ecological Assessment Field Sampling Plan	B1 Sampling Process Design B2 Sampling Methods Requirements
5 Sample Custody	A8 Special Training Requirement or Certification B3 Sample Handling and Custody Requirements
5.1.2 Field Logbooks/Documentation 5.3 Final Evidence File Custody Procedure 9.3 Data Reporting	A9 Documentation and Records
6 Calibration Procedures and Frequency	B7 Instrument Calibration and Frequency
7 Analytical Procedures	B4 Analytical Methods Requirements
8 Internal Quality Control Checks	B5 Quality Control Requirements
9 Data Reduction, Validation, and Reporting	D1 Data Review, Validation, and Verification Requirements D2 Validation and Verification Methods B9 Data Acquisition Requirements B10 Data Quality Management
10 Performance and System Audits	C1 Assessments and Response Actions
11 Preventative Maintenance	B6 Instrument/Equipment Testing, Procedures and Schedules Inspection, and Maintenance Requirements B8 Inspection/Acceptance Requirements for Supplies and Consumables
12 Specific Routine Procedures to Assess Data Precision, accuracy, and Completeness	D3 Reconciliation with Data Used to Assess PARCC for Quality Objectives Measurement
13 Corrective Actions	C1 Assessments and Response Actions
14 Quality Assurance Reports to Management	C2 Reports to Management

## 1.0 PROJECT DESCRIPTION

This "Toxicological Surface Water, Sediment, and Fish Sampling Work Plan and Quality Assurance Project Plan for the Industri-Plex Site, Woburn, Massachusetts" has been prepared as part of a planned sampling program for the Halls Brook Holding Area (HBHA) and other water bodies near the Industri-Plex Site (Site) in Woburn, Massachusetts. The purpose of this Work Plan/Quality Assurance Project Plan, termed "QAPP" throughout this document, is to ensure that all sample collection and data generation activities associated with Ecological and Human Health Risk Assessment Work Plans yield data that are of acceptable quality for their intended use. To eliminate the duplication of information, and for ease of review, the required components of the Field Sampling Plan have been incorporated into the QAPP in Section 4. This format was agreed upon with Joe LeMay, the Remedial Project Manager (RPM) for the U.S. Environmental Protection Agency (USEPA).

The purpose of the sampling and analysis activities, supported by this QAPP, is to fill data gaps of previous investigations and to augment existing data for use in the ecological and human health risk assessments. In particular, USEPA raised a number of questions related to the design, implementation, and interpretation of past ecological studies and the ecological risk assessment performed as part of the Ground-Water/Surface-Water Investigation Plan (GSIP) Phase 2 Remedial Investigation (RI). These questions led eventually to a request for additional work and this project. The project has evolved over the past several months through discussions with USEPA. However, the primary tasks to be accomplished were set forth by USEPA in Section 2.3.1 and 2.3.2 of the final Groundwater/Surface water Investigation Plan (GSIP) Statement of Work issued by the Agency on August 25, 1998. Sections 2.3.1 and 2.3.2 are included below:

*Section 2.3.1 Toxicological Surface Water and Sediment Sampling (extracted from USEPA August 25, 1998 letter)*

*EPA is requiring that comprehensive sediment and surface water toxicity data be collected for the site to properly assess ecological impacts related to site-related contaminated sediments and surface water. EPA's triad sediment sampling analysis approach shall be applied for each of the thirteen sediment samples collected from locations shown on Figure 5. Analytical parameters for sediment samples will be VOCs, metals, and SVOCs, as well as PCBs and pesticides. In addition, macro-invertebrate samples shall be collected at each of these sediment locations and analyzed qualitatively for species and quantitatively for contaminant concentrations. Qualitative analysis will identify type of organisms/species, and number of organisms/species at each of the 13 sediment sample locations. Quantitative benthic analysis will also be conducted at each of the 13 sediment sampling locations, and analyzed for metals at a experienced, certified laboratory. Acute and chronic toxicity testing will be performed on *Hyalella* and chironomids as the indicator species at each of the 13 sediment-sampling locations. A copy of the chronic toxicity Standard Operating Procedures for *Hyalella* is attached. The data collected will be applied to*

*human health and ecological risk assessments, and utilized in food chain models to evaluate the impact to the mallard duck.*

*Section 2.3.2 Fish Sampling (extracted from the USEPA's August 25, 1998 letter)*

*Additional fish samples shall be collected to further evaluate the impacts to fish from the site-related contaminants qualitatively and quantitatively. Previous fish sampling activities have illustrated a depleted fish population in the HBHA Pond. This depletion appears to be associated with the presence of site related contaminants in the HBHA Pond and contaminant plume discharges into the HBHA Pond. This additional sampling will be conducted in four ponds near the Site (two downgradient and two upgradient) and the data will be applied to the human health and ecological risk assessments. These Ponds are identified as North Pond, Phillips Pond, HBHA Pond, and HBHA Wetland pond 3 at Mishawum Road. See figure 5 for fish sampling locations.*

*The fish samples collected at the reference stations should reflect species collected at the downgradient ponds (HBHA Pond and HBHA Wetland Pond 3). Therefore, fish should be collected from the downgradient ponds first. All fish sampling activities shall comply with EPA's Guidelines for Fish Tissue Preparation and Analyses" (1995). If possible, a minimum of five fish from each of three trophic species (predator, forager, and bottom feeder) should be collected. The variety of species should be representative of different trophic levels. Prior to preparing the fish for tissue analysis, the fish will be examined for histological effects from potential contaminant exposure. The USFWS, with assistance from the Contractor, will collect the fish species, and assist in documenting qualitative fish observations (species; number of fish collected of each species; age; length; weight; visual observation, such as tumors, sores, lesions, etc; fish collecting technique; other environmental observations surrounding sampling area; etc.). Documentation will also include photographing the fish species. A log will be kept by the USFWS and the Contractor to document these observations. The Contractor shall quantitatively prepare the fish for laboratory analysis. The fish will be analyzed for tissue analysis as follows:*

- Small fish: analyze whole fish for metals*
- Medium fish: analyze offal and fillet for metals*
- Large fish: analyze target organs (liver and kidneys) for metals*

Some modifications of this scope have occurred through discussions with the USEPA and as a result of a Reconnaissance Survey conducted in April 1999 (see Section 4 and Appendix A). This work is being performed for the Industri-Plex Site Remedial Trust (ISRT) under the direction of USEPA Region I.

## **1.1 Geographic Area**

The study area (Figure 4-1) is located adjacent to the Industri-Plex Site, an industrial park in the northwest corner of Woburn, Massachusetts near the intersection of two major highways, Route 93 and Route 128. A number of streams and pond environments are located on and near the Site. Collectively these are part of the Aberjona River Watershed, a system that eventually drains to the Mystic River. One of the major aquatic features adjacent to the Site and the focus of this investigation is the Halls Brook Holding Area.

The Hall's Brook Holding Area (HBHA) is an 18.5-acre detention and storage facility designed to mitigate flooding. It was constructed in the early 1970s to replace flood storage lost by the filling of Lake Mishawum. The facility is comprised of a 4.2 surface-acre detention basin termed "the HBHA Pond" and a 14-acre downstream storage area comprised of wetlands, small ponds, and stream-like segments. This downstream area is referred to as "HBHA Wetlands." The pond/wetland complex traverses a total reach length of approximately 3,900 feet with a vertical drop of less than 1 foot. The flat hydraulic grade (less than 0.03 percent) was designed to maintain low flow velocities during high runoff events. The HBHA terminates at Mishawum Road where water flows through a weir to the Aberjona River.

There are three contributing tributaries to the HBHA. These include: 1) Hall's Brook, originating in the Town of Burlington to the west; 2) the Atlantic Avenue Drainway, discharging to the HBHA Pond from the north; and 3) a small unnamed tributary entering the HBHA Pond from the east, which generates streamflow only in response to precipitation events of sufficient intensity and/or duration. At its point of inflow to the HBHA Pond, Hall's Brook drains an area of 1.8 square miles or approximately 62 percent of the area draining to the pond.

## **1.2 Past Data Collection Activity/Current Status**

A summary of the data collection activities important to the ecological risk assessment that were previously performed at the Site is briefly discussed in this section and presented in Table 1-1. Two main investigations that generated data potentially useful to risk assessment activities were the Ground-Water/Surface-Water Investigation Plan Phase 1 Remedial Investigation (GSIP Phase 1 RI), performed 1990-1991 and the Ground-Water/Surface-Water Investigation Plan Phase 2 Remedial Investigation (GSIP Phase 2 RI), performed 1991-1992. In addition, a Supplemental Site Investigation was performed by ISRT in 1997; however, this investigation produced limited data.

### **1.2.1 Phase 1 and Phase 2 Remedial Investigations**

In 1983, the Phase 1 RI was completed by Roux Associates (Roux). The study defined the aerial extent of the waste deposits, determined the chemical composition of the waste, and measured concentrations of organic compounds and metals in the groundwater. The Phase 2 RI was a subsurface investigation conducted by Roux during 1983. The Phase 2 RI further

delineated the extent of inorganic and organic compounds at the Site. The movement of the benzene and toluene plume in groundwater was also identified.

### **1.2.2 Ground-Water/Surface-Water Investigation Plan (GSIP) Phase 1 Remedial Investigation (RI)**

The Ground-Water/Surface-Water Investigation Plan (GSIP) Phase 1 Remedial Investigation (RI) was performed from March 1990 to January 1991 by Roux. GSIP Phase 1 consisted of a groundwater investigation, a surface water/stream-sediment investigation, a metals mobility study, a human health evaluation, and an ecological evaluation.

The results of the GSIP Phase 1 groundwater investigation identified the presence of the following chemicals at elevated levels in groundwater: benzene (in the West Hide Pile and in the area just south of Atlantic Avenue), toluene (in an upgradient well north of trailer compound and in the area just south of Atlantic Avenue; dissolved arsenic (downgradient from the West Hide Pile, in the East-Central Hide Pile, and the South Hide Pile, with discharges of dissolved arsenic from the South Hide Pile into Hall's Brook Holding Area); and dissolved chromium (downgradient of the West Hide Pile and the East-Central Hide.)

The results of the GSIP Phase 1 stream-sediment sampling showed that chlorinated volatile organic compounds (VOCs), phthalates, and polyaromatic hydrocarbons (PAHs) were detected in sediment. Toluene was detected upstream of the Site and on-Site, but not downstream. Benzene was detected in pond sediments, downstream (HBHA), and on-Site (Lower South Pond), but not in stream sediments. Arsenic, chromium, and lead were detected upstream, on-Site, and downstream of the Site.

During the GSIP RIs, two arsenic/chromium plumes were identified. One plume migrated away from the East-Central Hide Pile. The other plume migrated downgradient from the West Hide Pile. The study revealed that the juxtaposition of anaerobically decaying hide residues, and metals-laden soils resulting from the placement of the hide piles in the late 1970s, created the conditions that allowed the formation of mobile metals.

The GSIP Phase 1 RI human health evaluation considered five exposure scenarios that applied to present and potential future use of the property. The GSIP Phase I RI ecological evaluation consisted of a field survey and an investigation of the floodplain and wetlands associated with the Aberjona River. The results showed that all stations showed signs of environmental stress. Depauperate communities of benthic macroinvertebrates within the HBHA were found, but may be associated with anoxic conditions in sediments. Internal and external examination of individual fish showed no gross abnormalities. The floodplain and wetland investigation concluded that the Lower South Pond, the HBHA, the unnamed pond near the Site Trailers, and an isolated wetland west of Commerce Way received environmentally acceptable scores for structural diversity, size, vegetative interspersion, and proximity to open water. The remaining wetlands received fair to poor scores.

### **1.2.3 Ground-Water/Surface-Water Investigation Plan (GSIP) Phase 2 Remedial Investigation (RI)**

The GSIP Phase 2 RI was performed from September 1991 through May 1992. The following were accomplished during the GSIP Phase 2 RI investigation:

- 1 groundwater flow conditions and ground water quality (specific emphasis on arsenic) were characterized at the selected areas of the site;
- 2 a metals mobility study in groundwater was performed through testing groundwater at 18 wells for arsenic, chromium, benzene and other geochemical parameters ;
- 3 additional surface water and sediment samples were collected and analyzed for VOCs, SVOCs, and total and dissolved metals to characterize the geochemical nature of the HBHA Pond; and
- 4 ecological risks associated with the surface water/sediment within the HBHA were evaluated through sediment toxicity bioassays, fish sampling survey and tissue analysis, and assessment of exposure and risk associated with contaminants-of-concern (COCs) to the mallard duck.

The USEPA raised a number of questions about the ecological risk assessment (in terms of design, implementation, and interpretation). These questions eventually led to the development of this Work Plan/QAPP.

### **1.3 Project Objectives and Scope**

The project objective is to gather additional data to fill data gaps and build on the existing data to evaluate the potential risk to public health and the environment from exposure to contaminants at the Industri-Plex Site and adjacent areas of the Aberjona River. This will be accomplished through the collection and analysis of representative environmental samples of surface water, sediment, fish, benthic invertebrates, and vegetation and through the evaluation of ecological habitats and sediment biotoxicity studies. The Field Sampling Plan (FSP), included in Section 4 of this QAPP, defines the type (media), number, and location of the samples that will be collected and describes the sampling protocols for this investigation. The Quality Assurance Project Plan (QAPP), which encompasses this entire document, defines the quality assurance objectives and procedures that will be implemented to generate data that are usable for both the ecological risk assessment (ERA) and the human health risk assessment (HHRA). Evaluation of the final usability of the data generated during this program will be based on USEPA Risk Assessment Guidance, USEPA Region I data validation guidelines, and technical judgment from regulatory and project personnel (see Section 9 and Appendix ?? for more detail on usability assessment).

The objectives of the ERA and the HHRA are described in detail the associated Site Work Plans. Briefly, the objectives of the risk assessments include:

- Identify chemicals of concern (COCs) at the Site.
- Identify potential exposure pathways of ecological and human health concern.

- Identify whether ecological and human health risks are likely to occur due to exposure to the Site COCs.

Sampling of Site sediments was previously performed in other investigations; however, the low percent solids (< 30%) of numerous samples resulted in data that did not meet risk assessment requirements for detection levels for pesticides and PCBs and were rejected (qualified "R" during data validation). In addition, the low percent solids levels resulted in high detection levels for other organic compounds that could be important at the site including PAHs and semi-volatile compounds. This QAPP/FSP defines the project-specific field collection and sample preparation procedures (i.e., freeze-drying) that will increase the percent solids of the samples prior to analysis. Based on the work performed during the Reconnaissance Survey (Appendix A), these procedures should generate data that meet the ecological and human health risk assessment requirements (risk-based concentrations, RBCs) for chemical detection levels as defined in Tables 1-11 and 1-12.

For this investigation the following samples will be collected from the Site study area:

- Sediment samples for chemical and physical analysis
- Surface water samples for chemical analysis
- Fish tissue samples for chemical analysis
- Collection of fish for observation of external abnormalities
- Benthic invertebrate tissue samples for chemical analysis
- Sediment samples for toxicity testing
- Benthic invertebrate samples for analysis of community structure
- Vegetation samples for chemical analysis

This investigation consists of two separate sampling events: 1) the Ecological Reconnaissance Field Survey (Survey) performed in April 1999 and 2) the Main Sampling program planned for June 1999.

### **1.3.1 The Ecological Reconnaissance Field Survey**

The Reconnaissance Field Survey (Survey) was performed on April 29-30, 1999. Details of the Survey activities are presented in Section 4.2.1 and Appendix A. Briefly, the objectives of the Survey were to:

1. Define sampling locations for the Main Sampling Program
  - select a downstream sampling location in the Aberjona River that exhibited depositional characteristics
  - visit potential Reference Locations and select locations appropriate for comparison to HBHA and HBHA downstream locations
2. Field-test sediment sample collection to determine what will be needed for the Main Sampling Program – logistics of field sampling

- Field-test various sediment sampling equipment
  - Field-test de-watering methods for sediment sample collection
3. Collect sediment samples in contaminated and reference locations for physical and chemical analyses
- Perform chemical laboratory analysis to evaluate modifications of analytical methods for project-specific needs, with emphasis on meeting project reporting limits (evaluate freeze-drying techniques and cleanup protocols)
  - Characterize the sediment (using percent solids, total organic carbon content, and grain size distribution data) to define the depositional areas planned for sampling during the Main Sampling Program
4. Perform a general habitat assessment through the qualitative evaluation of biological conditions and physical habitat structure
- Qualitatively evaluate the logistics and potential success for collection of benthic invertebrates for community structure needed to perform the ERA and tissue analysis for chemical parameters
  - Qualitatively evaluate the potential species for collection of emergent and submergent vegetation for tissue analysis of chemical parameters
  - Qualitatively evaluate collection of fish for ERA and tissue analysis

In addition to the above objectives, USEPA personnel collected sediment for the analysis of acid volatile sulfides and simultaneously extracted metals (AVS/SEM). Personnel from the US Fish and Wildlife Service (USFWS) and the National Oceanographic and Atmospheric Administration (NOAA) examined sites for electroshocker boat access and for use as fish Reference Locations.

The results of the Survey are presented in Appendix A and are discussed as needed to provide rationale for sampling and/or analytical methods presented in the FSP (Section 4). The sampling and analysis activities for the Main Sampling program were developed based on the observations made during the Survey and the results of the chemical and physical analyses of the Survey sediments.

### **1.3.2 The Main Sampling Program**

The Main Sampling program is scheduled for June 1999 and consists the following sampling and analysis activities:

- Collection of sediment samples at 13 locations for chemical and physical analyses for use in the Ecological Risk Assessment (ERA) and as part of the sediment triad approach.
- Collection of sediment samples at 13 locations for sediment toxicity tests for use in the ERA and as part of the sediment triad approach.
- Collection of benthic invertebrates at 13 locations for analysis of community structure for use in the ERA and as part of the sediment triad approach.

- Collection of benthic invertebrates for chemical analyses of tissues for use in the food chain models used in the ERA.
- Collection of surface water samples at 13 locations and two deep water locations for a total of 15 samples for chemical analysis for use in the ERA and to evaluate the source of arsenic (i.e., by examining speciation of arsenic). The sampling locations where the two deeper water samples will be collected is within the HBHA and the reference location of Phillips Pond.
- Collection of fish samples for chemical analysis for use in the ERA and for the Human Health Risk Assessment (HERA);
- Observations on the fish community and their habitat for use in the ERA and habitat assessment to evaluate recreational fishing as an exposure pathway in the HHRA.
- Collection of vegetation for chemical analysis for use in bird and mammal food chain models used in the ERA;

The chemical analytical data for benthic invertebrate tissue, fish tissue, and plant tissue will be used in the ERA in dietary exposure models for selected wildlife species. The approach for the ERA dietary exposure models is presented in the ERA Work Plan. Exposures associated with site-related chemicals will be quantified for the selected wildlife species. Predicted risks attributed to these exposures will then be determined for the selected wildlife species. The chemical analytical data will also be used in ingestion exposure models in the HHRA.

The type (media) of samples to be collected and the chemical analyses to be performed in support of the Main Sampling program for this Industri-Plex Site investigation are summarized in Tables 1-2 through 1-4. The sample locations are listed in Section 4, Table 4-1. The project reporting limits for the chemical and physical analyses for all media, surface water, sediment, and biota are listed in Tables 1-5 through 1-10. The risk-based concentrations (RBC) required for all chemicals being measured in surface water, sediment, and biota to support the Ecological Risk Assessment is presented in Table 1-11. The RBCs for all chemicals in support of the Human Health Risk Assessment is presented in Table 1-12.

### **1.3.3 Project Reporting Limits**

Project required reporting limits (RL) for all media were derived from searches of background concentrations and bioaccumulation information available in the scientific literature to support the Ecological Risk Assessment and Human Health Risk Assessment needs. This resulted in the development of the RBCs presented in Tables 1-11 and 1-12. Where information was not available for a specific chemical, the method and practical limits of quantitation for the specific chemical and media formed the basis for the project RL. Further details on the exposure pathways, endpoints, and development of the RBCs can be found in the associated ERA and HHRA Work Plans and footnotes to Tables 11 and 12. For HHRA, Drinking Water Standards were not included in the RBCs because there is no

complete drinking water pathway. Surface water RBCs for HHRA are based on USEPA National Recommended Water Quality Criteria (April 1999).

To meet some project RLs, the laboratory will need to report down to their method detection limits (MDLs) for some compounds. The laboratory reporting limits will be supported by a low-level standard in their calibration curves (for organic compounds), for all compounds for which they cannot achieve the project RLs. For those compounds that the laboratory reports down below their practical quantitation limits (PQLs), down to the MDLs, the results will be flagged with a "J" indicating an estimated value. This approach will generate the lowest level reporting, using the laboratory protocols and EPA methods described, to support the Ecological and Human Health Risk Assessment activities.

It is anticipated that this approach will achieve the required RBCs for the Ecological Risk Assessment as listed in Table 1-11. However, even using the approach of reporting down to the laboratory MDLs, the achievable levels of detection in some samples may not meet the RBCs for Human Health Risk Assessment as listed in Table 1-12.

To meet the needs of this program, field sampling personnel, the analytical laboratory, the data validator and the risk assessors (human health and ecological) will work together on a frequent and regular basis to ensure that the project RLs (or PQLs) are as low as feasible for the media being sampled and that sample analytical results will achieve RLs within the limits of the selected analytical methods. The usability of such data with higher RLs will be evaluated during the risk assessment activities. In general, one half of the sample-specific detection levels may be used in risk calculations as a conservative estimate for compounds that do not meet the project RLs.

**TABLE 1-1 Summary of Data Collection Activities from Previous Investigations at the Industri-Plex Site, Woburn, MA**

Activity	GSIP Phase 1 RI	GSIP Phase 2 RI
Floodplain and Wetland investigation	X	
Benthic Macroinvertebrate Community Survey	X	
Human Health Evaluation	X	
Metals Mobility Study	X	
Groundwater Investigation	X	X
Surface Water and Stream – Sediment Investigation	X	X
HBHA Pond Geochemical Investigation		X
Sediment Bioassays		X
Fish Sampling Survey	X	X
Assessment of Hazard to Wetland-dependent Birds		X
Groundwater Geochemistry (Source Area and Down-gradient)		
Soil Geochemistry (Source Area)		
Groundwater Modeling		
HBHA Pond (Surface Water and Sediment)		
HBHA Wetland (Surface Water and Sediment)		

Notes:

GSIP Phase 1 RI = Ground-Water/Surface-Water Investigation Plan Phase 1 Remedial Investigation, performed 1990-1991.  
 GSIP Phase 2 RI = Ground-Water/Surface-Water Investigation Plan Phase 2 Remedial Investigation, performed 1991-1992.

**Table 1-2 Analytical Parameters for Sediment Samples in Support of the Ecological and Human Health Risk Assessments <sup>1</sup>**

<b>Chemical Parameter</b>	<b>Project-Specific Preparation Methods</b>	<b>Analytical Method</b>
Volatile Organics	Method 5035 Modified low-level	EPA Method 8260B
Full Scan Semivolatile Organics	Freeze-drying	EPA Method 8270C
Pesticides	Freeze-drying	EPA Method 8081A
PCBs	Freeze-drying	EPA Method 8082
Metals – Total	Freeze-drying	EPA Methods 6010B and 7000 series
AVS/SEM	No Freeze-drying	EPA Draft Method
TOC	No Freeze-drying	EPA Method 9060 modified
Grain Size	No Freeze-drying	ASTM
Sediment Biototoxicity Testing	No Freeze-drying	Laboratory Method SOP

<sup>1</sup>This table is a general guide to the types of parameters that will be evaluated in each matrix. Complete tables of analyte lists, preservation techniques, and methods of analysis appear in subsequent tables of this QAPP.

**Table 1-3 Analytical Parameters for Surface Water Samples in Support of the Ecological and Human Health Risk Assessments <sup>1</sup>**

<b>Chemical Parameter</b>	<b>Analytical Method</b>
Volatile Organics	EPA Method 8260B
Full Scan Semivolatile Organics	EPA Method 8270C
Pesticides	EPA Method 8081A
PCBs	EPA Method 8082
Metals – Total (except arsenic)	EPA Method 6010B and 7000 series
Metals – Dissolved Filter upon receipt in Laboratory (0.45 µm pore size) (except arsenic)	EPA Method 6010B and 7000 series
Hardness	Calculation
TSS	EPA Method 160.2
Arsenic (III and V) Speciation <sup>2</sup>	Laboratory-modified EPA Method
TOC	EPA Method 9060 or 415.1
<u>Field Measurements:</u>  Temperature, pH, conductivity, dissolved oxygen, turbidity	YSI Meter SOP,  Field SOPs

<sup>1</sup> This table is a summary of the chemical testing that will be evaluated in each matrix. Complete tables of analyte lists, preservation techniques, and methods of analysis appear in subsequent tables of this QAPP.

<sup>2</sup> Arsenic speciation planned for two surface water locations only: HBHA and Phillips Pond Reference locations. Samples will be collected from surface and deep to evaluate vertical changes in arsenic species.

**Table 1-4 Analytical Parameters for Biota Samples in Support of the Ecological and Human Health Risk Assessments <sup>1</sup>**

Chemical Parameter	Analytical Method	Fish	Benthic Invertebrates	Vegetation
Polynuclear Aromatic Hydrocarbons	EPA Method 8270C-SIM	Store Frozen for possible future analysis	X	Store Frozen for possible future analysis
Pesticides	EPA Method 8081A	Store Frozen for possible future analysis	Store Frozen for possible future analysis <sup>2</sup>	NA
PCBs	EPA Method 8082	Store Frozen for possible future analysis	Store Frozen for possible future analysis <sup>2</sup>	NA
Percent Lipids <sup>3</sup>	EPA-600/4-81-055	Store Frozen for possible future analysis	NA	NA
Metals – Total	EPA Methods 6010B and 7000 series	X	X	X
Arsenic organic/inorganic Speciation	EPA Method 1632 and Lab SOP	X	NA <sup>2</sup>	NA

<sup>1</sup> This table is a general guide to the types of parameters that will be evaluated in each matrix. Complete tables of analyte lists, preservation techniques, and methods of analysis appear in subsequent tables of this QAPP.

<sup>2</sup> It may be difficult to obtain sufficient sample mass of benthic invertebrates to allquot a sample for freezing for future analyses. Additionally, arsenic speciation in benthic invertebrates is not planned due to the expected difficulty in obtaining sufficient sample volume to perform this analysis. For limited sample mass, priority will be given to metals analysis.

<sup>3</sup> Percent lipids will only be performed if organic analyses are performed.

**Table 1-5. Semivolatile Organic Analytical Parameters and Reporting Limits in Support of the Ecological Risk Assessment**

Analyte	CAS Number	Surface Water RL µg/L (ppb)	Sediment RL <sup>1</sup> µg/kg (ppb)	Sediment RL <sup>2</sup> µg/kg (ppb)	Biota RL <sup>3</sup> µg/kg (ppb)
Phenol	108-95-2	5	170	NA	NA
bis-(2-Chloroethyl)ether	111-44-4	5	170	NA	NA
2-Chlorophenol	95-57-8	5	170	NA	NA
1,3-Dichlorobenzene	541-73-1	5	170	NA	NA
1,4-Dichlorobenzene	106-46-7	5	170	NA	NA
1,2-Dichlorobenzene	95-50-1	5	170	NA	NA
2-Methylphenol	95-48-7	5	170	NA	NA
2,2'-oxybis(1-chloropropane)	108-60-1	5	170	NA	NA
4-Methylphenol	106-44-5	5	170	NA	NA
N-Nitroso-di-n-propylamine	621-64-7	5	170	NA	NA
Hexachloroethane	67-72-1	5	170	NA	NA
Nitrobenzene	98-95-3	5	170	NA	NA
Isophorone	78-59-1	5	170	NA	NA
2-Nitrophenol	88-75-5	5	170	NA	NA
2,4-Dimethylphenol	105-67-9	5	170	NA	NA
bis-(2-Chloroethoxy)methane	111-91-1	5	170	NA	NA
2,4-Dichlorophenol	120-83-2	5	170	NA	NA
1,2,4-Trichlorobenzene	120-82-1	5	170	NA	NA
Naphthalene	91-20-3	5	170	1	1
4-Chloroaniline	106-47-8	5	170	NA	NA
Hexachlorobutadiene	87-68-3	5	170	NA	NA
4-Chloro-3-methylphenol	59-50-7	5	170	NA	NA
2-Methylnaphthalene	91-57-6	5	170	1	1
Hexachlorocyclopentadiene	77-47-4	5	170	NA	NA
2,4,6-Trichlorophenol	88-06-2	5	170	NA	NA
2,4,5-Trichlorophenol	95-95-4	12	420	NA	NA
2-Chloronaphthalene	91-58-7	5	170	NA	NA
2-Nitroaniline	88-74-4	12	420	NA	NA
Dimethylphthalate	131-11-3	5	170	NA	NA
Acenaphthylene	208-96-8	5	170	1	1
2,6-Dinitrotoluene	606-20-2	12	420	NA	NA
3-Nitroaniline	99-09-2	5	170	NA	NA

<sup>1</sup> Sediments must be reported on a dry-weight basis. The project reporting limits (RLs) are nominal limits assuming 100% solids using Method 8270C in the EI mode of operation (full scan mode). Sample-specific RLs will vary based on the % solids of the sediment sample.

<sup>2</sup> Sediments must be reported on a dry-weight basis. The project reporting limits (RLs) are nominal limits assuming 100% solids using Method 8270C in the SIM mode of operation. Sample-specific RLs will vary based on the % solids of the sediment sample.

<sup>3</sup> Biota results must be reported on a wet-weight basis. Percent solids will not be performed on tissue sample. The project reporting limits (RLs) are nominal limits using Method 8270C in the SIM mode of operation.

**Table 1-5. Semivolatile Organic Analytical Parameters and Reporting Limits in Support of the Ecological Risk Assessment (continued)**

Analyte	CAS Number	Surface Water RL µg/L (ppb)	Sediment RL <sup>1</sup> µg/kg (ppb)	Sediment RL <sup>2</sup> µg/kg (ppb)	Biota RL <sup>3</sup> µg/kg (ppb)
Acenaphthene	83-32-9	5	170	1	1
2,4-Dinitrophenol	51-28-5	12	420	NA	NA
4-Nitrophenol	100-02-7	12	420	NA	NA
Dibenzofuran	132-64-9	5	170	NA	NA
2,4-Dinitrotoluene	121-14-2	5	170	NA	NA
Diethyl phthalate	84-86-2	5	170	NA	NA
4-Chlorophenyl phenyl ether	7005-72-3	5	170	NA	NA
Fluorene	86-73-7	5	170	1	1
4-Nitroaniline	100-01-6	12	420	NA	NA
4,6-Dinitro-2-methylphenol	534-52-1	12	420	NA	NA
N-Nitrosodiphenylamine	86-30-6	5	170	NA	NA
4-Bromophenyl phenyl ether	101-55-3	5	170	NA	NA
Hexachlorobenzene	118-74-1	5	170	NA	NA
Pentachlorophenol	87-86-5	12	420	NA	NA
Phenanthrene	85-01-8	5	170	1	1
Anthracene	120-12-7	5	170	1	1
Carbazole	86-74-8	5	170	NA	NA
Di-n-butylphthalate	84-74-2	5	170	NA	NA
Fluoranthene	206-44-0	5	170	1	1
Pyrene	129-00-0	5	170	1	1
Butylbenzylphthalate	85-68-7	5	170	NA	NA
3,3'-Dichlorobenzidine	91-94-1	5	170	NA	NA
Benzo(a)anthracene	56-55-3	5	170	1	1
Chrysene	218-01-9	5	170	1	1
bis-(2-Ethylhexyl)phthalate	117-81-7	5	170	NA	NA
Di-n-octylphthalate	117-84-0	5	170	NA	NA
Benzo(b)fluoranthene	205-99-2	5	170	1	1
Benzo(k)fluoranthene	207-08-9	5	170	1	1
Benzo(a)pyrene	50-32-8	5	170	1	1
Indeno (1,2,3-cd) pyrene	193-39-5	5	170	1	1
Dibenzo(a,h)anthracene	53-70-3	5	170	1	1
Benzo(g,h,i)perylene	191-24-2	5	170	1	1

<sup>1</sup> Sediments must be reported on a dry-weight basis. The project reporting limits (RLs) are nominal limits assuming 100% solids using Method 8270C in the EI mode of operation (full scan mode). Sample-specific RLs will vary based on the % solids of the sediment sample.

<sup>2</sup> Sediments must be reported on a dry-weight basis. The project reporting limits (RLs) are nominal limits assuming 100% solids using Method 8270C in the SIM mode of operation. Sample-specific RLs will vary based on the % solids of the sediment sample.

<sup>3</sup> Biota results must be reported on a wet-weight basis. Percent solids will not be performed on tissue sample. The project reporting limits (RLs) are nominal limits using Method 8270C in the SIM mode of operation.

**Table 1-6. Volatile Organic Compound Analytical Parameters and Reporting Limits in Support of the Ecological Risk Assessment**

Analyte	CAS Number	Surface Water RL µg/L (ppb)	Sediment RL <sup>1</sup> µg/kg (ppb)
Chloromethane	74-87-3	2	2
Bromomethane	74-83-9	2	2
Vinyl Chloride	75-01-4	2	2
Chloroethane	75-00-3	2	2
Methylene Chloride	75-09-2	2	2
Acetone	67-64-1	2	2
Carbon Disulfide	75-15-0	2	2
1,1-Dichloroethene	75-35-4	2	2
1,1-Dichloroethane	75-34-3	2	2
cis-1,2-Dichloroethene	156-59-4	2	2
Trans-1,2-Dichloroethene	156-60-5	2	2
Chloroform	67-66-3	2	2
1,2-Dichloroethane	107-06-2	2	2
2-Butanone	78-93-3	2	2
1,1,1-Trichloroethane	71-55-6	2	2
Carbon Tetrachloride	56-23-5	2	2
Bromodichloromethane	75-27-4	2	2
1,2-Dichloropropane	78-87-5	2	2
cis-1,3-Dichloropropene	10061-01-5	2	2
Trichloroethene	79-01-6	2	2
Dibromochloromethane	124-48-1	2	2
1,1,2-Trichloroethane	79-00-5	2	2
Benzene	71-43-2	2	2
Trans-1,3-Dichloropropene	10061-02-6	2	2
Bromoform	75-25-2	2	2
4-Methyl-2-pentanone	108-10-1	2	2
2-Hexanone	591-78-6	2	2
Tetrachloroethene	127-18-4	2	2
1,1,2,2-Tetrachloroethane	79-34-5	2	2
Toluene	108-88-3	2	2
Chlorobenzene	108-90-7	2	2
Ethyl Benzene	100-41-4	2	2
Styrene	100-42-5	2	2
m/p-Xylene		2	2
Xylenes (total)	1330-20-7	2	2

<sup>1</sup> Sediments must be reported on a dry-weight basis. The project reporting limits (RLs) are nominal limits assuming 100% solids. Sample-specific RLs will vary based on the % solids of the sediment sample. The reporting limit for sediments is dependent upon the sample preservation technique used. Low-level Method 5035 is planned; RL = 2 (g/kg). If High-level preservation is used for any samples, the RL would be in 100 (g/kg RL).

**Table 1-7. Inorganic Analytical Parameters and Reporting Limits in Support of the Ecological Risk Assessment**

Analyte	CAS Number	Surface Water RL <sup>1</sup> µg/L (ppb)	Sediment RL <sup>2</sup> mg/kg (ppm)	Biota RL <sup>3</sup> mg/kg (ppm)
Aluminum	7429-90-5	50	10	10
Antimony	7440-36-0	100	0.5 <sup>4</sup>	0.5 <sup>4</sup>
Arsenic <sup>5</sup>	7440-38-2	0.01	0.1	0.1 <sup>4</sup>
Barium	7440-39-3	6.3 <sup>4</sup>	10	10
Beryllium	7440-41-7	4 <sup>4</sup>	1	1
Cadmium	7440-43-9	1	0.5	0.5
Calcium	7440-70-2	500	NA	NA
Chromium	7440-47-3	10	1	1
Cobalt	7440-48-4	3.6 <sup>4</sup>	10	10
Copper	7440-50-8	2	10	10
Iron	7489-89-6	100	10	10
Lead	7439-92-1	1 <sup>4</sup>	100	1
Magnesium	7439-95-4	500	NA	NA
Manganese	7439-96-5	50	10	10
Mercury	7439-97-6	0.2	0.1	0.1
Nickel	7440-02-0	10	10	10
Selenium	7782-49-2	2	0.5	0.5
Silver	7440-22-4	2	0.5	0.5
Thallium	7440-28-0	20	2	2
Vanadium	7440-62-2	15	0.5 <sup>4</sup>	0.5 <sup>4</sup>
Zinc	7440-66-6	10	2	2
Hardness	NA	Calculation <sup>6</sup>	NA	NA
TOC	NA	1000	100	NA
TSS	NA	2000	NA	NA

<sup>1</sup> Surface water reporting limits were based on ecological RBCs.

<sup>2</sup> Sediments must be reported on a dry-weight basis. The project reporting limits (RLs) are nominal limits assuming 100% solids. Sample-specific RLs will vary based on the % solids of the sediment sample.

<sup>3</sup> Biota results must be reported on a wet-weight basis.

<sup>4</sup> Increased initial weight of sediment or tissue and/or reporting down to the MDLs may be required to achieve the low-level project RLs defined to meet ecological and human health RBCs.

<sup>5</sup> See also arsenic speciation detection limit requirements in following table.

<sup>6</sup> Hardness will be calculated from the calcium and magnesium results in surface water.

NA = Not applicable

**Table 1-8. Arsenic Speciation Analytical Parameters and Reporting Limits in Support of the Ecological Risk Assessment**

Analyte	CAS Number	Surface Water RL µg/L (ppb)	Sediment RL <sup>1</sup> mg/kg (ppm)	Biota RL <sup>2</sup> mg/kg (ppm)
Arsenic (Total)	7440-38-2	0.01	0.1	0.1
Arsenic (III)	-	0.01	NA	NA
Arsenic (V)	-	0.01 <sup>3</sup>	NA	NA
Arsenic (Organic)	-	NA	NA	0.1 <sup>4</sup>
Arsenic (Inorganic)	-	NA	NA	0.1 <sup>4</sup>

<sup>1</sup> Sediments must be reported on a dry-weight basis. The project reporting limits (RLs) are nominal limits assuming 100% solids. Sample-specific RLs will vary based on the % solids of the sediment sample.

<sup>2</sup> Biota results must be reported on a wet-weight basis.

<sup>3</sup> Arsenic V is calculated as [As total – As III].

<sup>4</sup> Fish Tissue only will be analyzed for Organic and Inorganic Arsenic. The lab will report down to their MDL, which may be lower than RL listed dependent upon the weight (g) of fish prepared and final volume of digestate.

NA = Not applicable

**Table 1-9. Pesticide and PCB Aroclor Analytical Parameters and Reporting Limits in Support of the Ecological Risk Assessment**

Analyte	CAS Number	Surface Water RL µg/L (ppb)	Sediment RL <sup>1</sup> µg/kg (ppb)	Biota RL <sup>2</sup> µg/kg (ppb)
alpha-BHC	319-84-6	0.01	1	1
beta-BHC	319-85-7	0.01	1	1
delta-BHC	319-86-8	0.01	1	1
gamma-BHC (lindane)	58-89-9	0.01	1	1
Heptachlor	76-44-8	0.01	1	1
Aldrin	309-00-2	0.01	1	1
Heptachlor epoxide	1024-57-3	0.01	1	1
Endosulfan I	959-98-8	0.01	1	1
Dieldrin	60-57-1	0.01	1	1
4,4'-DDE	72-55-9	0.01	1	1
Endrin	72-20-8	0.01	1	1
Endosulfan II	33213-65-9	0.01	1	1
4,4'-DDD	72-54-8	0.01	1	1
Endosulfan sulfate	1031-07-8	0.01	1	1
4,4'-DDT	50-29-3	0.01	1	1
Methoxychlor	72-43-5	0.05	5	5
Endrin Ketone	53494-70-5	0.01	1	1
Endrin Aldehyde	7421-36-3	0.01	NR <sup>3</sup>	NR <sup>3</sup>
alpha-Chlordane	5103-71-9	0.01	1	1
gamma-Chlordane	5103-74-2	0.01	1	1
Toxaphene	8001-35-2	0.1	10	10
Aroclor 1016	12674-11-2	0.1	10	10
Aroclor 1221	11104-28-2	0.1	10	10
Aroclor 1232	11141-16-5	0.1	10	10
Aroclor 1242	53469-21-9	0.1	10	10
Aroclor 1248	12672-29-6	0.1	10	10
Aroclor 1254	11097-79-1	0.1	10	10
Aroclor 1260	11096-82-5	0.1	10	10

<sup>1</sup> Sediments must be reported on a dry-weight basis. The project reporting limits (RLs) are nominal limits assuming 100% solids. Sample-specific RLs will vary based on the % solids of the sediment sample.

<sup>2</sup> Biota results must be reported on a wet-weight basis.

<sup>3</sup> NR = Not required because endrin aldehyde will not recover if alumina cleanup techniques are employed to reduce expected matrix effects. The *Status and Trends* list of pesticides does not include endrin aldehyde. Project decision was made to remove endrin aldehyde from the list of pesticides for this investigation based on technical issues and because it is not an expected contaminant of concern at the site (conference call confirmation with EPA to Menzie-Cura, March 1999).

**Table 1-10. Acid Volatile Sulfides and Simultaneously Extracted Metals Analytical Parameters and Reporting Limits in Support of the Ecological Risk Assessment**

Analyte	CAS Number	Sediment RL <sup>1</sup> mg/kg (ppm)
Acid Volatile Sulfides (AVS)	--	0.1
Cadmium	7440-43-9	0.5
Copper	7440-50-8	2
Lead	7439-92-1	10
Nickel	7440-02-0	2
Zinc	7440-66-6	2

<sup>1</sup> Sediments must be reported on a dry-weight basis. The project reporting limits (RLs) are nominal limits assuming 100% solids. Sample-specific RLs will vary based on the % solids of the sediment sample.

Table 1-11a  
Ecological Surface Water Risk-Based Concentrations (RBCs)  
Industri-Plex Site, Woburn, MA

Analyte	Analyte Class	CAS #	ORNL RBCs (mg/L) <sup>b</sup>	Analytical Reporting Limits for Surface Water (ug/L)	Ecological Surface Water RBC <sup>a</sup> (ug/L)	Source of Eco RBCs <sup>b,c,d</sup>
<b>RBC = Risk-Based Concentration</b>						
<b>Inorganic Analytes</b>						
Aluminum	Metal	7429-90-5	411.6	50	87	AWQC
Antimony	Metal	7440-36-0		100		
Arsenic - Total	Metal	7440-38-2	22.8	0.01	150 <sup>1,2,3</sup>	AWQC
Arsenic - species: As(III)				0.01	150 <sup>1,2,3</sup>	AWQC
Arsenic - species: As(V)				0.01	8.1	GLWQI
Barium	Metal	7440-39-3	192.4	6.3 (MDL)	3.9	GLWQI
Beryllium	Metal	7440-41-7		4	5.1	GLWQI
Cadmium	Metal	7440-43-9	13.41	1	1 <sup>2</sup>	AWQC
Calcium	Metal	7440-70-2		500		
Chromium (total)	Metal	7440-47-3		10	10	assume Cr(VI)
Chromium (VI)				NA	10	GLWQI
Chromium (III)	Metal		9.25	NA	180	ORNL
Cobalt	Metal	7440-48-4		3.6 (MDL)	3	GLWQI
Copper	Metal	7440-50-8	434.8	2	9	AWQC
Iron	Metal	7439-89-6		100		
Lead	Metal	7439-92-1	10.45	1 (MDL)	2.5 <sup>2,3</sup>	AWQC
Magnesium	Metal	7439-95-4		500		
Manganese	Metal	7439-96-5	9222	50	80	GLWQI
Mercury	Metal	7439-97-6	4.16	0.2	0.77 <sup>2,5,8</sup>	AWQC
Nickel	Metal	7440-02-0	715.95	10	52 <sup>2,3</sup>	AWQC
Selenium	Metal	7782-49-2	3.7	2	5 <sup>2,3</sup>	AWQC
Silver	Metal	7440-22-4		2	3.4	AWQC
Thallium	Metal	7440-28-0		20		
Vanadium	Metal	7440-62-2	105.45	15	19	GLWQI
Zinc	Metal	7440-66-6	134.1	10	100 <sup>2,3</sup>	AWQC
<b>Volatile Organic Analytes</b>						
Chloromethane (Methyl Chloride)	VOC	74-87-3		2		
Bromomethane (Methyl Bromide)	VOC	74-83-9		2		
Vinyl Chloride	VOC	75-01-4		2		
Chloroethane	VOC	75-00-3		2		
Methylene Chloride (Dichloromethane)	VOC	75-09-2		2		
Acetone	VOC	67-64-1		2		
Carbon Disulfide	VOC	75-15-0		2		
1,1-Dichloroethene	VOC	75-35-4		2		
1,1-Dichloroethane	VOC	75-34-3		2	47	GLWQI
cis-1,2-Dichloroethene	VOC	156-59-4		2		
trans-1,2-Dichloroethene	VOC	156-60-5		2		
Chloroform	VOC	67-66-3		2		
1,2-Dichloroethane	VOC	107-06-2	159.1	2	159100	ORNL
2-Butanone (Methyl Ethyl Ketone)	VOC	78-93-3		2		
1,1,1-Trichloroethane	VOC	71-55-6		2	62	GLWQI
Carbon Tetrachloride (Tetrachloromethane)	VOC	56-23-5		2	240	GLWQI
Bromodichloromethane	VOC	75-27-4		2		
1,2-Dichloropropane	VOC	78-87-5		2		
cis-1,3-Dichloropropene	VOC	10061-01-5		2		
Trichloroethene	VOC	79-01-6		2	350	GLWQI
Dibromochloromethane (Chlorodibromomethane)	VOC	124-48-1		2		
1,1,2-Trichloroethane	VOC	79-00-5		2		
Benzene	VOC	71-43-2		2	46	GLWQI
trans-1,3-Dichloropropene	VOC	10061-02-6		2		
Bromoform (Tribromomethane)	VOC	75-25-2		2	320	GLWQI
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	VOC	108-10-1		2		
2-Hexanone (Methyl Butyl Ketone)	VOC	581-78-6		2		
Tetrachloroethene	VOC	127-18-4		2	120	GLWQI
1,1,2,2-Tetrachloroethane	VOC	79-34-5		2	420	GLWQI
Toluene	VOC	108-88-3		2	130	GLWQI
Chlorobenzene	VOC	108-90-7		2	130	GLWQI
Ethylbenzene	VOC	100-41-4		2	290	GLWQI
Styrene	VOC	100-42-5		2		
Xylenes (total)	VOC	1330-20-7		2		
(m/p-Xylenes)	VOC	108-38-3		2	1.8	GLWQI

Table 1-11a  
Ecological Surface Water Risk-Based Concentrations (RBCs)  
Industri-Plex Site, Woburn, MA

Analyte	Analyte Class	CAS #	ORNL RBCs (mg/L) <sup>b</sup>	Analytical Reporting Limits for Surface Water (ug/L)	Ecological Surface Water RBC <sup>a</sup> (ug/L)	Source of Eco RBCs <sup>c,d</sup>
<b>Semivolatile Organic Analytes</b>						
Phenol	SVOC	108-95-2		5		
bis(2-Chloroethyl)ether	SVOC	111-44-4		5		
2-Chlorophenol	SVOC	95-57-8		5		
1,3-Dichlorobenzene	SVOC	541-73-1		5	71	GLWQI
1,4-Dichlorobenzene	SVOC	106-46-7		5	15	GLWQI
1,2-Dichlorobenzene	SVOC	95-50-1		5	14	GLWQI
2-Methylphenol	SVOC	95-48-7		5		
2,2-oxybis(1-Chloropropane) (bis(2-Chloroisopropyl)ether)	SVOC	108-60-1		5		
4-Methylphenol	SVOC	106-44-5		5		
N-Nitroso-di-n-propylamine	SVOC	621-84-7		5		
Hexachloroethane	SVOC	87-72-1		5	12	GLWQI
Nitrobenzene	SVOC	88-95-3		5		
Isophorone	SVOC	78-59-1		5		
2-Nitrophenol	SVOC	88-75-5		5		
2,4-Dimethylphenol	SVOC	105-87-9		5		
bis(2-Chloroethoxy)methane	SVOC	111-91-1		5		
2,4-Dichlorophenol	SVOC	120-83-2		5		
1,2,4-Trichlorobenzene	SVOC	120-82-1		5	110	GLWQI
Naphthalene	SVOC	91-20-3		5	24	GLWQI
4-Chloroaniline	SVOC	106-47-8		5		
Hexachlorobutadiene	SVOC	87-68-3		5		
4-Chloro-3-methylphenol	SVOC	59-50-7		5		
2-Methylnaphthalene	SVOC	91-57-6		5		
Hexachlorocyclopentadiene	SVOC	77-47-4		5		
2,4,6-Trichlorophenol	SVOC	88-06-2		5		
2,4,5-Trichlorophenol	SVOC	95-95-4		12		
2-Chloronaphthalene (Betachloronaphthalene)	SVOC	91-58-7		5		
2-Nitroaniline	SVOC	88-74-4		12		
Dimethylphthalate	SVOC	131-11-3		5		
Acenaphthylene	SVOC	208-96-8		5		
2,6-Dinitrotoluene	SVOC	606-20-2		12		
3-Nitroaniline	SVOC	99-09-2		5		
Acenaphthene	SVOC	83-32-9		5		
2,4-Dinitrophenol	SVOC	51-28-5		12		
4-Nitrophenol	SVOC	100-02-7		12		
Dibenzofuran	SVOC	132-64-9		5	20	GLWQI
2,4-Dinitrotoluene	SVOC	121-14-2		5		
Diethylphthalate	SVOC	84-66-2		5	220	GLWQI
4-Chlorophenyl-phenylether	SVOC	7005-72-3		5		
Fluorene	SVOC	86-73-7		5	3.9	GLWQI
4-Nitroaniline	SVOC	100-01-6		12		
4,6-Dinitro-2-methylphenol	SVOC	534-52-1		12		
N-Nitrosodiphenylamine	SVOC	86-30-6		5		
4-Bromophenyl-phenylether	SVOC	101-55-3		5	1.5	GLWQI
Hexachlorobenzene	SVOC	118-74-1		5		
Pentachlorophenol	SVOC	87-86-5		12	13	GLWQI
Phenanthrene	SVOC	85-01-8		5		
Anthracene	SVOC	120-12-7		5		
Carbazole	SVOC	86-74-8		5		
Di-n-butylphthalate	SVOC	84-74-2	1.02	5	33	GLWQI
Fluoranthene	SVOC	206-44-0		5		
Pyrene	SVOC	129-00-0		5		
Butylbenzylphthalate	SVOC	85-68-7		5	19	GLWQI
3,3'-Dichlorobenzidine	SVOC	91-94-1		5		
Benzo(a)anthracene	SVOC	56-55-3		5		
Chrysene	SVOC	218-01-9		5		
bis(2-Ethylhexyl)phthalate	SVOC	117-81-7	10.18	5	32	GLWQI
Di-n-octylphthalate	SVOC	117-84-0		5		
Benzo(b)fluoranthene	SVOC	205-99-2		5		
Benzo(k)fluoranthene	SVOC	207-08-9		5		
Benzo(a)pyrene	SVOC	50-32-8		5	0.014	GLWQI
Indeno(1,2,3-cd)pyrene	SVOC	193-39-5		5		
Dibenz(a,h)anthracene	SVOC	53-70-3		5		
Benzo(g,h,i)perylene	SVOC	191-24-2		5		

**Table 1-11a**  
**Ecological Surface Water Risk-Based Concentrations (RBCs)**  
**Industri-Plex Site, Woburn, MA**

Analyte	Analyte Class	CAS #	ORNL RBCs (mg/L) <sup>b</sup>	Analytical Reporting Limits for Surface Water (ug/L)	Ecological Surface Water RBC <sup>a</sup> (ug/L)	Source of Eco RBCs <sup>b,c,d</sup>
<b>Pesticides</b>						
α-BHC (Hexachlorocyclohexane, HCH)	PEST	319-84-6		0.01		
β-BHC (Hexachlorocyclohexane, HCH)	PEST	319-85-7		0.01		
δ-BHC (Technical hexachlorocyclohexane)	PEST	319-86-8		0.01		
γ-BHC (Hexachlorocyclohexane, Lindane)	PEST	58-89-9	18.5	0.01	0.08	GLWQI
(BHC mixed isomers)			5.18	0.01	5180	ORNL
Heptachlor	PEST	76-44-8		0.01	0.0069	GLWQI
Aldrin	PEST	309-00-2		0.01	3	AWQC
Heptachlor epoxide	PEST	1024-57-3		0.01	0.52	AWQC
Endosulfan I	PEST	959-98-8		0.01	0.51	GLWQI
Dieldrin	PEST	60-57-1	0.712	0.01	0.056	AWQC
4,4'-DDE	PEST	72-55-9		0.01		
Endrin	PEST	72-20-8	0.093	0.01	0.036	AWQC
Endosulfan II	PEST	33213-65-9		0.01	0.051	GLWQI
4,4'-DDD	PEST	72-54-8		0.01		
Endosulfan sulfate	PEST	1031-07-8		0.01		
(Endosulfan)			92.5	NA	0.051	GLWQI
4,4'-DDT	PEST	50-29-3		0.01	0.001	AWQC
Methoxychlor	PEST	72-43-5		0.05	0.019	GLWQI
Endrin ketone	PEST	53494-70-5		0.1		
Endrin Aldehyde	PEST	7421-36-3		0.1		
α-Chlordane	PEST	5103-71-9		0.1		
γ-Chlordane	PEST	5103-74-2		0.1		
Chlordane			19.8	NA	0.0043	AWQC
Toxaphene	PEST	8001-35-2		0.1	0.0002	AWQC
<b>PCBs</b>						
Total PCBs				NA	0.014 <sup>f</sup>	AWQC
Aroclor-1016	PCB	12674-11-2		0.1	0.014 <sup>f</sup>	AWQC
Aroclor-1221	PCB	11104-28-2		0.1	0.014 <sup>f</sup>	AWQC
Aroclor-1232	PCB	11141-16-5		0.1	0.014 <sup>f</sup>	AWQC
Aroclor-1242	PCB	53469-21-9	3.8	0.1	0.014 <sup>f</sup>	AWQC
Aroclor-1248	PCB	12672-29-6		0.1	0.014 <sup>f</sup>	AWQC
Aroclor-1254	PCB	11097-79-1	1.7	0.1	0.014 <sup>f</sup>	AWQC
Aroclor-1260	PCB	11098-82-5		0.1	0.014 <sup>f</sup>	AWQC

<sup>a</sup> The most conservative RBC was chosen.

<sup>b</sup> ORNL: Toxicological Benchmarks for Wildlife: 1996 Revision (Oak Ridge National Laboratory, 1996). Selected figures are for avian piscivore.

<sup>c</sup> AWQC: USEPA Drinking Water Database (12/28/98, 40CFR 131.36). AWQC figures are footnoted according to the original text. Footnotes have been numbered and corresponding notations are below.

<sup>d</sup> GLWQI: Great Lakes Water Quality Initiative, Tier II methodology values, as found in Ecotox Thresholds table (EPA, 1998)

<sup>e</sup> Organic Metal

<sup>f</sup> Cannot be separated from Diphenylamine

**AWQC footnotes:**

<sup>1</sup> This recommended water quality criterion was derived from data for arsenic (III), but is applied here to total arsenic. See Federal Register vol. 63, no. 237 for explanation.

<sup>2</sup> Freshwater criteria for metals are expressed in terms of dissolved metals in the water column. The recommended water quality criteria value was calculated by using hardness of 25 mg/L.

<sup>3</sup> This water quality criterion is based on 304(a) aquatic life criterion that was derived using the 1985 Guidelines (Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses, PB85-227049, January 1985).

<sup>4</sup> When the concentration of dissolved organic carbon is elevated, copper is substantially less toxic and use of Water-Effect Ratios might be appropriate.

<sup>5</sup> This recommended water quality criterion was derived on page 43 of the mercury criteria document (EPA 440/5-84-026, January 1985). The saltwater CCC of 0.025 µg/L given on page 23 of the criteria document is based on the Final Residue Value procedure in the 1985 Guidelines. Since the publication of the Great Lakes Aquatic Life Criteria Guidelines in 1985, the Agency no longer uses the Final Residue Value procedure for deriving CCCs for new or revised 304(a) aquatic life criteria.

<sup>6</sup> This recommended water quality criterion was derived from data for inorganic mercury (II), but is applied here to total mercury. If a substantial portion of the mercury in the water column is methylmercury, this criterion will probably be under protective. In addition, even though inorganic mercury is converted to methylmercury and methylmercury bioaccumulates to a great extent, this criterion does not account for uptake via the food chain because sufficient data were not available when the criterion was derived.

<sup>7</sup> PCBs are a class of chemicals which include Aroclors 1242, 1254, 1221, 1232, 1248, 1260, and 1016, CAS numbers 53469219, 11097691, 11104282, 11141165, 12672296, 11096825, and 12674112 respectively. The aquatic life criteria apply to this set of PCBs.

Table 1-11b  
Ecological Sediment and Biota Risk-Based Concentrations (RBCs)  
Industri-Plex Site, Woburn, MA

Analyte	CAS #	Analyte class	Ecological Sediment RBC (ug/kg) or (mg/kg) dry-weight	Source of Sediment RBC <sup>a,b,c</sup>	Analytical Reporting Limit for Sediment/ Biota (mg/kg or ug/kg) wet	Ecological Receptor Food RBC <sup>a</sup> (mg/kg) wet weight	Ecological Receptor (ORNL for Otter or Avian Piscivore)
RBC = Risk-Based Concentration							
<b>Inorganic Analytes</b>			<b>mg/kg</b>		<b>mg/kg</b>	<b>mg/kg</b>	
Aluminum	7429-90-5	Metal			10	4.245	Otter
Antimony	7440-36-0	Metal	2	NOAA	0.5	0.275	Otter
Arsenic - Total	7440-38-2	Metal	6	Persaud	0.1	0.277	Otter
Arsenic Species: As (III), As (V)		Metal	NA		0.1	NA	
Arsenic Species: organic (fish only)		Metal	NA		0.1	NA	
Arsenic Species: inorganic (fish only)		Metal	NA		0.1	0.277	Otter
Barium	7440-39-3	Metal			10	21.9	Otter
Beryllium	7440-41-7	Metal			1	2.68	Otter
Cadmium	7440-43-9	Metal	0.6	Persaud	0.5	2.86	avian piscivore
Chromium (total)	7440-47-3	Metal	26	Persaud	1		
(Chromium (III))		Metal			NA	1.97	avian piscivore
Cobalt	7440-48-4	Metal			10		
Copper	7440-50-8	Metal	16	Persaud	10	61.8	Otter
Iron	7439-89-6	Metal			10		
Lead	7439-92-1	Metal	31	Persaud	100sed/1 biota	2.23	avian piscivore
Manganese	7439-96-5	Metal	460	Persaud	10	358	Otter
Mercury	7439-97-6	Metal	0.15	NOAA	0.1	0.89	avian piscivore
Nickel	7440-02-0	Metal	16	Persaud	10	152.74	avian piscivore
Selenium	7782-49-2	Metal			0.5	0.789	avian piscivore
Silver	7440-22-4	Metal	1	NOAA	10		
Thallium	7440-28-0	Metal			2	0.030	Otter
Vanadium	7440-62-2	Metal			0.5 (MDL)	0.793	Otter
Zinc	7440-66-6	Metal	120	Persaud	2	28.6	avian piscivore
<b>Volatile Organic Analytes</b>			<b>ug/kg</b>		<b>ug/kg</b>		
Chloromethane	74-87-3	VOC			2		
Bromomethane	74-83-9	VOC			2		
Vinyl Chloride	75-01-4	VOC			2	0.691	Otter
Chloroethane	75-00-3	VOC			2		
Methylene Chloride	75-09-2	VOC			2	23.8	Otter
Acetone	67-64-1	VOC			2	40.7	Otter
Carbon Disulfide	75-15-0	VOC			2		
1,1-Dichloroethene	75-35-4	VOC			2	23.5	Otter
1,1-Dichloroethane	75-34-3	VOC			2		
cis-1,2-Dichloroethene	156-59-4	VOC			2		
trans-1,2-Dichloroethene	156-60-5	VOC			2		
Chloroform	67-66-3	VOC			2	61	Otter
1,2-Dichloroethane	107-06-2	VOC			2	33.9	avian piscivore
2-Butanone (Methyl Ethyl Ketone)	78-93-3	VOC			2	7200	Otter
1,1,1-Trichloroethane	71-55-6	VOC	1190	SQB	2	2286	Otter
Carbon Tetrachloride	56-23-5	VOC	8400	SQB	2	65.0	Otter
Bromodichloromethane	75-27-4	VOC			2		
1,2-Dichloropropane	78-87-5	VOC			2		
cis-1,3-Dichloropropene	10061-01-5	VOC			2		
Trichloroethene	79-01-6	VOC	11200	SQB	2	1.540	Otter
Dibromochloromethane	124-48-1	VOC			2		
1,1,2-Trichloroethane	79-00-5	VOC			2		
Benzene	71-43-2	VOC	399	SQB	2	58.0	Otter
trans-1,3-Dichloropropene	10061-02-6	VOC			2		
Bromoform	75-25-2	VOC	4550	SQB	2		
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	108-10-1	VOC			2	101.6	Otter

**Table 1-11b**  
**Ecological Sediment and Biota Risk-Based Concentrations (RBCs)**  
**Industri-Plex Site, Woburn, MA**

Analyte	CAS #	Analyte class	Ecological Sediment RBC (ug/kg) or (mg/kg) dry-weight	Source of Sediment RBC <sup>a,b,c</sup>	Analytical Reporting Limit for Sediment/ Biota (mg/kg or ug/Kg) wet	Ecological Receptor Food RBC * (mg/kg) wet weight	Ecological Receptor (ORNL for Otter or Avian Piscivore)
2-Hexanone	591-78-6	VOC			2		
Tetrachloroethene	127-18-4	VOC	3710	SQB	2		
1,1,2,2-Tetrachloroethane	79-34-5	VOC	4580	SQB	2		
Toluene	108-88-3	VOC	4670	SQB	2	57.2	Otter
Chlorobenzene	108-90-7	VOC	5740	SQB	2		
Ethylbenzene	100-41-4	VOC	25200	SQB	2		
Styrene	100-42-5	VOC			2		
Xylenes (total)	1330-20-7	VOC			2	4.619	Otter
( <i>m/p-Xylenes</i> )	108-38-3	VOC	175	SQB	2		
<b>Semivolatile Organic Analytes</b>			<b>ug/kg</b>		<b>ug/kg</b>		
(PAHs only for Biota)							
Phenol	108-95-2	SVOC			170		
bis(2-Chloroethyl)ether	111-44-4	SVOC			170		
2-Chlorophenol	95-57-8	SVOC			170		
1,3-Dichlorobenzene	541-73-1	SVOC	11900	SQB	170		
1,4-Dichlorobenzene	106-46-7	SVOC	2450	SQB	170		
1,2-Dichlorobenzene	95-50-1	SVOC	2380	SQB	170		
2-Methylphenol	95-48-7	SVOC			170		
2,2-oxybis(1-Chloropropane)	108-60-1	SVOC			170		
4-Methylphenol	106-44-5	SVOC			170		
N-Nitroso-di-n-propylamine	621-64-7	SVOC			170		
Hexachloroethane	67-72-1	SVOC	7000	SQB	170		
Nitrobenzene	98-95-3	SVOC			170		
Isophorone	78-59-1	SVOC			170		
2-Nitrophenol	88-75-5	SVOC			170		
2,4-Dimethylphenol	105-67-9	SVOC			170		
bis(2-Chloroethoxy)methane	111-91-1	SVOC			170		
2,4-Dichlorophenol	120-83-2	SVOC			170		
1,2,4-Trichlorobenzene	120-82-1	SVOC	64400	SQB	170		
Naphthalene	91-20-3	SVOC	160	NOAA	170 / 1		
4-Chloroaniline	106-47-8	SVOC			170		
Hexachlorobutadiene	87-68-3	SVOC			170		
4-Chloro-3-methylphenol	59-50-7	SVOC			170		
2-Methylnaphthalene	91-57-6	SVOC	70	NOAA	170 / 1		
Hexachlorocyclopentadiene	77-47-4	SVOC			170		
2,4,6-Trichlorophenol	88-06-2	SVOC			170		
2,4,5-Trichlorophenol	95-95-4	SVOC			420		
2-Chloronaphthalene	91-58-7	SVOC			170		
2-Nitroaniline	88-74-4	SVOC			420		
Dimethylphthalate	131-11-3	SVOC			170		
Acenaphthylene	208-96-8	SVOC	44	NOAA	170 / 1		
2,6-Dinitrotoluene	606-20-2	SVOC			0.42		
3-Nitroaniline	99-09-2	SVOC			170		
Acenaphthene	83-32-9	SVOC	16	NOAA	170 / 1		
2,4-Dinitrophenol	51-28-5	SVOC			420		
4-Nitrophenol	100-02-7	SVOC			420		
Dibenzofuran	132-64-9	SVOC	14000	SQB	170		
2,4-Dinitrotoluene	121-14-2	SVOC			170		
Diethylphthalate	84-68-2	SVOC	4400	SQB	170	10081	Otter
4-Chlorophenyl-phenylether	7005-72-3	SVOC			170 / 1		
Fluorene	86-73-7	SVOC	19	NOAA	170		
4-Nitroaniline	100-01-6	SVOC			420		
4,6-Dinitro-2-methylphenol	534-52-1	SVOC			420		
N-Nitrosodiphenylamine	86-30-6	SVOC			170		
4-Bromophenyl-phenylether	101-55-3	SVOC			170		

Table 1-11b  
Ecological Sediment and Biota Risk-Based Concentrations (RBCs)  
Industri-Plex Site, Woburn, MA

Analyte	CAS #	Analyte class	Ecological Sediment RBC (ug/kg) or (mg/kg) dry-weight	Source of Sediment RBC <sup>a,b,c</sup>	Analytical Reporting Limit for Sediment/ Biota (mg/kg or ug/kg) wet	Ecological Receptor RBC * (mg/kg) wet weight	Ecological Receptor (ORNL for Otter or Avian Piscivore)
Hexachlorobenzene (HCB)	118-74-1	SVOC			170		
Pentachlorophenol	87-86-5	SVOC			420	0.976	Otter
Phenanthrene	85-01-8	SVOC	240	NOAA	170 / 1 <sup>b</sup>		
Anthracene	120-12-7	SVOC	85.3	NOAA	170 / 1 <sup>b</sup>		
Carbazole	86-74-8	SVOC			170		
Di-n-butylphthalate	84-74-2	SVOC	77000	SQB	170	0.22	avian piscivore
Fluoranthene	206-44-0	SVOC	600	NOAA	170 / 1		
Pyrene	129-00-0	SVOC	665	NOAA	170 / 1		
Butylbenzylphthalate	85-68-7	SVOC	77000	SQB	170		
3,3'-Dichlorobenzidine	91-94-1	SVOC			170		
Benzo(a)anthracene	56-55-3	SVOC	261	NOAA	170 / 1 <sup>b</sup>		
Chrysene	218-01-9	SVOC	384	NOAA	170 / 1 <sup>b</sup>		
bis(2-Ethylhexyl)phthalate	117-81-7	SVOC			170	2.17	avian piscivore
Di-n-octylphthalate	117-84-0	SVOC			170		
Benzo(b)fluoranthene	205-99-2	SVOC			170 / 1 <sup>b</sup>		
Benzo(k)fluoranthene	207-08-9	SVOC			170 / 1 <sup>b</sup>		
Benzo(a)pyrene	50-32-8	SVOC	430	NOAA	170 / 1 <sup>b</sup>	2.2	Otter
Indeno(1,2,3-cd)pyrene	193-39-5	SVOC			170 / 1 <sup>b</sup>		
Dibenz(a,h)anthracene	53-70-3	SVOC	63.4	NOAA	170 / 1 <sup>b</sup>		
Benzo(g,h,i)perylene	191-24-2	SVOC			170 / 1 <sup>b</sup>		
<b>Pesticides</b>			<b>ug/kg</b>		<b>ug/kg</b>		
α-BHC	319-84-6	PEST			1		
β-BHC	319-85-7	PEST			1	1.63	Otter
δ-BHC	319-86-8	PEST			1		
γ-BHC (Lindane)	58-89-9	PEST	25.9	SQB	1	3.95	avian piscivore
BHC mixed isomers					1	0.07	Otter
Heptachlor	76-44-8	PEST			1	0.529	Otter
Aldrin	309-00-2	PEST			1	0.813	Otter
Heptachlor epoxide	1024-57-3	PEST			1		
Endosulfan I	959-98-8	PEST	70.3	SQB	1		
Dieldrin	60-57-1	PEST	364	SQC	1	0.081	Otter
4,4'-DDE	72-55-9	PEST	2.2	NOAA	1		
Endrin	72-20-8	PEST	140	SQC	1	0.02	avian piscivore
Endosulfan II	33213-65-9	PEST	98	SQB	1		
4,4'-DDD	72-54-8	PEST			1		
Endosulfan sulfate	1031-07-8	PEST			1		
Endosulfan			37.8	SQB	NA	0.61	Otter
4,4'-DDT	50-29-3	PEST			1		
DDT and metabolites			1.58	NOAA	NA	0.006	avian piscivore
Methoxychlor	72-43-5	PEST	133	SQB	5	16.3	Otter
Endrin ketone	53494-70-5	PEST			1		
Endrin aldehyde	7421-36-3	PEST			NA		
α-Chlordane	5103-71-9	PEST			1		
γ-Chlordane	5103-74-2	PEST			1		
Chlordane					NA	4.2	avian piscivore
Toxaphene	8001-35-2	PEST	196	SQB	10	32.5	Otter
<b>PCBs</b>			<b>ug/kg</b>		<b>ug/kg</b>		
Total PCBs			22.7	NOAA	NA		
Aroclor-1016	12674-11-2	PCB			10	7.24	Otter
Aroclor-1221	11104-28-2	PCB			10		
Aroclor-1232	11141-16-5	PCB			10		

Table 1-11b  
Ecological Sediment and Biota Risk-Based Concentrations (RBCs)  
Industri-Plex Site, Woburn, MA

Analyte	CAS #	Analyte class	Ecological Sediment RBC (ug/kg) or (mg/kg) dry-weight	Source of Sediment RBC <sup>a,b,c</sup>	Analytical Reporting Limit for Sediment/ Biota (mg/kg or ug/Kg) wet	Ecological Receptor Food RBC <sup>e</sup> (mg/kg) wet weight	Ecological Receptor (ORNL for Otter or Avian Piscivore)
Aroclor-1242	53469-21-9	PCB			10	0.365	Otter
Aroclor-1248	12672-29-6	PCB			10	0.079	Otter
Aroclor-1254	11097-79-1	PCB			10	0.355	avian piscivore
Aroclor-1260	11096-82-5	PCB			10		

<sup>a</sup> NOAA: Edward R. Long, Donald D. MacDonald, Sherri L. Smith, Fred D. Calder, 1995. "Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments," Environmental Management. 19(1):81-97, 1995.

<sup>b</sup> SQC: USEPA Sediment Quality Criteria (SQC). Assumes 5 percent organic carbon (USEPA, 1993g)(modified).

Values are lower limit of 95 percent confidence interval.

<sup>c</sup> SQB: Sediment quality benchmarks (SQBs) by equilibrium partitioning. Assumes 7 percent organic carbon (USEPA, 1995b)(modified).

<sup>d</sup> Persaud, et al. 1992. Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario. Ontario Ministry of the Environment.

<sup>e</sup> ORNL: Toxicological Benchmarks for Wildlife: 1996 Revision (EPA, 1996). Selected figures are for an avian piscivore.

<sup>f</sup> Cannot be separated from Diphenylamine

<sup>g</sup> The Laboratories will report estimated data between this RL and their MDL. The MDL is 3-5 times lower than the RL.

<sup>h</sup> The lower limit is based upon 8270C-SIM analysis, the higher limit is full scan 8270C - EI analysis

**TABLE 1-12a**  
**HUMAN HEALTH RISK-BASED CONCENTRATIONS (RBCs) FOR SURFACE WATER**  
**INDUSTRIPLEX**

Analyte	CAS Number	Surface Water (a) ug/L
<b>Semi-volatile Organics</b>		
1,2,4-Trichlorobenzene	120-82-1	9.4E+02
1,2-Dichlorobenzene	95-50-1	1.7E+04
1,3-Dichlorobenzene	541-73-1	2.6E+03
1,4-Dichlorobenzene	106-46-7	2.6E+03
2,2'-oxybis(1-chloropropane)	108-60-1	9.6E-01 (b)
2,4,5-Trichlorophenol	95-95-4	9.8E+03
2,4,6-Trichlorophenol	88-06-2	6.5E+00
2,4-Dichlorophenol	120-83-2	7.9E+02
2,4-Dimethylphenol	105-67-9	2.3E+03
2,4-Dinitrophenol	51-28-5	1.4E+04
2,4-Dinitrotoluene	121-14-2	9.1E+00
2,6-Dinitrotoluene	606-20-2	3.7E+01 (b)
2-Chloronaphthalene	91-58-7	4.3E+03
2-Chlorophenol	95-57-8	4.0E+02
2-Methylnaphthalene	91-57-6	6.2E+00 (b,c)
2-Methylphenol	95-48-7	1.8E+03 (b)
2-Nitroaniline	88-74-4	2.2E+00 (b)
2-Nitrophenol	88-75-5	2.3E+03 (b,d)
3,3'-Dichlorobenzidine	91-94-1	7.7E-02
3-Nitroaniline	99-09-2	2.2E+00 (b,m)
4,6-Dinitro-2-methylphenol	534-52-1	7.7E+02
4-Bromophenyl phenyl ether	101-55-3	NA
4-Chloro-3-methylphenol	59-50-7	NA
4-Chloroaniline	106-47-8	1.5E+02 (b)
4-Chlorophenyl phenyl ether	7005-72-3	NA
4-Methylphenol	106-44-5	1.8E+02 (b)
4-Nitroaniline	100-01-6	2.2E+00 (b,m)
4-Nitrophenol	100-02-7	2.3E+03 (b)
Acenaphthene	83-32-9	2.7E+03
Acenaphthylene	208-96-8	2.7E+03 (e)
Anthracene	120-12-7	1.1E+05
Benz[a]anthracene	56-55-3	4.9E-02
Benzo[a]pyrene	50-32-8	4.9E-02
Benzo[b]fluoranthene	205-99-2	4.9E-02
Benzo[g,h,i]perylene	191-24-2	1.1E+04 (f)
Benzo[k]fluoranthene	207-08-9	4.9E-02
bis(2-Chloroethoxy)methane	111-91-1	NA
bis(2-Chloroethyl)ether	111-44-4	1.4E+00
bis(2-Ethylhexyl)phthalate	117-81-7	5.9E+00
Butyl benzyl phthalate	85-68-7	5.2E+03
Carbazole	86-74-8	3.4E+00 (b)
Chrysene	218-01-9	4.9E-02
Dibenzo[a,h]anthracene	53-70-3	4.9E-02
Dibenzofuran	132-64-9	2.4E+01 (b)
Diethylphthalate	84-66-2	1.2E+05
Dimethylphthalate	131-11-3	2.9E+06
Di-n-butylphthalate	84-74-2	1.2E+04
Di-n-octylphthalate	117-84-0	7.3E+02 (b)
Fluoranthene	206-44-0	3.7E+02

**TABLE 1-12a**  
**HUMAN HEALTH RISK-BASED CONCENTRATIONS (RBCs) FOR SURFACE WATER**  
**INDUSTRIPLEX**

Analyte	CAS Number	Surface Water (a) ug/L
Fluorene	86-73-7	1.4E+04
Hexachlorobenzene	118-74-1	7.7E-04
Hexachlorobutadiene	87-68-3	5.0E+01
Hexachlorocyclopentadiene	77-47-4	1.7E+04
Hexachloroethane	67-72-1	8.9E+00
Indeno(1,2,3-cd) pyrene	193-39-5	4.9E-02
Isophorone	78-59-1	2.6E+03
Naphthalene	91-20-3	6.2E+00 (b)
Nitrobenzene	98-95-3	1.9E+03
N-Nitroso-di-n-propylamine	621-64-7	1.4E+00
N-Nitrosodiphenylamine	86-30-6	1.6E+01
Pentachlorophenol	87-86-5	8.2E+00
Phenanthrene	85-01-8	1.1E+05 (g)
Phenol	108-95-2	4.6E+06
Pyrene	129-00-0	1.1E+04
<b>Volatile Organics</b>		
1,1,1-Trichloroethane	71-55-6	7.9E+02 (b)
1,1,2,2-Tetrachloroethane	79-34-5	1.1E+01
1,1,2-Trichloroethane	79-00-5	4.2E+01
1,1-Dichloroethane	75-34-3	8.1E+02 (b)
1,1-Dichloroethene	75-35-4	3.2E+00
1,2-Dichloroethane	107-06-2	9.9E+01
1,2-Dichloropropane	78-87-5	3.9E+01
2-Butanone	78-93-3	1.9E+03 (b)
2-Hexanone	591-78-6	NA
4-Methyl-2-pentanone	108-10-1	1.6E+02 (b)
Acetone	67-64-1	6.1E+02 (b)
Benzene	71-43-2	7.1E+01
Bromodichloromethane	75-27-4	4.6E+01
Bromoform	75-25-2	3.6E+02
Bromomethane	74-83-9	8.7E+00 (b)
Carbon Disulfide	75-15-0	1.0E+03 (b)
Carbon Tetrachloride	56-23-5	4.4E+00
Chlorobenzene	108-90-7	2.1E+04
Chloroethane	75-00-3	8.6E+03 (b)
Chloroform	67-66-3	4.7E+02
Chloromethane	74-87-3	1.5E+00 (b)
cis-1,2-Dichloroethene	156-59-2	6.1E+01 (b)
cis-1,3-Dichloropropene	10061-01-5	1.7E+03 (h)
Dibromochloromethane	124-48-1	3.4E+01
EthylBenzene	100-41-4	2.9E+04
m/p-Xylene	NA	1.4E+03 (b,i)
Methylene Chloride	75-09-2	1.6E+03
Styrene	100-42-5	1.6E+03 (b)
Tetrachloroethene	127-18-4	8.9E+00
Toluene	108-88-3	2.0E+05
trans-1,2-Dichloroethene	156-60-5	1.4E+05
trans-1,3-Dichloropropene	10061-02-6	1.7E+03 (h)
Trichloroethene	79-01-6	8.1E+01

**TABLE 1-12a**  
**HUMAN HEALTH RISK-BASED CONCENTRATIONS (RBCs) FOR SURFACE WATER**  
**INDUSTRIPLEX**

<b>Analyte</b>	<b>CAS Number</b>	<b>Surface Water (a)</b> <b>ug/L</b>
Vinyl Chloride	75-01-4	5.3E+02
Xylenes (total)	1330-20-7	1.4E+03 (b,i)
<b>Inorganics</b>		
Aluminum	7429-90-5	3.7E+04 (b)
Arsenic (Total)	7440-38-2	1.4E-01 (a)
Arsenic (Inorganic)	NA	1.4E-01 (n)
Arsenic (Organic)	NA	NA (o)
Antimony	7440-36-0	4.3E+03
Barium	7440-39-3	2.6E+03 (b)
Beryllium	7440-41-7	7.3E+01 (b)
Cadmium	7440-43-9	1.8E+01 (b)
Calcium	7440-70-2	NA
Chromium	NA	1.8E+02 (b)
Chromium VI	7440-47-3	1.8E+02 (b)
Cobalt	7440-48-4	2.2E+03 (b)
Copper	7440-50-8	1.4E+03 (b)
Iron	7439-89-6	1.1E+04 (b)
Lead	7439-92-1	4.0E+00 (b)
Magnesium	7439-95-4	NA
Manganese	7439-96-5	1.0E+02
Mercury	7439-97-6	5.1E-02
Nickel	7440-02-0	4.6E+03
Selenium	7782-49-2	1.1E+04
Silver	7440-22-4	1.8E+02 (b)
Thallium	7440-28-0	6.3E+00
Vanadium	7440-62-2	2.6E+02 (b)
Zinc	7440-66-6	6.9E+04
<b>Pesticide and PCB</b>		
4,4'-DDD	72-54-8	8.4E-04
4,4'-DDE	72-55-9	5.9E-04
4,4'-DDT	50-29-3	5.9E-04
Aldrin	309-00-2	1.4E-04
alpha-BHC	319-84-6	1.3E-02
alpha-Chlordane	5103-71-9	2.2E-03 (j)
beta-BHC	319-85-7	4.6E-02
delta-BHC	319-86-8	1.3E-02 (k)
Dieldrin	60-57-1	1.4E-04
Endosulfan I	959-98-8	2.4E+02
Endosulfan II	33213-65-9	2.4E+02
Endosulfan sulfate	1031-07-8	2.4E+02
Endrin	72-20-8	8.1E-01
Endrin Aldehyde	7421-36-3	8.1E-01
Endrin Ketone	53494-70-5	8.1E-01 (l)
gamma-BHC (lindane)	58-89-9	6.3E-02
gamma-Chlordane	5103-74-2	2.2E-03 (j)
Heptachlor	76-44-8	2.1E-04
Heptachlor epoxide	1024-57-3	1.1E-04
Methoxychlor	72-43-5	1.8E+02 (b)

**TABLE 1-12a  
HUMAN HEALTH RISK-BASED CONCENTRATIONS (RBCs) FOR SURFACE WATER  
INDUSTRIPLEX**

Analyte	CAS Number	Surface Water (a) ug/L
Toxaphene	8001-35-2	7.5E-04
Aroclor-1016	12674-11-2	1.7E-04
Aroclor-1221	11104-28-2	1.7E-04
Aroclor-1232	11141-16-5	1.7E-04
Aroclor-1242	53469-21-9	1.7E-04
Aroclor-1248	12672-29-6	1.7E-04
Aroclor-1254	11097-69-1	1.7E-04
Aroclor-1260	11096-82-5	1.7E-04

## Notes:

CAS - Chemical Abstracts Service.

DQL - Data Quality Levels.

NA - Not Available.

PCB - Polychlorinated biphenyls.

PRG - Preliminary Remediation Goal.

(a) Surface water DQLs are based on US EPA National Recommended Water Quality Criteria (April 1999) for "consumption of organism only." For compounds that do not have these criteria, Region 9 PRGs (May 1, 1998) for tap water were used. This is conservative, as surface water is not utilized as drinking water.

(b) Indicates Region 9 PRG for tap water.

(c) Due to structural similarities, the value for Naphthalene was used.

(d) Due to structural similarities, the value for 4-Nitrophenol was used.

(e) Due to structural similarities, the value for Acenaphthene was used.

(f) Due to structural similarities, the value for Pyrene was used.

(g) Due to structural similarities, the value for Anthracene was used.

(h) Due to structural similarities, the value for 1,3-Dichloropropene was used.

(i) Due to structural similarities, the value for m-Xylene was used.

(j) Due to structural similarities, the value for Chlordane was used.

(k) Due to structural similarities, the value for alpha-BHC was used.

(l) Due to structural similarities, the value for Endrin was used.

(m) Due to structural similarities, the value for 2-Nitroaniline was used.

(n) Inorganic arsenic considered same value as for total arsenic.

(o) No applicable organic arsenic level because it is considered nontoxic.

**TABLE 1-12b  
HUMAN HEALTH RISK-BASED CONCENTRATIONS (RBCs) FOR SEDIMENT  
INDUSTRIPLEX**

Analyte	CAS Number	Sediment (a) mg/kg
<b>Semi-volatile Organics</b>		
1,2,4-Trichlorobenzene	120-82-1	4.8E+02
1,2-Dichlorobenzene	95-50-1	3.7E+02
1,3-Dichlorobenzene	541-73-1	4.1E+01
1,4-Dichlorobenzene	106-46-7	3.0E+00
2,2'-oxybis(1-chloropropane)	108-60-1	6.3E+00
2,4,5-Trichlorophenol	95-95-4	5.5E+03
2,4,6-Trichlorophenol	88-06-2	4.0E+01
2,4-Dichlorophenol	120-83-2	1.6E+02
2,4-Dimethylphenol	105-67-9	1.1E+03
2,4-Dinitrophenol	51-28-5	1.1E+02
2,4-Dinitrotoluene	121-14-2	1.1E+02
2,6-Dinitrotoluene	606-20-2	5.5E+01
2-Chloronaphthalene	91-58-7	3.7E+03
2-Chlorophenol	95-57-8	5.9E+01
2-Methylnaphthalene	91-57-6	5.5E+01 (b)
2-Methylphenol	95-48-7	2.7E+03
2-Nitroaniline	88-74-4	3.3E+00
2-Nitrophenol	88-75-5	3.4E+03 (c)
3,3'-Dichlorobenzidine	91-94-1	9.9E-01
3-Nitroaniline	99-09-2	3.3E+00 (n)
4,6-Dinitro-2-methylphenol	534-52-1	NA
4-Bromophenyl phenyl ether	101-55-3	NA
4-Chloro-3-methylphenol	59-50-7	NA
4-Chloroaniline	106-47-8	2.2E+02
4-Chlorophenyl phenyl ether	7005-72-3	NA
4-Methylphenol	106-44-5	2.7E+02
4-Nitroaniline	100-01-6	3.3E+00 (n)
4-Nitrophenol	100-02-7	3.4E+03
Acenaphthene	83-32-9	2.6E+03
Acenaphthylene	208-96-8	2.6E+03 (d)
Anthracene	120-12-7	1.4E+04
Benz[a]anthracene	56-55-3	5.6E-01
Benzo[a]pyrene	50-32-8	5.6E-02
Benzo[b]fluoranthene	205-99-2	5.6E-01
Benzo[g,h,i]perylene	191-24-2	1.5E+03 (e)
Benzo[k]fluoranthene	207-08-9	5.6E+00
bis(2-Chloroethoxy)methane	111-91-1	NA
bis(2-Chloroethyl)ether	111-44-4	1.8E-01
bis(2-Ethylhexyl)phthalate	117-81-7	3.2E+01
Butylbenzylphthalate	85-68-7	9.3E+02
Carbazole	86-74-8	2.2E+01
Chrysene	218-01-9	5.6E+01
Dibenzo(a,h)anthracene	53-70-3	5.6E-02
Dibenzofuran	132-64-9	2.1E+02
Diethyl phthalate	84-66-2	4.4E+04
Dimethylphthalate	131-11-3	1.0E+05
Di-n-butylphthalate	84-74-2	5.5E+03
Di-n-octylphthalate	117-84-0	1.1E+03
Fluoranthene	206-44-0	2.0E+03

**TABLE 1-12b  
HUMAN HEALTH RISK-BASED CONCENTRATIONS (RBCs) FOR SEDIMENT  
INDUSTRIPLEX**

<b>Analyte</b>	<b>CAS Number</b>	<b>Sediment (a) mg/kg</b>
Fluorene	86-73-7	1.8E+03
Hexachlorobenzene	118-74-1	2.8E-01
Hexachlorobutadiene	87-68-3	5.7E+00
Hexachlorocyclopentadiene	77-47-4	3.8E+02
Hexachloroethane	67-72-1	3.2E+01
Indeno (1,2,3-cd) pyrene	193-39-5	5.6E-01
Isophorone	78-59-1	4.7E+02
Naphthalene	91-20-3	5.5E+01
Nitrobenzene	98-95-3	1.6E+01
N-Nitroso-di-n-propylamine	621-64-7	6.3E-02
N-Nitrosodiphenylamine	86-30-6	9.1E+01
Pentachlorophenol	87-86-5	2.5E+00
Phenanthrene	85-01-8	1.4E+04 (f)
Phenol	108-95-2	3.3E+04
Pyrene	129-00-0	1.5E+03
<b>Volatile Organics</b>		
1,1,1-Trichloroethane	71-55-6	6.8E+02
1,1,2,2-Tetrachloroethane	79-34-5	3.6E-01
1,1,2-Trichloroethane	79-00-5	8.2E-01
1,1-Dichloroethane	75-34-3	5.7E+02
1,1-Dichloroethene	75-35-4	5.2E-02
1,2-Dichloroethane	107-06-2	3.4E-01
1,2-Dichloropropane	78-87-5	3.4E-01
2-Butanone	78-93-3	6.9E+03
2-Hexanone	591-78-6	NA
4-Methyl-2-pentanone	108-10-1	7.5E+02
Acetone	67-64-1	1.4E+03
Benzene	71-43-2	6.2E-01
Bromodichloromethane	75-27-4	9.8E-01
Bromoform	75-25-2	5.6E+01
Bromomethane	74-83-9	3.8E+00
Carbon Disulfide	75-15-0	3.5E+02
Carbon Tetrachloride	56-23-5	2.3E-01
Chlorobenzene	108-90-7	5.4E+01
Chloroethane	75-00-3	1.6E+03
Chloroform	67-66-3	2.4E-01
Chloromethane	74-87-3	1.2E+00
cis-1,2-Dichloroethene	156-59-2	4.2E+01
cis-1,3-Dichloropropene	10061-01-5	8.1E-02 (m)
Dibromochloromethane	124-48-1	5.3E+00
Ethyl Benzene	100-41-4	2.3E+02
m/p-Xylene	NA	2.1E+02 (g)
Methylene Chloride	75-09-2	8.5E+00
Styrene	100-42-5	1.7E+03
Tetrachloroethene	127-18-4	4.7E+00
Toluene	108-88-3	5.2E+02
trans-1,2-Dichloroethene	156-60-5	6.2E+01
trans-1,3-Dichloropropene	10061-02-6	8.1E-02 (m)
Trichloroethene	79-01-6	2.7E+00

**TABLE 1-12b  
HUMAN HEALTH RISK-BASED CONCENTRATIONS (RBCs) FOR SEDIMENT  
INDUSTRIPLEX**

<b>Analyte</b>	<b>CAS Number</b>	<b>Sediment (a) mg/kg</b>
Vinyl Chloride	75-01-4	2.1E-02
Xylenes (total)	1330-20-7	2.1E+02 (g)
<b>Inorganics</b>		
Aluminum	7429-90-5	7.5E+04
Arsenic (Total)	7440-38-2	3.8E-01 (a)
Arsenic (Inorganic)	NA	3.8E-01 (o)
Arsenic (Organic)	NA	NA (p)
Antimony	7440-36-0	3.0E+01
Barium	7440-39-3	5.2E+03
Beryllium	7440-41-7	1.5E+02
Cadmium	7440-43-9	3.7E+01
Calcium	7440-70-2	NA
Chromium	NA	2.1E+02
Chromium VI	7440-47-3	3.0E+01
Cobalt	7440-48-4	3.3E+03
Copper	7440-50-8	2.8E+03
Iron	7439-89-6	2.2E+04
Lead	7439-92-1	4.0E+02
Magnesium	7439-95-4	NA
Manganese	7439-96-5	3.1E+03
Mercury	7439-97-6	2.2E+01
Nickel	7440-02-0	1.5E+03
Selenium	7782-49-2	3.7E+02
Silver	7440-22-4	3.7E+02
Thallium	7440-28-0	6.0E+00 (h)
Vanadium	7440-62-2	5.2E+02
Zinc	7440-66-6	2.2E+04
<b>Pesticide and PCB</b>		
4,4'-DDD	72-54-8	2.4E+00
4,4'-DDE	72-55-9	1.7E+00
4,4'-DDT	50-29-3	1.7E+00
Aldrin	309-00-2	2.6E-02
alpha-BHC	319-84-6	8.6E-02
alpha-Chlordane	5103-71-9	1.6E+00 (i)
beta-BHC	319-85-7	3.0E-01
delta-BHC	319-86-8	8.6E-02 (j)
Dieldrin	60-57-1	2.8E-02
Endosulfan I	959-98-8	3.3E+02 (k)
Endosulfan II	33213-65-9	3.3E+02 (k)
Endosulfan sulfate	1031-07-8	3.3E+02 (k)
Endrin	72-20-8	1.6E+01
Endrin Aldehyde	7421-36-3	1.6E+01 (l)
Endrin Ketone	53494-70-5	1.6E+01 (l)
gamma-BHC (lindane)	58-89-9	4.2E-01
gamma-Chlordane	5103-74-2	1.6E+00 (i)
Heptachlor	76-44-8	9.9E-02
Heptachlor epoxide	1024-57-3	4.9E-02
Methoxychlor	72-43-5	2.7E+02

**TABLE 1-12b  
HUMAN HEALTH RISK-BASED CONCENTRATIONS (RBCs) FOR SEDIMENT  
INDUSTRIPLEX**

<b>Analyte</b>	<b>CAS Number</b>	<b>Sediment (a) mg/kg</b>
Toxaphene	8001-35-2	4.0E-01
Aroclor 1016	12674-11-2	2.0E-01
Aroclor 1221	11104-28-2	2.0E-01
Aroclor 1232	11141-16-5	2.0E-01
Aroclor 1242	53469-21-9	2.0E-01
Aroclor 1248	12672-29-6	2.0E-01
Aroclor 1254	11097-69-1	2.0E-01
Aroclor 1260	11096-82-5	2.0E-01
<p>Notes:</p> <p>CAS - Chemical Abstracts Service.</p> <p>DQL - Data Quality Levels.</p> <p>NA - Not Available.</p> <p>PCB - Polychlorinated biphenyls.</p> <p>PRG - Preliminary Remediation Goal.</p> <p>(a) Sediment DQLs are based on Region 9 PRGs (May 1, 1998) for residential soil.</p> <p>(b) Due to structural similarities, the value for Naphthalene was used.</p> <p>(c) Due to structural similarities, the value for 4-Nitrophenol was used.</p> <p>(d) Due to structural similarities, the value for Acenaphthene was used.</p> <p>(e) Due to structural similarities, the value for Pyrene was used.</p> <p>(f) Due to structural similarities, the value for Anthracene was used.</p> <p>(g) Due to structural similarities, the value for m-Xylene was used.</p> <p>(h) Due to structural similarities, the value for Thallium carbonate was used.</p> <p>(i) Due to structural similarities, the value for Chlordane was used.</p> <p>(j) Due to structural similarities, the value for alpha-BHC was used.</p> <p>(k) Due to structural similarities, the value for Endosulfan was used.</p> <p>(l) Due to structural similarities, the value for Endrin was used.</p> <p>(m) Due to structural similarities, the value for 1,3-Dichloropropene was used.</p> <p>(n) Due to structural similarities, the value for 2-Nitroaniline was used.</p> <p>(o) Inorganic arsenic considered same value as for total arsenic.</p> <p>(p) No applicable organic arsenic level because it is considered nontoxic.</p>		

**TABLE 1-12c**  
**HUMAN HEALTH RISK-BASED CONCENTRATIONS (RBCs) FOR FISH TISSUE**  
**INDUSTRIPLEX**

Analyte	CAS Number	Fish (a) mg/kg	
<b>Semi-volatile Organics</b>			
1,2,4-Trichlorobenzene	120-82-1	1.4E+01	
1,2-Dichlorobenzene	95-50-1	1.2E+02	
1,3-Dichlorobenzene	541-73-1	1.2E+00	
1,4-Dichlorobenzene	106-46-7	1.3E-01	
2,2'-oxybis(1-chloropropane)	108-60-1	4.5E-02	
2,4,5-Trichlorophenol	95-95-4	1.4E+02	
2,4,6-Trichlorophenol	88-06-2	2.9E-01	
2,4-Dichlorophenol	120-83-2	4.1E+00	
2,4-Dimethylphenol	105-67-9	2.7E+01	
2,4-Dinitrophenol	51-28-5	2.7E+00	
2,4-Dinitrotoluene	121-14-2	2.7E+00	
2,6-Dinitrotoluene	606-20-2	1.4E+00	
2-Chloronaphthalene	91-58-7	1.1E+02	
2-Chlorophenol	95-57-8	6.8E+00	
2-Methylnaphthalene	91-57-6	2.7E+01	(b)
2-Methylphenol	95-48-7	6.8E+01	
2-Nitroaniline	88-74-4	NA	
2-Nitrophenol	88-75-5	1.1E+01	(c)
3,3'-Dichlorobenzidine	91-94-1	7.0E-03	
3-Nitroaniline	99-09-2	NA	
4,6-Dinitro-2-methylphenol	534-52-1	1.4E-01	
4-Bromophenyl phenyl ether	101-55-3	NA	
4-Chloro-3-methylphenol	59-50-7	NA	
4-Chloroaniline	106-47-8	5.4E+00	
4-Chlorophenyl phenyl ether	7005-72-3	NA	
4-Methylphenol	106-44-5	6.8E+00	
4-Nitroaniline	100-01-6	NA	
4-Nitrophenol	100-02-7	1.1E+01	
Acenaphthene	83-32-9	8.1E+01	
Acenaphthylene	208-96-8	8.1E+01	(d)
Anthracene	120-12-7	4.1E+02	
Benz[a]anthracene	56-55-3	4.3E-03	
Benzo[a]pyrene	50-32-8	4.3E-04	
Benzo[b]fluoranthene	205-99-2	4.3E-03	
Benzo[g,h,i]perylene	191-24-2	4.1E+01	(e)
Benzo[k]fluoranthene	207-08-9	4.3E-02	
bis(2-Chloroethoxy)methane	111-91-1	NA	
bis(2-Chloroethyl)ether	111-44-4	2.9E-03	
bis(2-Ethylhexyl)phthalate	117-81-7	2.3E-01	
Butyl benzyl phthalate	85-68-7	2.7E+02	
Carbazole	86-74-8	1.6E-01	
Chrysene	218-01-9	4.3E-01	
Dibenzo(a,h)anthracene	53-70-3	4.3E-04	
Dibenzofuran	132-64-9	5.4E+00	
Diethylphthalate	84-66-2	1.1E+03	
Dimethylphthalate	131-11-3	1.4E+04	
Di-n-butylphthalate	84-74-2	1.4E+02	
Di-n-octylphthalate	117-84-0	2.7E+01	

**TABLE 1-12c**  
**HUMAN HEALTH RISK-BASED CONCENTRATIONS (RBCs) FOR FISH TISSUE**  
**INDUSTRIPLEX**

Analyte	CAS Number	Fish (a) mg/kg	
Fluoranthene	206-44-0	5.4E+01	
Fluorene	86-73-7	5.4E+01	
Hexachlorobenzene	118-74-1	2.0E-03	
Hexachlorobutadiene	87-68-3	4.0E-02	
Hexachlorocyclopentadiene	77-47-4	9.5E+00	
Hexachloroethane	67-72-1	2.3E-01	
Indeno(1,2,3-cd) pyrene	193-39-5	4.3E-03	
Isophorone	78-59-1	3.3E+00	
Naphthalene	91-20-3	2.7E+01	
Nitrobenzene	98-95-3	6.8E-01	
N-Nitroso-di-n-propylamine	621-64-7	4.5E-04	
N-Nitrosodiphenylamine	86-30-6	6.4E-01	
Pentachlorophenol	87-86-5	2.6E-02	
Phenanthrene	85-01-8	4.1E+02	(f)
Phenol	108-95-2	8.1E+02	
Pyrene	129-00-0	4.1E+01	
<b>Volatile Organics</b>			
1,1,1-Trichloroethane	71-55-6	2.7E+01	
1,1,2,2-Tetrachloroethane	79-34-5	1.6E-02	
1,1,2-Trichloroethane	79-00-5	5.5E-02	
1,1-Dichloroethane	75-34-3	1.4E+02	
1,1-Dichloroethene	75-35-4	5.3E-03	
1,2-Dichloroethane	107-06-2	3.5E-02	
1,2-Dichloropropane	78-87-5	4.6E-02	
2-Butanone	78-93-3	8.1E+02	
2-Hexanone	591-78-6	5.4E+01	
4-Methyl-2-pentanone	108-10-1	1.1E+02	
Acetone	67-64-1	1.4E+02	
Benzene	71-43-2	1.1E-01	
Bromodichloromethane	75-27-4	5.1E-02	
Bromoform	75-25-2	4.0E-01	
Bromomethane	74-83-9	1.9E+00	
Carbon Disulfide	75-15-0	1.4E+02	
Carbon Tetrachloride	56-23-5	2.4E-02	
Chlorobenzene	108-90-7	2.7E+01	
Chloroethane	75-00-3	1.1E+00	
Chloroform	67-66-3	5.2E-01	
Chloromethane	74-87-3	2.4E-01	
cis-1,2-Dichloroethene	156-59-2	1.4E+01	
cis-1,3-Dichloropropene	10061-01-5	1.8E-02	(m)
Dibromochloromethane	124-48-1	3.8E-02	
EthylBenzene	100-41-4	1.4E+02	
m/p-Xylene	NA	2.7E+03	(g)
Methylene Chloride	75-09-2	4.2E-01	
Styrene	100-42-5	2.7E+02	
Tetrachloroethene	127-18-4	6.1E-02	
Toluene	108-88-3	2.7E+02	
trans-1,2-Dichloroethene	156-60-5	2.7E+01	

**TABLE 1-12c**  
**HUMAN HEALTH RISK-BASED CONCENTRATIONS (RBCs) FOR FISH TISSUE**  
**INDUSTRIPLEX**

Analyte	CAS Number	Fish (a) mg/kg	
trans-1,3-Dichloropropene	10061-02-6	1.8E-02	(m)
Trichloroethene	79-01-6	2.9E-01	
Vinyl Chloride	75-01-4	1.7E-03	
Xylenes (total)	1330-20-7	2.7E+03	
<b>Inorganics</b>			
Aluminum	7429-90-5	1.4E+03	
Arsenic (Total)	7440-38-2	2.1E-03	(a)
Arsenic (Inorganic)	NA	2.1E-03	(g)
Arsenic (Organic)	NA	NA	(r)
Antimony	7440-36-0	5.4E-01	
Barium	7440-39-3	9.5E+01	
Beryllium	7440-41-7	2.7E+00	
Cadmium	7440-43-9	1.4E+00	(n)
Calcium	7440-70-2	NA	
Chromium	7440-47-3	2.0E+03	(o)
Chromium VI	1854-02-99	4.1E+00	
Cobalt	7440-48-4	8.1E+01	
Copper	7440-50-8	5.4E+01	
Iron	7439-89-6	4.1E+02	
Lead	7439-92-1	NA	
Magnesium	7439-95-4	NA	
Manganese	7439-96-5	1.9E+02	(p)
Mercury	7439-97-6	NA	
Nickel	7440-02-0	2.7E+01	
Selenium	7782-49-2	6.8E+00	
Silver	7440-22-4	6.8E+00	
Thallium	7440-28-0	9.5E-02	(h)
Vanadium	7440-62-2	9.5E+00	
Zinc	7440-66-6	4.1E+02	
<b>Pesticide and PCB</b>			
4,4'-DDD	72-54-8	1.3E-02	
4,4'-DDE	72-55-9	9.3E-03	
4,4'-DDT	50-29-3	9.3E-03	
Aldrin	309-00-2	1.9E-04	
alpha-BHC	319-84-6	5.0E-04	
alpha-Chlordane	5103-71-9	9.0E-03	(i)
beta-BHC	319-85-7	1.8E-03	
delta-BHC	319-86-8	5.0E-04	(j)
Dieldrin	60-57-1	2.0E-04	
Endosulfan I	959-98-8	8.1E+00	(k)
Endosulfan II	33213-65-9	8.1E+00	(k)
Endosulfan sulfate	1031-07-8	8.1E+00	(k)
Endrin	72-20-8	4.1E-01	
Endrin Aldehyde	7421-36-3	4.1E-01	(l)
Endrin Ketone	53494-70-5	4.1E-01	(l)
gamma-BHC (lindane)	58-89-9	2.4E-03	
gamma-Chlordane	5103-74-2	9.0E-03	(i)

**TABLE 1-12c  
HUMAN HEALTH RISK-BASED CONCENTRATIONS (RBCs) FOR FISH TISSUE  
INDUSTRIPLEX**

Analyte	CAS Number	Fish (a) mg/kg
Heptachlor	76-44-8	7.0E-04
Heptachlor epoxide	1024-57-3	3.5E-04
Methoxychlor	72-43-5	6.8E+00
Toxaphene	8001-35-2	2.9E-03
Aroclor-1016	12674-11-2	4.5E-02
Aroclor-1221	11104-28-2	1.6E-03
Aroclor-1232	11141-16-5	1.6E-03
Aroclor-1242	53469-21-9	1.6E-03
Aroclor-1248	12672-29-6	1.6E-03
Aroclor-1254	11097-69-1	1.6E-03
Aroclor-1260	11096-82-5	1.6E-03

## Notes:

CAS - Chemical Abstracts Service.

DQL - Data Quality Levels.

NA - Not Available.

PCB - Polychlorinated biphenyls.

RBC - Risk Based Concentration.

(a) Fish tissue DQLs are based on Region 3 RBCs (April 12, 1999) for fish tissue.

(b) Due to structural similarities, the value for Naphthalene was used.

(c) Due to structural similarities, the value for 4-Nitrophenol was used.

(d) Due to structural similarities, the value for Acenaphthene was used.

(e) Due to structural similarities, the value for Pyrene was used.

(f) Due to structural similarities, the value for Anthracene was used.

(g) Due to structural similarities, the value for m-Xylene was used.

(h) Due to structural similarities, the value for Thallium carbonate was used.

(i) Due to structural similarities, the value for Chlordane was used.

(j) Due to structural similarities, the value for alpha-BHC was used.

(k) Due to structural similarities, the value for Endosulfan was used.

(l) Due to structural similarities, the value for Endrin was used.

(m) Due to structural similarities, the value for 1,3-Dichloropropene was used.

(n) Value for cadmium-food used.

(o) Value for chromium III used.

(p) Value for manganese-food used.

(q) Inorganic arsenic considered same value as for total arsenic.

(r) No applicable organic arsenic level because it is considered nontoxic.

## **2.0 PROJECT ORGANIZATION AND RESPONSIBILITY**

For the sampling and analysis activities to support the Ecological Risk Assessment, the following project organization and responsibilities have been defined. The project team consists of EPA personnel, the Ecological Risk Project Manager, the Chemistry Quality Assurance Officer, the Field Sampling Team, and the analytical Laboratory Project Managers

### **EPA Remedial Project Manager**

The USEPA Region I Remedial Project Manager (RPM), Joe LeMay, has the overall responsibility for all aspects of the Industri-Plex investigations.

### **EPA Quality Assurance Officer**

The EPA Region I Quality Assurance Officer (QAO) is Andrew Beliveau. The EPA QAO has the responsibility for technical evaluation and decisions for the project-specific sampling and analysis protocols defined in this QAPP.

### **ISRT Point-of-Contact**

The ISRT Point-of-Contact is Bruce Yare of Solutia, Inc. He has the overall responsibility for ensuring that the project meets EPA objectives and quality standards. In addition, he is responsible for technical quality control and project implementation and oversight. The ISRT Point-of-Contact will ensure that technical, financial, and scheduling objectives are achieved successfully and will provide the ISRT point of contact and control for matters concerning the project with EPA Region I.

### **Ecological Project Manager and Field Leader for Ecological Risk Assessment**

The Ecological Project Manger and Field Leader for the Ecological Risk Assessment is Charles Menzie, Ph.D., Principal of Menzie-Cura & Associates, Chelmsford, MA. The Ecological Project Manager will provide the high-level technical direction for the ecological risk assessment and will lead and coordinate the day-to-day activities of the various resource specialists under his supervision in support of the Ecological Risk Assessment activities. Responsibilities include the following.

- Provision of coordination with the EPA RPM on technical issues concerning the sampling and analysis activities in support of the Ecological Risk Assessment;
- Development and implementation of the Ecological Risk Assessment Work Plan, this QAPP;
- Coordination and management of field staff for the collection of surface water, sediment, and biota samples and documentation of field observations important for the Ecological Risk Assessment evaluation;

- Implementation of QAPP procedures for the collection and analysis of all samples data;
- Identification of problems at the field team level, discussion of resolutions and implementation of corrective actions, as necessary; and
- Authorship, review, and approval of Ecological Risk Assessment Report for Industri-Plex including coordination and oversight of technical efforts of sub-contractors assisting the ecological risk assessment team.

#### **Ecological Chemistry Quality Assurance Team**

Quality Assurance (QA) oversight for the Ecological Risk Assessment sampling and analysis activities described in this QAPP will be provided by the team of Nancy C. Rothman, Ph.D. and Susan D. Chapnick, MS, principals of New Environmental Horizons, Inc. and associates of Menzie-Cura. Dr. Rothman will provide chemistry QA oversight and technical assistance for all organic analyses and Ms. Chapnick will provide chemistry QA oversight and technical assistance for all inorganic analyses planned in support of the Ecological Risk Assessment. Responsibilities include:

- Preparation of the QAPP in support of the Ecological Risk Assessment;
- Development of project DQOs to support the Ecological and Human Health Assessment activities;
- Coordination with the analytical laboratory and field teams, as necessary, to ensure proper implementation of QAPP procedures;
- Evaluation of data collected during the Reconnaissance Survey and the Main Sampling Program to determine usability of the data for evaluation of ecological risk;
- Technical assistance to the Ecological Project Manager and the EPA RPM, as necessary, for chemistry and QA-related issues.

#### **Technical Staff for the Ecological Risk Assessment Activities**

The technical staff (team members) for this Ecological Risk Assessment will be assembled from Menzie-Cura staff. The technical team staff will be utilized to gather and analyze data, and to prepare various task reports and support materials. All of the designated technical team members are experienced professionals who possess the degree of specialization and technical competence required to effectively and efficiently perform the Ecological Risk Assessment required work. The technical staff includes field observation and environmental sample collection staff, ecological risk assessors, quality assurance professionals, and regulatory experts.

## **Table 2-1 Project Team Members**

### **EPA Region I Regional Project Manager**

Joe LeMay  
EPA - New England, Region I  
1 Congress St.  
Suite 1100 Mail Code HBO  
Boston, MA 02114-2023  
Phone: 617-918-1323  
Fax: 617-918-1291  
Email: LeMay.Joe@epa.gov

### **EPA Quality Assurance Officer**

Andrew Beliveau  
U.S. EPA  
60 Westview St.  
Lexington, MA 02173  
Phone: 781-860-4300  
Fax: 781-860-4397

### **Ecological Project Manager**

Menzie-Cura & Associates, Inc.  
Dr. Charles Menzie  
1 Courthouse Lane, Suite 2  
Chelmsford, MA 01824-1734  
Phone: 978-970-2620  
Fax: 978-970-2791  
Email: charliemen@aol.com

### **Chemistry QA Team**

New Environmental Horizons, Inc.  
Dr. Nancy Rothman  
Susan Chapnick  
63 College Avenue  
Arlington, MA 02474  
Phone: 781-643-4294  
Fax: 908-874-4786  
Email: [chapnick@world.std.com](mailto:chapnick@world.std.com)

**Table 2-1 Project Team Members – continued**

**Analytical Laboratories**

Woods Hole Group Environmental Laboratory  
Helder Costa, Project Manager  
375 Paramount Drive, Suite B  
Raynham, MA 02767-5154  
Phone: 508-822-9300  
Fax: 508-822-3288  
Email: [whale@ultranet.com](mailto:whale@ultranet.com)

Frontier Geosciences, Inc.  
Dirk Wallschlager, Project Mngr.  
414 Pontius North  
Seattle, WA 98109  
Phone: 206-622-6960  
Fax: 206-622-6870  
Email: [dirkw@frontier.wa.com](mailto:dirkw@frontier.wa.com)

Aquatec Biological Sciences  
Phil Downey  
75 Green Mountain Drive  
South Burlington, VT 05403  
Phone: 802-860-1638  
Fax: 802-658-3189

### 3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

The Data Quality Objective (DQO) Process is a series of planning steps based on the Scientific Method that is designed to ensure that the type, quantity, and quality of environmental data used in decision making are appropriate for the intended application. The DQO process is presented in *Guidance for the Data Quality Objectives Process, USEPA QA/G-4 (USEPA 1994a)*. DQOs are quantitative and qualitative statements derived from outputs of each step of the DQO process that:

Clarify the study objective;  
Define the most appropriate type of data to collect; and  
Determine the most appropriate conditions from which to collect the data.

The DQO process is developed through a multi-step process that includes the following:

- Step 1. State the problem to be resolved.
- Step 2. Identify the decision to be made.
- Step 3. Identify the inputs to the decision.
- Step 4. Define the boundaries of the study.
- Step 5. Develop a decision rule.
- Step 6. Specify the tolerable limits on decision errors.
- Step 7. Optimize the design for obtaining the data.

The overall QA objective for this project is to develop and implement procedures for field sampling, laboratory analysis, chain-of-custody, and reporting for surface water, sediment, and biota samples that will provide results which are technically valid for use in the Ecological and Human Health Risk Assessments. This section provides in greater detail specific project DQOs and intended data usages mentioned in Section 1 of this QAPP that were developed through the DQO process.

If there was a discrepancy between the data quality needs of the ecological and human health risk assessments, the ecological assessment needs were prioritized. The data quality objective (DQO) process, compliant with *USEPA Guidance for the Data Quality Objectives Process, EPA QA/G-4, EPA/600/R-96-055*, was performed to define the specific DQOs needed for the risk assessment data uses.

Tables 3-1 through 3-5 define the project-specific DQOs for chemical data collected from samples in support of the Environmental and Human Health Risk Assessments. Specific procedures for sampling, chain-of-custody, laboratory instrument calibration, laboratory analysis, reporting of data, internal QC, audits, preventive maintenance, and corrective action are described in other sections of this QAPP.

### **3.1 Level of Quality Control Effort**

The following specific quality control (QC) parameters will be collected, prepared and analyzed to evaluate the quality of the data generated to support the risk assessments. Tables 3-1 through 3-5 define the level of the quality for the assessment activities through setting project criteria for acceptance of QC sample results. Table 3-6 summarizes the type and frequency of QC samples in support of this QAPP.

Field blanks, laboratory method blanks, field duplicates, laboratory matrix duplicates and matrix spike duplicates, matrix spikes, laboratory control samples, surrogates, laboratory calibration QC, and standard reference materials (SRM) will be analyzed to assess the quality of the data resulting from the field sampling and analysis of the surface water, sediment, and biota samples.

#### **3.1.1 Field Blanks**

Field equipment/rinsate blanks, consisting of distilled, analyte-free, water (preserved with appropriate preservative as provided by the laboratory, see Tables in Section 4) will be carried to the sampling site, exposed to sampling conditions and sampling equipment, and returned to the laboratory to provide the means to assess the quality of the data resulting from the field sampling program. These field blanks are field equipment/rinsate blanks and are analyzed to check for procedural contamination that may have occurred during sample collection or handling in the field, prior to analysis. Field rinsate blanks will be collected daily for all parameters.

Trip blanks are specific to the analysis of volatile organic compounds. For surface water and biota samples, the trip blank consists of organic-free water that is preserved with HCl. The trip blanks for sediment samples to be taken during the Main Sampling Program will consist of 5-mL of VOC-free water in a sealed VOA vial, equivalent to the low-level modified analysis being performed. Methanol trip blanks will be collected associated with high-level VOC sediment samples. The trip blanks employed during the Reconnaissance Survey were both the low-level and high-level (methanol-preserved) types because both types of sediment samples were collected (EPA SW846 Method 5035).

#### **3.1.2 Method Blanks**

Method blank samples are generated within the laboratory and used to assess contamination resulting from laboratory procedures. Results of method blanks provide an estimate of the within-batch variability of the blank response and an indication of bias introduced by the preparation and analytical procedures. They must be performed for each extraction or digestion batch at a minimum frequency of 1 method blank per 20 field samples. Criteria for method blank acceptance for all compounds of interest in biota are listed in Tables 3-1 through 3-5.

#### **3.1.3 Laboratory or Matrix Duplicates and Field Duplicates**

Duplicate samples are two samples taken from, and representative of, the same population and carried through all steps of the sampling and analytical procedures in an identical manner. Two

types of duplicate samples will be performed for this project. The Laboratory or Matrix Duplicate is actually a “subsample” duplicate because it was collected in the field from a composite sediment from a single bowl (see Section 4 for sediment collection procedures). In the laboratory, duplicate samples are analyzed to check for sampling and analytical reproducibility as a measure of precision and representativeness. For organic analyses, a matrix spike duplicate is performed; for inorganic analysis, a matrix duplicate is performed. The duplicate sample is a separate aliquot of a sample (“subsample” duplicate) that the laboratory prepares and analyzes identical to the original sample. The relative percent difference between the duplicate results is a measure of precision and representativeness. Criteria for laboratory matrix duplicates for all inorganic compounds of interest are listed in Tables 3-2. Laboratory or Matrix duplicates will be performed for all media.

The second type of duplicate that will be performed for this project is the Field Duplicate (FD). The FD is a collocated duplicate sample collected separately but physically near the original sample. It will provide a measure of the reproducibility (precision) of the sampling procedures and the representativeness of the samples. Two collocated/separate samples from a single sample location are obtained and prepared and analyzed by the laboratory. Each sample is labeled with a unique sample number, and both are submitted to the laboratory for the appropriate analyses. FD will be collected at the frequency of one pair for the Survey and one pair for the Main Sampling Event for both sediments and surface water. Criteria for FD precision is defined in Tables 3-1 through 3-5.

#### **3.1.4 Matrix Spikes and Matrix Spike Duplicates**

Matrix spikes (MS) and Matrix Spike Duplicates (MSD) provide information about the effect of the sample matrix (media) on the preparation and measurement methodologies. One MS/MSD pair, spiked with the compounds of interest, must be generated for every 20 or fewer samples for each matrix for organic analyses. For inorganic analyses, a single matrix spike and a laboratory or matrix duplicate (i.e., one MS/MD pair) is required for every 20 or fewer samples for each matrix. Criteria for acceptance are based upon percent recoveries of the MS or MSD and are defined for this project in Tables 3-1 through 3-5.

The relative percent difference of the MS/MSD results also gives a measure of the precision and representativeness of the organic data (see above). Tables 3-1, 3-3, 3-4, and 3-5 list the criteria for MS/MSD precision for this QAPP.

#### **3.1.5 Laboratory Control Sample/Standard Reference Material**

A laboratory control sample (LCS) and/or standard reference material (SRM) will be prepared and analyzed with each batch of field samples or at a minimum frequency of one LCS or SRM per 20 samples per matrix. The LCS or SRM will contain the compounds of interest, for organics and inorganics, in an appropriate matrix as available from a reliable, verifiable source (e.g., NIST, certified vendor). The results of the SRM must meet vendor’s limits for acceptance and measures the accuracy of the method. See Table 3-2 for project criteria for inorganic

compounds (metals and cyanide). LCS acceptance criteria for the organic analyses are given in Tables 3-1, 3-3, 3-4, and 3-5.

For metals and organics, standard reference material will be obtained for sediments and tissues (biota), as available, for the compounds of interest. Vendor-generated 95% confidence limits will be the acceptance criteria for the SRMs. For metals and organics, SRMs should be analyzed at a frequency of 1 per 20 sediment or tissue samples or per laboratory sample batch. The SRM can replace the LCS for metals batch QC for sediment and tissue samples.

### **3.1.6 Surrogate Spikes**

A surrogate spike contains pure substances not usually found in nature, with properties that mimic the compounds of interest. This spike is added to all organic samples prior to extraction to assess the accuracy of the method in the sample matrix. Criteria for surrogate spike recoveries are listed in Tables 3-1, 3-3, 3-4, and 3-5.

### **3.1.7 Laboratory Calibration Check Samples**

A variety of QC samples are analyzed for separate analytical methods to assess the accuracy of the analysis on a day-to-day basis. These QC checks, include but are not limited to the following: criteria for initial calibration, continuing calibration, baseline drift, contamination, instrument performance and sensitivity are performed per method requirements by the laboratory. The details of these QC checks are available in the methods referenced in Section 7 of this QAPP and the laboratory specific SOPs for analysis. A summary is presented in Table 3-6.

## **3.2 Precision**

Precision is a measure of the degree to which two or more measurements are in agreement. Field and laboratory precision QC requirements for this project are listed in Tables 3-1 through 3-5. Field and laboratory precision will be assessed through the calculation of relative percent differences (RPD) of the field duplicate results, matrix spike duplicate results, and matrix duplicate results. The equations to be used for calculation of precision criteria in this project can be found in Section 12 of this QAPP.

### **3.2.1 Field Precision Objectives**

Field precision will be assessed through the collection and measurement of field duplicates. Field duplicates will be collected at a minimum frequency of 1 duplicate per 20 samples per media. The total number of samples by media planned for this project is found in Section 4, the FSP portion of this QAPP.

### **3.2.2 Laboratory Precision Objectives**

Laboratory precision will be assessed through the preparation and analysis of matrix spike duplicate samples (for organic compounds) and matrix duplicate samples (for metals) results.

Precision control limits are provided in Tables 3-1 through 3-5 and also in the applicable SOPs as referenced in Section 7 of this QAPP.

### **3.3 Accuracy**

Accuracy is the degree of agreement between an observed value and an accepted reference or true value. Accuracy will be assessed through the evaluation of recoveries of spiked compounds of interest from the samples, as well as the evaluation of standard reference materials (SRM) for tissues, laboratory control samples (LCS), and through the evaluation of field and laboratory blanks. Tables 3-1 through 3-5 provide accuracy criteria for matrix spike (MS) and matrix spike duplicate (MSD) samples, laboratory control samples, and blanks for this program. The equations to be used for accuracy in this project can be found in Section 12 of this QAPP.

#### **3.3.1 Survey Results of Freeze-Drying Sediments on Accuracy of Chemical Data**

During the Reconnaissance Survey for Industri-Plex, dewatered and freeze-dried samples were prepared and analyzed for Site chemicals of concern as listed in Section 1. Duplicate samples were collected from a "contaminated" location in HBHA pond and from a "reference" location in Phillips Pond (SD-3).

As a project-specific measure of the potential affect of freeze-drying sediments on the accuracy of the metals, SVOC, pesticide, and PCB results, aliquots of SRMs were re-constituted to approximate the percent solids of the Site sediments. Then, these re-constituted sediments were freeze-dried using the procedure described in Appendix C-1. These freeze-dried SRMs were then prepared/extracted and analyzed using the methods described in Section 7. The recoveries of the chemicals of concern for the project in these re-constituted, freeze-dried SRMs all met acceptable levels as defined by the 95% confidence limits of these verified standard materials. This is an indication of acceptable accuracy of the freeze-drying method for sediments.

Freeze-dried and non-freeze-dried ("dewatered") split samples of Site sediments from HBHA and Phillips Pond were prepared and analyzed to evaluate potential differences in the Site sediment chemistry due to the freeze-drying technique. Quality control during analysis included field duplicates, addition of surrogates to all samples for organic analyses, method blanks, laboratory control samples for metals, and analysis of Standard Reference Material (SRM). These paired sediment results showed acceptable correlation for metals and most SVOC compounds, based on EPA Region I Inorganic Data Validation (December 1996) criterion of  $\pm 35\%$  (relative percent difference) for acceptability of duplicate pair results in soil/sediments.

The data to support these observations and conclusions have been submitted to the EPA Region I RPM and the EPA QAO.

### **Specific Accuracy Evaluation for Semivolatile Organic Compounds in Freeze-Dried Sediments**

The results of the SRM from the “as received” analyses and the freeze-dried analyses showed good comparability as measured through relative percent difference ( $RPD \leq 11\%$ ) for all analytes indicating that the freeze-drying process does not adversely impact the recovery of semivolatile organic analytes from the SRM. A comparison of the HBHA and SD-3 dewatered results with the HBHA and SD-3 freeze-dried results indicate that, in general, the freeze-dried aliquots recovered higher concentrations of the analytes than were observed in the dewatered samples. This observation may be the result of a higher extraction efficiency in the freeze-dried analysis as compared to the dewatered analysis since more solid sample was extracted for the freeze-dried analysis. For example, for HBHA, the dewatered percent solids of the sample was 16% while the freeze-dried percent solids for this same aliquot was 54%. For extraction of each sample, approximately 30g of total sample was used, which for the dewatered sample translates to 4.8g of solid and for the freeze-dried sample was equivalent to 16.2g of solid extracted. Therefore, higher concentrations in the freeze-dried analyses may be due to the higher amount of solids extracted during this analysis.

Sample SD-3 (reference location in Phillips Pond) results for the freeze-dried aliquots were approximately 100-200% higher than the dewatered analyses while the HBHA results for the freeze-dried aliquots were 0-100% higher than the dewatered analyses. Evaluation of the dewatered duplicates and freeze-dried duplicates for SD-3 suggests more sample heterogeneity in the SD-3 aliquots than was observed in the HBHA sample aliquots (i.e., RPD between duplicate aliquots was higher in the SD-3 than in the HBHA). Andy Beliveau, EPA Region I QA Officer, was present during the Reconnaissance Survey and indicated that the reference location in Phillips Pond was less well defined than the HBHA location and that perhaps the sample heterogeneity may have been a result of the SD-3 sampling location. Therefore, the higher SD-3 results for the freeze-dried analyses may have been impacted by both increased extraction efficiency and sample heterogeneity.

The reconnaissance results for semivolatile analysis suggest that: 1) freeze-drying is an acceptable process for preparing the samples for analysis, and 2) that the reference site sampling must be done in the center of this pond location, rather than at the edges, to try and improve sample homogeneity.

#### **3.3.2 Field Accuracy Objectives**

Accuracy in the field will be assessed through the use of field blanks and through the strict adherence to all sample handling, preservation, and holding times to maintain the integrity of the samples.

### **3.3.3 Laboratory Accuracy Objectives**

Laboratory accuracy will be assessed through the analysis of MS/MSD, standard reference materials (SRM), laboratory control samples (LCS) and surrogate compounds, and the determination of percent recoveries. Accuracy control limits are given in Tables 3-1 through 3-5 and also in the applicable SOPs as referenced in Section 7 of this QAPP.

### **3.4 Sensitivity - Reporting Limit Requirements**

The sensitivity or reporting limit requirements for this project were defined to meet Ecological and Human Health Risk Assessment requirements. Tables 1-1 through 1-10 list the compounds of concern, the media to be sampled and analyzed, and the environmental project-required reporting limits for the level of detection.

These reporting limits will be achieved in samples through following the procedures as specified in this QAPP in Section 7. Note that the achievable reporting limits in the samples may be affected by matrix interferences. Sample cleanups, such as GPC and silica gel, may be performed by the laboratory to minimize matrix effects and to obtain project-reporting limits.

During the Reconnaissance Survey, Site sediment samples were collected to test the effect of the freeze-drying technique on the sample detection limits. Since sediment sample detection limits are reported on a dry-weight basis for comparison to risk levels, the percent solids of the sample affects the detection levels. The freeze-drying technique was tested to see if it would improve the percent solids of the samples such that the project-required reporting limits for risk assessment could be met. The freeze-dried sediments showed lower sample detection limits for all compounds due to the increase in percent solids of the samples during the freeze-drying technique. The result of the percent solids determinations for freeze-dried and non-freeze-dried sediments are listed in the following table. The full set of chemical results as reported by the laboratory were previously submitted to the USEPA RPM (Joe LeMay) and the USEPA QAO (Andy Beliveau).

**Comparison of Percent Solids for Different Sample Preparation Techniques  
 Reconnaissance Survey Results  
 April 29-30, 1999**

<b>Sample ID</b>	<b>Percent Solids Non-Freeze-Dried Sediment</b>	<b>Percent Solids Freeze-Dried Sediment</b>
HBHA Pond Deep Sample	13.2 %	69.4 %
HBHA Pond Deep Field Duplicate Sample	16.0 %	54.0 %
Phillips Reference Pond SD-03	27.0 %	65.6 %
Phillips Reference Pond SD-03 Field Duplicate Sample	23.7 %	72.8 %

**3.5 Completeness**

Completeness is a measure of the amount of valid and usable data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. The equation for completeness is presented in Section 12 of this QAPP.

**3.5.1 Field Completeness Objectives**

Field completeness is a measure of the amount of valid and usable measurements obtained from all the field measurements as well as the successful execution of all planned field activities. Note that to support the environmental risk assessment, field completeness refers to the collection of samples, measurement of field parameters and the documentation of ecological observations on Site. The field completeness objective for this project is greater than or equal to 90 percent.

**3.5.2 Laboratory Completeness Objectives**

Laboratory completeness is a measure of the amount of valid and usable results obtained from all the measurements taken in the project. The laboratory completeness objective for this project, with respect to the chemical data being generated for surface water, sediment, and biota in support of the Environmental Risk Assessment (see Tables 1-1 through 1-10 of this QAPP) is greater than or equal to 90 percent.

### **3.6 Representativeness**

Representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition within a defined spatial and/or temporal boundary. Representativeness is dependent upon the proper design of the sampling program. The field sampling rationale, as presented in the Environmental Risk Assessment Work Plan in Section 4 of this QAPP, has been developed to collect representative samples of media to assess environmental and human health impacts at the Industri-Plex Site locations.

#### **3.6.1 Measures to Ensure Representativeness of Field Data**

Representativeness is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the procedures described in the Environmental Risk Assessment Work Plan and the field sampling procedures in Section 4 of this QAPP are followed. The media of concern for sampling in this QAPP are surface waters, sediments, benthic invertebrates, vegetation, and fish. One measure of the representativeness of the samples to the Site includes the precision of the field duplicate measurements.

#### **3.6.2 Measures to Ensure Representativeness of Laboratory Data**

Representativeness in the laboratory is ensured by using the analytical procedures defined in this QAPP (see Section 7), maintaining proper preservation and meeting sample holding times to maintain sample integrity, performing appropriate homogenization and aliquoting procedures to ensure representative samples for analysis, and analyzing and assessing field and laboratory duplicate samples.

### **3.7 Comparability**

Comparability is an expression of the confidence with which one data set can be compared to another. Comparability is dependent upon the proper design of the field sampling and analytical measurement program.

#### **3.7.1 Measures to Ensure Comparability of Field Data**

Comparability is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the field sampling and measurement procedures detailed in Section 4 of this QAPP and associated Field SOPS (see Appendix B) are followed.

#### **3.7.2 Measures to Ensure Comparability of Laboratory Data**

Planned analytical data will be comparable when similar sampling and analytical methods are used and documented as required by this QAPP. Comparability is also dependent on similar QA objectives. As such, comparability of data for the media to be sampled and analyzed in support of the Environmental Risk Assessment will be achieved through the following activities:

- following the sampling procedures for collection of samples as described in Section 4 of this QAPP;

- using standard EPA methods or other standard protocols for analysis of samples as described in Section 7 of this QAPP; and
- evaluating the validity and usability of the data generated for the risk assessment using standard EPA procedures and QA/QC criteria defined in this QAPP as described in Section 9 of this QAPP and Appendix D.

**Table 3-1a. Analytical Laboratory Data Quality Objectives for Precision and Accuracy for Semivolatile Organic Compound Analyses of Surface Water Samples**

PARAMETER	QC COMPOUNDS	FIELD <sup>a</sup> DUPLICATE PRECISION ( RPD)	MS/MSD <sup>b</sup> PRECISION ( RPD)	BLANKS	LCS& MS/MSD <sup>a</sup> ACCURACY (% REC)	SURROGATE <sup>a</sup> ACCURACY (% RECOVERY)
Semivolatile Analysis	All analytes	≤30		≤ 5x RL for phthalates ≤ RL for all others		
	phenol		≤ 42		12-110	
	2-chlorophenol		≤ 40		27-123	
	1,4-dichlorobenzene		≤ 28		36-97	
	N-nitroso-di-n-propylamine		≤ 38		41-116	
	1,2,4-trichlorobenzene		≤ 28		39-98	
	p-chloro-m-cresol		≤ 42		23-97	
	acenaphthene		≤ 31		46-118	
	4-nitrophenol		≤ 50		10-80	
	2,4-dinitrotoluene		≤ 38		24-96	
	pentachlorophenol		≤ 50		9-103	
	pyrene		≤31		26-127	
	nitrobenzene-d <sub>5</sub>					35-114
	2-fluorobiphenyl					43-116
	terphenyl-d <sub>14</sub>					33-141
	phenol-d <sub>5</sub>					10-110
	2-fluorophenol					21-110
2,4,6-tribromophenol					10-123	
2-chlorophenol-d <sub>4</sub>					33-110 *	
1,2-dichlorobenzene-d <sub>4</sub>					16-110 *	

NOTES: \* Advisory Limits Only      RL = Project Reporting Limit

<sup>a</sup> Provisions for wider acceptance limits near the RL may be based on professional judgment during data review/validation.

<sup>b</sup> Limits are based on those given in the USEPA Contract Laboratory Program, Statement of Work for Organic Analysis, Multi-media, Multi-concentration Revision OLM03.1.



**Table 3-2. Analytical Laboratory Data Quality Objectives for Precision and Accuracy for Metals, AVS/SEM, and TOC Analyses**

Parameter	Matrix	QC Analytes	FIELD <sup>a</sup> DUPLICATE PRECISION ( RPD)	Sample/MD Precision (RPD)	MS Accuracy (% Recovery)	Blanks	LCS/SRM Accuracy (% Recovery)
Metals (including arsenic III and V species)	Surface Water	All analytes	≤30	<20% RPD for results >5x RL; difference <± RL for results <5x RL	75-125 <sup>b</sup>	< ± RL	80-120 or SRM Vendor's Control Limits at 95% confidence limit
Metals (including arsenic III and V species) AVS/SEM <sup>c</sup> TOC <sup>c</sup>	Sediments and Biota	All analytes	≤50	<35% RPD for results >5x RL; difference <± 2x RL for results <5x RL	75-125 <sup>b</sup>	< ± RL	80-120 or SRM Vendor's Control Limits at 95% confidence limit
NOTES:							
<sup>a</sup> Provisions for wider acceptance limits near the RL may be based on professional judgment during data review/validation. <sup>b</sup> Unless the sample concentration exceeds the spike added concentration by a factor of 4 or more. <sup>c</sup> TOC and AVS/SEM in sediments only. For TOC no matrix spike analysis is performed.							

**Table 3-3. Analytical Laboratory Data Quality Objectives for Precision and Accuracy for Volatile Organic Compound Analyses**

Parameter	Matrix	QC Compounds	FIELD <sup>a</sup> DUPLICATE PRECISION ( RPD)	MS/MSD Precision (RPD) <sup>b</sup>	Blanks	LCS& MS/MSD <sup>a</sup> ACCURACY (% REC)	Surrogate <sup>a</sup> Accuracy (% Rec)
Volatile Organic	Surface Water	All analytes	≤30	≤ 14	< 2.5 x RL for methylene chloride; <5 x RL for acetone, 2-butanone; <RL for all other analytes	61-145	88-110 86-115 76-114
		1,1-dichloroethene		≤ 14		71-120	
		trichloroethene		≤ 11		76-127	
		benzene		≤ 13		76-125	
		toluene		≤ 13		75-130	
		chlorobenzene					
		toluene-d <sub>8</sub>					
bromofluorobenzene							
1,2-dichloroethane-d <sub>4</sub>							
Volatile Organic	Sediments	All analytes	≤50	≤ 22	< 2.5 x RL for methylene chloride; <5 x RL for acetone, 2- butanone; <RL for all other analytes	59-172	84-138 59-113 70-121
		1,1-dichloroethene		≤ 24		62-137	
		trichloroethene		≤ 21		66-142	
		benzene		≤ 21		59-139	
		toluene		≤ 21		60-133	
		chlorobenzene					
		toluene-d <sub>8</sub>					
bromofluorobenzene							
1,2-dichloroethane-d <sub>4</sub>							

NOTES: RL = Project Reporting Limit

<sup>a</sup> Provisions for wider acceptance limits near the RL may be based on professional judgment during data review/validation.

<sup>b</sup> Limits are based on those given in the USEPA Contract Laboratory Program, Statement of Work for Organic Analysis, Multi-media, Multi-concentration Revision OLMO3.1.

**Table 3-4. Analytical Laboratory Data Quality Objectives for Precision and Accuracy for Pesticide Analyses**

PARAMETER	Matrix	QC COMPOUNDS	FIELD <sup>a</sup> DUPLICATE PRECISION ( RPD)	MS/MSD <sup>b</sup> PRECISION ( RPD)	BLANKS	LCS& MS/MSD <sup>a</sup> ACCURACY (% REC)	SURROGATE <sup>a</sup> ACCURACY (% REC)
Pesticides	Surface Water	All analytes gamma-BHC (lindane) heptachlor aldrin dieldrin endrin 4,4'-DDT tetrachloro-m-xylene decachlorobiphenyl	≤30	≤ 15 ≤ 20 ≤ 22 ≤ 18 ≤ 21 ≤ 27	< RL	56-123 40-131 40-120 52-126 56-121 38-127	30-150 30-150
Pesticides	Sediment and Biota	All analytes gamma-BHC (lindane) heptachlor aldrin dieldrin endrin 4,4'-DDT tetrachloro-m-xylene decachlorobiphenyl	≤50	≤ 50 ≤ 31 ≤ 43 ≤ 38 ≤ 45 ≤ 50	< RL	46-127 35-130 34-132 31-134 42-139 23-134	30-150 30-150

NOTES: RL = Project Reporting Limit  
<sup>a</sup> Provisions for wider acceptance limits near the RL may be based on professional judgment during data review/validation.  
<sup>b</sup> Limits for Pesticides are based on those given in the USEPA Contract Laboratory Program, Statement of Work for Organic Analysis, Multi-media, Multi-concentration Revision OLMO3.1.

**Table 3-5. Analytical Laboratory Data Quality Objectives for Precision and Accuracy for PCB Aroclor Analyses**

PARAMETER	Matrix	QC COMPOUNDS	FIELD <sup>a</sup> DUPLICATE PRECISION ( RPD)	MS/MSD <sup>b</sup> PRECISION ( RPD)	BLANKS	LCS& MS/MSD <sup>a</sup> ACCURACY (% REC)	SURROGATE <sup>a</sup> ACCURACY (% REC)
PCB Aroclors	Surface Water	All analytes AR1254 tetrachloro-m-xylene	≤30	≤ 30	< RL	70-130	70-130
PCB Aroclors	Sediment and Biota	All analytes AR1254 tetrachloro-m-xylene	≤50	≤ 50	< RL	70-130	70-130

NOTES: RL = Project Reporting Limit

<sup>a</sup> Provisions for wider acceptance limits near the RL may be based on professional judgment during data review/validation.

<sup>b</sup> Limits for PCB Aroclor analysis are based on broad limits given in SW-846, 3<sup>rd</sup> Edition, Method 8000B, and must be modified to laboratory's limits for Accuracy and Precision based on analysis of samples. The MS/MSD should contain the most representative PCBs for the site.

**Table 3-6. Summary of QC Sample Types, Criteria, and Corrective Action**

**Field Generated QC Samples**

<b>TYPE</b>	<b>PURPOSE</b>	<b>FREQUENCY</b>	<b>CRITERIA</b>	<b>CORRECTIVE ACTION</b>
<b>Field Blank (Field Rinsate and Trip Blanks)</b>	Evaluate cleanliness of sample containers and sample handling and collection procedures	1 per media per 10 field samples collected for sediments and surface water (if equipment used in collection)	All compounds of interest $\leq$ RL	Qualify data
<b>Field Duplicate (collocated)</b>	Evaluate precision and representativeness taking into account variability of sample matrix	1 per media for sediments and surface water	$\pm 30\%$ RPD for surface waters, $\pm 50\%$ RPD for other media with provisions for wider acceptance limits near the detection limits	Compare to matrix duplicates, check for possible matrix interferences or improper sample collection procedure, qualify data
<b>Matrix Spikes and Duplicates (MS/MSD/MD) (subsample duplicates and spikes)</b>	Evaluate precision and accuracy taking into account variability of sample matrix	1 set per media per 20 field samples	Recoveries for MS/MSD specified in Tables 3-1 through 3-5. RPD for sample/MD in Table 3-2.	Qualify data for matrix effect if LCS/SRM is acceptable.

**Table 3-6. Summary of QC Sample Types, Criteria, and Corrective Action - continued**

**Laboratory Generated QC Samples**

TYPE	PURPOSE	FREQUENCY	CRITERIA	CORRECTIVE ACTION
<b>Laboratory Control Sample (LCS) and Standard Reference Material (SRM)</b>	Evaluate laboratory performance (accuracy) using verified standards from an outside source	1 per media per 20 field samples or per laboratory sample batch, whichever is more frequent	Vendor-supplied: Within the 95% confidence interval/ vendor supplied limits  Lab-generated: recoveries as specified in Tables 3-1, 3-3, 3-4, 3-5	Re-prepare and re-analyze associated samples to obtain acceptable LCS/SRM. Check if MS/MSD acceptable to compare for matrix effects
<b>Calibration Check Sample</b>	Verifies calibration curve	Minimum of 1 per analytical batch per day	90-110% recovery for inorganics; as specified in EPA methods for organics listed in Table 7-1	Recalibrate; check system
<b>Method Blank</b>	Verifies clean reagents, instrument systems, and lab procedures	Minimum of 1 per analytical batch or per 20 field samples; whichever is more frequent	All compounds of interest < RL	Reanalyze; if second blank exceeds criteria, clean and recalibrate system; document corrective action
<b>Surrogate Standards</b>	Measures recoveries in actual sample matrices	All GC/MS and all GC samples for organic analyses	Recoveries as specified in Tables 3-1, 3-3, 3-4, 3-5	Reanalyze samples; qualify data
<b>Internal Standards</b>	Provides standard for calculating analyte response and concentrations	All GC/MS and GC samples for organic analyses	Recoveries as specified in the EPA methods listed in Table 7-1.	Reanalyze samples; qualify data

RL = Reporting Limit  
 MS = Matrix Spike Sample  
 MSD = Matrix Spike Duplicate Sample  
 MD = Matrix Duplicate Sample  
 RPD = Relative Percent Difference (between duplicate results)

GC = Gas Chromatography  
 GC/MS = Gas Chromatography/Mass Spectrometry  
 LCS = Laboratory Control Sample  
 SRM = Standard Reference Material

## **4.0 ECOLOGICAL ASSESSMENT FIELD SAMPLING PLAN**

### **4.1 Study Area**

The study area includes the HBHA Pond, HBHA Wetlands, a segment of the Aberjona River downstream of Mishawum Road, and several water bodies that will serve as Reference Locations for the study (Halls Brook, Northern Branch of the Aberjona River, Phillips Pond, and North Pond.) The water body referred to, as South Pond is located just north of the berm that forms the northern boundary of the Site (Figure 4-1).

The HBHA Pond is characterized by a relatively narrow and flat littoral zone (typically less than three feet deep) along the western, northern, and southern edges of the pond. In some places this littoral "lip" extends to a few feet from shore while in others (e.g., along the western shore) it extend to approximately 40 feet. Most of the pond consists of a dug basin with depths of 8 to 15 feet. The demarcation between the shallow littoral lip and deep basin is sharp and occurs over horizontal distances of a few feet. The deeper locations of HBHA Pond have been observed to stratify vertically, and anoxic conditions can develop beneath the thermocline. At such times, animals that require oxygen (e.g., fish and benthic invertebrates) cannot make use of this zone as habitat. The HBHA Pond and HBHA Wetlands are separated from the downstream portion of the Aberjona watershed by a weir at Mishawum Road. Therefore, the HBHA Pond and HBHA Wetlands can be considered a small-scale pond/wetland system. HBHA Pond is 4.2 acres in size. Vegetation occurs along the banks of the HBHA Pond and HBHA Wetlands and these bordering areas are known to support birds and some wildlife.

### **4.2 Field Sampling Rationale and Sampling Locations**

The plan for sampling to support the risk assessments (ERA and HERA) is based on the August 25, 1998 letter from the USEPA, discussions that have occurred among scientists and managers at the U.S. Environmental Protection Agency (USEPA), U.S. Fish and Wildlife Service (USFWS), National Oceanic and Atmospheric Administration (NOAA), and representatives for the ISRT including its consultant Menzie-Cura & Associates. A number of questions and issues raised during these discussions were addressed by conducting an Ecological Reconnaissance Field Survey (Reconnaissance Survey) in April 1999. The USEPA is also checking the physical characteristics of certain potential sediment sampling locations and this information will be used to finalize the locations. The Main Sampling Program is planned for June 14 – June 23 1999.

Table 4-1 lists the sample locations for the 13 sampling stations. Tables 4-2 through 4-9 list number of samples, sample preservation, containers and holding times for all media and all analyses. Table 4-10 lists the sample preservation, container, and holding time requirements for the field and trip blanks.

#### 4.2.1 Reconnaissance Survey Objectives and Results

The Reconnaissance Survey was performed on April 29-30, 1999. The objectives of the Survey were to:

1. Select a downstream sampling location in the Aberjona River that exhibited depositional characteristics;
2. Visit potential Reference Locations and select locations appropriate for comparison to Halls Brook Holding Area (HBHA) and HBHA Downstream locations (including Ponds 1-3);
3. Field-test sediment sampling equipment to determine what will be needed for the main sampling event;
4. Field-test de-watering methods for sediment sample collection;
5. Evaluate modifications of analytical methods including the use of freeze-drying techniques; and
6. Qualitatively evaluate biological conditions and physical habitat structure with respect to the collection of benthic invertebrates (for assessment and for tissue analysis), emergent and submergent vegetation (for tissue analysis), and fish (for assessment and tissue analysis).

In addition to the above objectives, USEPA personnel collected sediment for the analysis of acid volatile sulfides and simultaneously extracted metals (AVS/SEM). Personnel from the US Fish and Wildlife Service (USFWS) and the National Oceanographic and Atmospheric Administration (NOAA) examined sites for electroshocker boat access and for use as fish Reference Locations.

Sediments collected from each of the 13 locations were sampled for physical parameters including total organic carbon (TOC), percent solids, and grain size distribution. These collections were made to obtain information for judging the comparability of stations. In particular, the information is used to establish whether stations are depositional (i.e., characterized by higher percentages of silt and clay as well as total organic carbon.) These analyses are also used to evaluate the relative effectiveness of de-watering in the field and freeze drying for increasing solids content of sediments; this was identified as an important issue for achieving adequate detection levels.

Sediments from two locations, HBHA Pond Deep and SD-3, were collected in duplicate for chemical analysis including volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, PCBs, and metals (including arsenic species III and V). These collections were made to evaluate proposed modifications to analytical methods and to evaluate the effect of freeze drying on chemical analytes.

Sediment sample aliquots were split for freeze-drying preparation to compare the accuracy of the methods for analysis of these chemicals from freeze-dried sediment vs. non-freeze dried sediments. The goal of the freeze-drying protocol is to elevate the percent solids of the samples, without altering the chemistry, and therefore improve the achievable sediment reporting limits on a dry-weight basis.

For VOCs, both low-level (sodium bisulfate preserved) and high-level (methanol preserved) sediment samples were collected to evaluate the method 5035 options for these sediments in meeting the project DQOs. Additionally, a low-level modification (5ml VOA-free water preserved) was performed.

The analytical and observational results of the Survey are provided in Appendix A. Information from the survey is incorporated into the planning of the Main Sampling Program and is included as part of the rationale sections for certain elements of the program. Chemical results from the analytical laboratory were provided to the USEPA Region I, RPM and QAO for review and comment.

#### **4.2.2 Main Sampling Program**

The Main Sampling Program is scheduled for June 14 – 23, 1999 and consists of:

- Collection of sediment samples at 13 locations for chemical and physical analyses for use in the Ecological Risk Assessment (ERA) and as part of the sediment triad approach;
- Collection of sediment samples at 13 locations for sediment toxicity tests for use in the ERA and as part of the sediment triad approach;
- Collection of benthic invertebrates at 13 locations for analysis of community structure for use in the ERA and as part of the sediment triad approach;
- Collection of benthic invertebrates for chemical analyses of tissues for use in assessing effects on these organisms and in the food chain models used in the ERA;
- Collection of surface water samples at 13 locations. Three of these locations are deep (> 8') and surface and deeper water samples (above the bottom) will be sampled. This yields 16 water samples for chemical analysis for use in the ERA and to evaluate the source of arsenic (i.e., by examining speciation of arsenic);
- Collection of fish samples for chemical analysis for use in the ERA and for the Human Health Risk Assessment (HERA);
- Observations on the fish community and their habitat for use in the ERA

- Collection of vegetation for chemical analysis for use in bird and mammal food chain models used in the ERA;

All of the above sampling and analysis activities will be performed under the direction of Menzie-Cura and Associates, with the exception of the fish sampling which will be performed by USFWS. Menzie-Cura and USFWS will coordinate during this activity and Menzie-Cura will select fish for tissue analyses. The selection of these fish will be guided by discussions between USFWS, USEPA, and Menzie-Cura. USEPA will also participate in various sampling activities and will provide on-site Agency oversight. USEPA and Menzie-Cura will perform evaluations of benthic habitats. The USFWS will evaluate the habitat for sustainability of fish.

The type (media) of samples to be collected and the chemical, physical, and toxicity analyses to be performed in support of the Main Sampling Program for this Industri-Plex Site investigation are summarized in Section 1, Tables 1-2 through 1-4.

Types and frequencies of field quality control (QC) samples, including Field Duplicates, Field Rinstate Blanks and sample volumes for matrix QC (MS/MSD/MD) are described in Section 3 of this QAPP. Analytical methods to be used for analyses are presented in Section 7 of this QAPP.

#### **4.2.3 Sample Locations**

Sample locations for the Main Sampling program are listed in Table 4-1 and shown on Figure 4-1. These locations were initially identified by USEPA and confirmed during the Reconnaissance Survey (Appendix A). Navigational coordinates for all sampling locations are established in the field using a Geographical Positioning System (GPS) as well as by line-of-sight.

**Table 4-1. Locations of the 13 Sampling Stations for Surface Water and Sediment**

<b>Location</b>	<b>Longitude (from GPS)</b>	<b>Latitude (from GPS)</b>
SD-01 (S. Branch of Aberjona east of Acadia St.)	71 07 24.0538 W	42 31 44.5577 N
SD-02 (South Pond)	71 08.6546 W	42 31.3426N
SD-03 (Phillips Pond)	71 07.9605 W	42 31.0135 N
SD-04 (Halls Brook Reference Location)	71 08 52.727023489 W	42 30 47.270006017 N
SD-05 (deep station at northern end of HBHA Pond)	71 08 28.291937546 W	42 30 46.710953435 N
SD-06 (west side of HBHA Pond, below Halls Brook)	71 08.4734 W	42 30.7551 N
SD-07 (deep station at southern end of HBHA Pond)	71 08.4254 W	42 30.6925 N
SD-08 (Stream segment in HBHA Wetland)	71 08 18.404373293 W	42 30 31.545846368 N
SD-09 (HBHA Wetland Pond #1)	71 08.3002 W	42 30.4131 N
SD-10 (stream segment in HBHA Wetland)	71 08.2272 W	42 30.2839 N
SD-11 (Pond 3 in HBHA Downstream)	71 08 07.044307109 W	42 30 14.902602803 N
SD-12 (Halls Brook Reference Location upstream of SD-04)	71 08.9418 W	42 30.7507 N
SD-13 (Aberjona north of Olympia)	71 08 03.409536975 W	42 29 57.463215787 N

Based on the results of the Reconnaissance Survey, several potential sampling locations were found to be non-depositional. During conversations with Joe LeMay and Patti Tyler of USEPA in May and early June, options for re-allocation of these stations were discussed. The Agency is also checking the physical characteristics of sediments at a few locations in Halls Brook, Phillips Pond and HBHA to help reach a final decision about sample locations. The current strategy and options for establishing the remaining stations are as follows.

1. Because the Reconnaissance Survey indicated that shallow locations in HBHA Pond (< 3' depth) are relatively sandy and non-depositional, the Agency has decided that there should be two deep locations and one shallow location (rather than two shallow and one deep location as initially proposed). Station SD-5 was established as a deep location during the Reconnaissance Survey. The second deep location will be identified as SD-6 and is established at the southern (down current) end of HBHA Pond in a deeper location of the pond as indicated by a bathymetric map of the pond. Water depths in this general area were checked during the Reconnaissance Survey and found to be approximately 12'. Sediments at this location are known to be depositional "soupy mud".
2. A shallow station (SD-7) will be established in HBHA Pond following USEPA's sediment survey.
3. Two locations in HBHA downstream (SD-8 and SD-10) are located in stream segments. Examination of the tentative location for SD-8 indicated that it is in a segment characterized by firm silty-sand sediment. This probably reflects the effects of faster water currents flowing over this location. USEPA requested that SD-8 and SD-10 be located in as depositional an area as possible within these stream segments. This will require additional examination of these locations and USEPA's contractor is examining these reaches for possible sampling locations. Additional data on the sediment characteristics are expected to be available from USEPA around June 9, 1999 and will be used to finalize locations for SD-8 and SD-10. USEPA will communicate this information to Menzie-Cura and will participate in the Main Sampling Program to insure that the correct locations are sampled.
4. If USEPA's examination of conditions in shallow areas of HBHA Pond and HBHA Wetland indicate that it is prudent to have a reference location that has a higher sand content, the Agency will consider the following: a) request the ISRT to consider an additional Reference Location (increasing the station number from 13 to 14), b) moving one of the non-reference stations (probably SD-12 located in the tributary to HBHA) to a Reference Location. To this end, the Agency is examining locations in Phillips Pond and Halls Brook that are less depositional.

## 4.3 Surface Water Sampling

### 4.3.1 Water Sample Collection

Surface water samples will be collected at the 13 Site locations identified in Table 4-1. Water depths at SD-1, SD-2, SD-4, SD-7, SD-8, SD-9, SD-10, SD-11, SD-12, and SD-13 are relatively shallow ranging between 0.5 and 3.5'. At these locations, a single water sample will be collected at mid-depth to represent water column conditions. Three sample locations – SD-3 in Phillips Pond and SD-5 and SD-6 in HBHA Pond – are deeper locations with water depths of 8' and greater. At these three locations a water sample will be collected at the surface and an additional water sample will be collected within 2 feet above the bottom (~ 7 - 10' water depth).

Surface water samples will be collected using the standard operating procedure, *Surface Water Sampling* (Appendix B). Water samples collected from depths of two feet and shallower will be obtained by lowering decontaminated bottles to the desired depth and allowing them to fill. Water from these bottles will be used either as samples or to fill other bottles. The mouth of the bottle will be orientated upstream to minimize the potential for contamination. If water depths are less than 0.5' (perhaps due to low water flow conditions at locations in June), samples will be collected with a decontaminated wide mouth sampling jar. A number of small samples may need to be collected in this manner and combined. Where depth permits (> 2' depth), decontaminated Niskin or Kemmerer water sample devices will be used to collect surface water samples. In all cases, the performance criteria for sampling are to collect water samples in a manner that prevents contamination from the sediments, minimizes the potential for contamination by the sampling system, and provides a representative sample of the water column. Potential contamination of surface water samples by sediments will also be minimized by either conducting all surface water sampling prior to the sediment sampling event or by performing surface water sampling prior to any sediment sampling at a location (if the sampling events are combined.) In either case, sampling will begin at the most downstream location (SD-13) and proceed upstream.

Water samples will be collected from the deep sections of the HBHA pond. These samples will be collected using a decontaminated Niskin or Kemmerer sampling device lowered to the specified depth (within 2 feet of the bottom). This is to evaluate exposure that may occur in these deeper waters and to examine the possible discharge/diffusion contributions of arsenic. Vertical variations of temperature, dissolved oxygen, and conductivity have been observed in HBHA pond indicating that this pond becomes stratified. Thus, contaminant concentrations may also vary with water depth. Arsenic speciation (as As III and As V) will be performed on the water samples collected from HBHA Pond. For comparison to a reference location, a shallow water and deep water sample will also be collected in Phillips Pond for the same analyses. This will assist in evaluating the origins of arsenic relative to surface water and future groundwater analysis, as well as specific arsenic levels for each species. Based upon previous

sampling results, USEPA expects higher arsenic concentrations to be present at depth (1-2 feet from the bottom) due to groundwater discharge, and/or desorption from sediment.

#### **4.3.2 Water Sample Analytes, Containers, and Shipment Requirements**

All surface water samples will be analyzed for VOCs, SVOCs, Pesticides, PCBs, total metals (unfiltered samples), dissolved (filtered samples), hardness, TOC, and TSS. Table 1-1 presents the chemical analytical parameters for surface water samples. Volatile organic samples will be drawn first and analyzed for VOCs. Two aliquots for all surface water samples at each location will be collected for metals so that the laboratory can filter one aliquot (through 0.45 $\mu$ m pore-size filtration unit) for analysis of dissolved metals and the other aliquot will be digested for total metals. Table 4-2 lists sample container types, preservation, and holding times for all analyses. All samples will be stored on ice, maintained at 4°C and delivered to the laboratory via courier on the same day of collection or via FedEx for next day delivery.

Information on sample containers, preservation techniques, and holding times is provided in Table 4-2. Field duplicates, field blanks and MS/MSD/MD samples for QC will be collected at frequencies as described in Section 3 of this document.

#### **4.3.3 Supporting Measurements for Surface Water Quality**

At each location, the following water quality parameters will be measured in the field: dissolved oxygen, specific conductivity, temperature, pH, and turbidity. At locations with depths of less than 2', measurements will be made at mid-depth. At locations with depths of greater than 2', measurements will be made at the surface and at the bottom of the water column. At the deep sampling locations in Phillips Pond and HBHA Pond, measurements will be made at the surface, bottom, above the pycnocline/thermocline, within the pycnocline/thermocline, and below the pycnocline/thermocline. Water quality measurements will be made using a YSI 600XL meter for dissolved oxygen, specific conductivity, temperature, and pH and a Hariba turbidometer for qualitative turbidity measurements (as an indication of light penetration). Calibration of field equipment will be performed as described in Section 6 of this QAPP and U.S.EPA Region I's Draft Calibration of Field Instruments, as appropriate (Appendix A).

**Table 4-2. Surface Water Samples: Number, Preservation, Container Specification, and Holding Time Requirements in Support of the Environmental Assessment.**

Parameter	Number of Samples	Sample Container(s)	Preservative	Holding Time
Semivolatile Organics	16	(2) 1-L Amber Glass Bottles	Cool, 4°C, protected from light	Extraction: within 7 days of collection Analysis: within 40 days of extraction
Metals (other than Arsenic)	16	(2) 500-ml Polyethylene Bottle's	(1) Nitric Acid, pH < 2, for total metals; Cool, 4°C (2) Unpreserved for lab-filtering/ dissolved metals	6 months 28d mercury 180 d all other metals
Arsenic – total and species	16	(1) 500-mL Ultra-clean, polyethylene or glass bottle; bottles for collection of speciation samples will be wrapped in aluminum foil	Cool, 4°C, protected from light	48 hours
Volatile Organics	16	(3) 40-mL glass vials with Teflon-lined septum	Cool, 4°C, protected from light, HCl to pH<2	14 days
Pesticides	16	(2) 1-L Amber Glass Bottles	Cool, 4°C, protected from light	Extraction: within 7 days of collection Analysis: within 40 days of extraction
PCB Aroclors	16	(2) 1-L Amber Glass Bottles	Cool, 4°C, protected from light	Extraction: within 7 days of collection Analysis: within 40 days of extraction
Total Organic Carbon	16	(1) 500-mL or 1-L Amber Glass Bottles	Cool, 4°C, pH ≤2, sulfuric acid	28 days
Total Suspended Solids	16	(1) 500 mL or 1-L amber - glass bottle	Cool 4°C	7 days

There will be 13 surface and mid-depth samples and three deep samples for a total of 16.

## 4.4 Sediment Sampling

### 4.4.1 Sediment Sample Collection

Sediment samples will be collected at each of the 13 sediment locations listed in Table 4-1 using the Tall Eckman grab sampler. The Petite Ponar Grab sampler with sliding screens will be used as a back-up sampling device. These grab devices can be deployed safely either from small boats or by wading and were successful in sediment collection during the Reconnaissance Survey. The standard operating procedures for sediment sampling are described in the SOP, *Sampling Soft and Fine-Grained Sediments* (Appendix B). Prior to sampling at a location, the grabs and all other sampling devices such as spoons are decontaminated in accordance with the SOP, *Decontamination of Field Equipment* (Appendix B).

The goal of the sampling program is to collect representative sediment from the upper 2 inches (5-cm). This depth interval was selected as the zone most relevant to exposures of ecological receptors. Depositional sediments, characterized by clay/silt to fine sand grain sizes as identified in the Reconnaissance Survey results, will be sampled so that chemical analytical results can be compared from location to location. The sediments will be collected and analyzed for the chemicals and sediment parameters presented in the tables in Section 1 of this QAPP. It is estimated that 6 grabs will need to be collected at a location to provide sufficient sample volume for all the chemical analyses and for the toxicity tests. Samples for VOCs and SEM/AVS will be obtained from the first grab. All other samples will be drawn from a composite made up of the upper 2 inches of sediment from the six grabs.

#### *Collection of VOC Samples*

VOC samples for sediments will be collected directly from the sampling device for the first grab taken at a location. The sample will be collected using a syringe and placed in the "low-level" prepared VOC sample container (see Table 4-3). Both the Eckman and Petite Ponar Grabs with sliding screens permit direct access of surface sediment. This makes it possible to collect a VOC sample from the upper 2 inches prior to removing sediment from the grab.

#### *Collection of SEM/AVS Samples*

Samples for SEM/AVS will also be collected directly from the sampling device for the first grab taken at a location. This sample will be obtained using a stainless steel spoon or scoop. The SEM/AVS sample bottles provided by the laboratory will be filled completely.

**Table 4-3. Sediment Samples: Number, Preservation, Container Specification, and Holding Time Requirements in Support of the Environmental Assessment**

Parameter	Number of Samples	Sample Container(s)	Preservative	Holding Time
Semivolatile Organics	13	(1) 4-ounce glass jar	Cool, 4°C, protected from light	Extraction: within 14 days of collection Analysis: within 40 days of extraction
Metals	13	(1) 4-ounce glass jar	Cool, 4°C	28d mercury, 180 d all other metals
Volatile Organics – Low Level Analysis	13	(3) 40-mL glass vials	5mL Organic-free water, teflon-coated stir bar, Cool, 4°C, protected from light	7 days
Volatile Organics – High Level Analysis	13	(1) 120-mL wide mouth glass jar	30-mL purge-and-trap grade Methanol, Cool, 4°C, protected from light	14 days
Pesticides	13	(1) 4-ounce glass jar	Cool, 4°C, protected from light	Extraction: within 14 days of collection Analysis: within 40 days of extraction
PCB Aroclors	13	(1) 4-ounce glass jar	Cool, 4°C, protected from light	Extraction: within 14 days of collection Analysis: within 40 days of extraction
AVS/SEM	13	(1) 4-ounce glass jar	Cool, 4°C, protected from light	21 days
Total Organic Carbon (TOC)	13	(1) 4-ounce glass jar	Cool, 4°C	28 days
Grain Size	13	Shelby Tubes or zip-lock bag	Cool, 4°C	NA

NA = Not Applicable

#### *Collection of Other Physical and Chemical Samples*

For all other parameters, the upper 2 inches of sediment will be removed from the grab and homogenized in a stainless steel bowl using a stainless steel spoon or scoop. Sufficient sediment will be collected (estimated to require 6 grabs) and mixed in the bowl so that subsamples can be taken for chemical analysis, physical analysis, and sediment toxicity testing. Each of these subsamples will be taken using either a stainless steel spoon or syringe. Each bottle will be labeled to identify sample location, analysis required, date, and the initials of the collector. All of these samples will be kept on ice within coolers and delivered to the appropriate laboratory within 24 hrs.

#### **4.4.2 Sediment Sample Analytes, Containers, and Shipment Requirements**

Required sample sizes are listed in Table 4-3 along with sample container types, preservation, and holding times. Sediment samples will be analyzed for VOCs, SVOCs, PCBs, pesticides, metals, AVS/SEM, arsenic speciation (for SD-3, SD-5, and SD-6), total organic carbon, and grain size using methods listed in Section 7 of this QAPP. Field QC samples, including field duplicates, field rinsate blanks and trip blanks, and matrix QC, described in Section 3 of this QAPP.

#### **4.5 Benthic Invertebrate Sample Collection**

Benthic invertebrates will be collected for tissue analyses of chemicals and to evaluate the composition and abundance of the benthic community. Information on tissue analyses will be used to evaluate potential effects on benthic invertebrate communities and to support food-chain modeling. Information on the composition and abundance of benthic invertebrates will be used to evaluate potential effects on the benthic invertebrate community.

##### **4.5.1 Benthic Invertebrate Collection for Tissue Analysis**

The goal of the sampling effort will be to obtain sufficient benthic invertebrate biomass for tissue analyses of chemicals at each of the 13 sampling locations listed in Table 4-1. It is recognized that this goal may be difficult to achieve and an approach has been developed to guide these sampling efforts. Part of this approach involves setting priorities for analysis with respect to analytes and with regard to the types of invertebrates.

USEPA and the ISRT have prioritized the analyses as follows: 1) all invertebrate samples will be analyzed for metals; 2) if sufficient additional sample is obtained, analysis will also be conducted for PAH compounds; 3) if sufficient extract is obtained for organic chemical analysis, the extract will be stored for possible future analysis of pesticides/PCBs.

During the Reconnaissance Survey in April 1999, amphipods were the most common benthic invertebrates observed and easily recognizable at most stations in the Aberjona River system. This group of organisms is important in the diet of many fish and wildlife species and is, therefore, a good candidate for collection and analysis of tissues if

sufficient sample amounts can be obtained. In softer sediments, chironomid insect larvae are likely to predominate.

During a conference call on May 21, 1999 with Joe LeMay and Patti Tyler of USEPA, a preference was expressed for collection of benthic invertebrate species at all locations and that amphipods and/or chironomid insect larvae should be favored as the benthic invertebrates of choice for collection. A key sampling issue is the level of effort required to achieve adequate sample sizes for tissue analysis. A subsequent call on June 2, 1999 helped finalize this aspect of the sampling design.

Based on the Reconnaissance Survey and discussions with Joe LeMay and Patti Tyler, the following approach was defined for collection of benthic invertebrates for tissue analysis.

The sample team dedicated to this effort will consist of at three to four people per sample location. At all stream sediment locations and in the shallow station of HBHA Pond amphipods and chironomids will be collected. These taxa will be kept separate. All amphipods will be placed in one jar and all chironomids in another. The goal will be to collect sufficient amounts of amphipods and/or chironomids at all stations. Once the samples have been collected, the results of the collections will be discussed with USEPA and decisions made concerning how to proceed with the analysis. If adequate sample is obtained for a particular taxon (e.g., chironomid larvae) at all or most stations, then analysis will focus on that taxon. If sample sizes are small (e.g., less than 1 g for individual taxa), then the option of combining taxa will be considered. Stream samples will be collected for tissue analysis using a combination of kick nets and sediment grabs. A special sediment-sieving device with an extra large screen and running water has been built to support this sampling effort. The laboratory requires a minimum of 1 g per sample for metals and an additional 1 to 2 g for PAHs, pesticides, and PCBs. Additional sample would be needed to perform project-defined matrix QC including matrix spike and duplicate analyses (see Section 3 of this QAPP). On this basis, a minimum of 1 g wet weight of invertebrates (sufficient to support metals analysis, identified by USEPA and ISRT as the priority for this effort), will be collected per location for metals analysis and up to 5 g to support other analyses, if adequate tissue can be obtained. The number of organisms required to achieve sufficient sample size will depend on the size of the organism. Sample size requirements have been calculated for a range of body lengths that may be encountered and two sets of length to width ratios considered representative of the species expected (Table 4-4). These estimates will be used by the field collection team to estimate sample size requirements. This method will be simpler to implement than in-field weighing because a considerable amount of water as well as debris adheres to the animals when they are picked and sorted from the sample.

**Table 4-4. Estimating Sample Size Requirements for Obtaining Sufficient Biomass for Tissue Analysis.**

Body Length (cm)	Length:Width Ratio	Sample Requirements (# of organisms) to Achieve Specified Biomass Levels <sup>a</sup>		
		1 g	2 g	5 g
0.5	10	863	1725	4313
1	10	108	216	539
2	10	13	27	67
3	10	4	8	20
0.5	5	216	431	1078
1	5	27	54	135
2	5	3	7	17
3	5	1	2	5

a. The estimates assume a cylindrical body shape and a specific gravity of 1.1 g/cm<sup>3</sup>

Many of the amphipods and chironomids observed during the Field Reconnaissance Survey were small (~ 1 cm) and had length:width ratios between 5 to 1 and 10 to 1. It is estimated that up to 200 benthic invertebrate organisms may be needed to achieve approximately 2-g wet weight of tissue. Actual collection needs will be judged in the field using the information provided in Table 4-4 and by making length and width measurements representative of the organisms being collected. This information will provide the basis for estimating the number of animals that need to be obtained to achieve between 2 and 5g of organisms (preferably amphipods) per location.

At all pond locations, grab samplers will be used to collect the amphipods and/or chironomid insect larvae. As with the stream samples, both amphipods and chironomids will be collected and kept separately. A field decision will be made in consultation with the USEPA representative concerning which group of organisms to use for tissue analysis. This judgment will also be documented in the Field Log.

The following scheme will be used to achieve benthic invertebrate sample size requirements within a "reasonable period of time" during the Main Sampling Program.

- Judgments concerning the abundance of invertebrates at a location will initially be made using grab samples and/or kick net samples. A minimum of five grabs and/or kick net samples will be collected at each location and an effort of 45 minutes to an hour will be expended. This allocation of time is for sampling and sorting and does not include travel and set up time.
- If this initial sampling effort yields less than 0.25 g (based on sizes and numbers of animals), sampling for benthic invertebrates will cease because

the location would be unlikely to yield the sample-size requirement of at least 1-g of organisms within a "reasonable period of time." For these locations, the invertebrate sampling effort will be reallocated to epiphytic invertebrates.

- If this initial sampling effort yields 0.25 g or more organisms, then the collection will continue for an additional two hours and/or until an estimated 5 g of organisms are collected, whichever occurs first.
- The decision to reallocate sampling effort or to consider a sampling location complete will be made in the field after consultation with and concurrence from the USEPA representative.
- After the collection is complete at a location, the samples will be washed and rinsed with site surface water to help remove debris. The sample will be stored on ice in surface water and washed again at the end of the day's sampling effort.
- Invertebrates (amphipods or chironomids) will be analyzed for metals and, if adequate additional sample size is available, for PAHs. Additional material will be stored frozen.
- Because of expected low abundance of invertebrates at some stations, sample sizes after 3 hours of collection effort may range between 1 and 2 g wet weight. The chain-of-custody will include specific directions to the laboratory in such cases of limited sample sizes. These directions will be: 1) analyzed for metals; and 2) batch the preparation of limited sample size benthic invertebrates with samples of adequate mass so that appropriate project-specific matrix QC can be performed on another benthic sample in the same batch.
- At locations where the collection of adequate sample sizes of benthic invertebrates is judged to take longer than three hours, the sampling effort will be reallocated to provide information on collection of epiphytic invertebrates. These invertebrates include chironomid insect larvae and amphipods that live on plants as well as on the surface of sediments and other substrates. These animals are typically exposed to the water column as well as re-suspended surface sediments. Importantly, these invertebrates include those that are eaten by the mallard, a wildlife species that will be evaluated in the ERA.
- Based on field observations during the Reconnaissance Survey, it is possible that few benthic invertebrates will be found at the HBHA Pond Deep sampling locations such as SD-6 and possibly at Phillips and North Pond locations as well. These may be locations where benthic invertebrate sampling could be reallocated to sampling epiphytic invertebrates.
- Field decisions concerning whether or how to reallocate sampling effort will be made based on discussions with the USEPA representative will require

concurrency of the USEPA representative and will be documented in the Field Sampling Log.

- If epiphytic samples are collected, it appears reasonable that benthic invertebrates may be found along the root system and roots system/surface water interface. Therefore, epiphytic vegetation will be collected in its entirety. Benthic organisms will be removed from the epiphytic roots and included for analysis.

Invertebrates living on plants will be collected for tissue analysis of chemicals for locations at which sufficient biomass of invertebrates living within sediments can not be obtained. The reallocation of sampling and analytical effort from sediment invertebrates to epiphytic invertebrates will be decided in the field and will be based on discussions between Project Field Manager for Menzie-Cura and the USEPA representative. Epiphytic samples will be collected by cutting submerged aquatic vegetation above the root system and washing the organisms off the plants and onto sieves. These will be processed as described above for benthic invertebrates.

Samples of benthic or epiphytic invertebrates for tissue analysis will be placed in ziplock bags or glass jars and stored on ice for overnight courier shipment to the analytical laboratory. Information recorded in field logs and/or the chain-of-custody for benthic invertebrates samples will include: the client, site name, Sample Identification Number, sampling location, physical characteristics of the sampling station, estimated weight of the sample, date and time, and names of field personnel. Subsequent processing of the sample will be completed at the laboratory.

Information on sample containers, preservation, and holding times are provided in Table 4-5. Analytical methods and detection limits for tissue analyses are presented in Section 7 of this QAPP. Collection locations are listed in Table 4-1.

**Table 4-5. Benthic Tissue Analysis Samples: Number, Sample Preservation, Container Specification, and Holding Time Requirements In Support of the Environmental Assessment**

Parameter	Number of Samples	Sample Container(s)	Preservative	Holding Time*
<b>Metals</b>	13 benthic or epiphytic	1-L Amber Glass Bottles or Clean Ziplock Bags	Cool, 4°C, protected from light; store frozen < -10°C	28 d mercury, 180 d all other metals
<b>Semivolatile Organics (PAHs)</b>	13 benthic or epiphytic (if sufficient biomass is collected)	Same as above for delivery to the lab	Cool, 4°C, protected from light; store frozen <10°C	Extraction: 1 year frozen, within 14 days of thawing Analysis: within 40 days of extraction
<b>Pesticides</b>	13 benthic or epiphytic (held for possible future analysis)	Same as above for delivery to the lab	Cool, 4°C, protected from light; store frozen <10°C	Extraction: 1 year frozen, within 14 days of thawing Analysis: within 40 days of extraction
<b>PCB Aroclors</b>	13 benthic or epiphytic (held for possible future analysis)	Same as above for delivery to the lab	Cool, 4°C shipment, stored at < -10°C, protected from light	Extraction: 1 year frozen, within 14 days of thawing Analysis: within 40 days of extraction

\*Note: Holding times start from when sample is thawed.

#### 4.5.2 Benthic Invertebrate Collection for Community Evaluation

The analysis of benthic community structure (e.g. diversity and abundance of benthic invertebrates) will be used to support the assessment of possible effects on benthic invertebrates. The data will be analyzed for taxa richness, abundance, percent dominant taxon/taxa, and community composition (see Section 7 of QAPP).

At each of the 13 locations described in Table 4-1, benthic invertebrates will be collected with an Eckman or petite ponar grab using techniques described in the standard operating procedure, *Collection of Benthic Invertebrates with a Grab Sampler* (Appendix B). Three samples will be collected from each location and analyzed separately to provide a measure of within-station variability. This will yield 13 locations x 3 grabs/location = 39 samples.

Each invertebrate benthic sample will be washed in the field through a 0.5-mm mesh sieve, placed into 1-liter plastic jars, and preserved with isopropyl alcohol (Table 4-6). A sample-washing device has been constructed for the project. The device is designed to provide running water to help wash the samples.

**Table 4-6. Samples for Analysis of Benthic Invertebrate Composition and Abundance: Number, Sample Preservation, Container Specification, and Holding Time Requirements in Support of the Environmental Assessment.**

Parameter	Number of Samples	Sample Container(s)	Preservative	Holding Time
Benthic invertebrates	39 (13 stations x 3 samples)	1 liter plastic jars	Isopropyl alcohol	NA

#### 4.5.3 Assessment of Habitat Conditions at Benthic Sampling Locations

Habitat conditions at each of the 13 sample locations will be evaluated in the field and by several of the analytical measurements made in the laboratory. At each station the following will be determined: physical characteristics of sediments (field observations and grain size analysis), organic content of sediments (field observations on the nature of the sediments and laboratory measurements of total organic carbon), water depth, stream flow velocity (estimated in the field), width of water body, characteristics of shoreline, bordering vegetation, extent of overhanging vegetation. Observations for the Habitat Assessment will be guided by the *Habitat Assessment Field Data Sheet-Low gradient Streams, USEPA Rapid Bioassessment Protocols, 1989*.

#### 4.6 Sediment Toxicity Tests

Samples for the sediment toxicity tests will be taken from the same homogenized composite sediment sample that is collected at each of the 13 sediment locations (Table 4-1) for chemical and physical analyses. This homogenized sample will consist of the upper 2 inches of sediment from 6 grabs. A clean scoop will be used to transfer the sediment sample from the mixing bowl to the sample container. Unrepresentative material (e.g., stones, wood chips) will be removed from the sample at the discretion of the field sampler and will be documented in the field log. Approximately 3.5 liters of sediment per location will be collected and placed into clean wide mouth glass jars, labeled, and placed on ice in a cooler. Samples will be provided to the laboratory within 24 hrs. At the laboratory, sediment samples for toxicity testing will be refrigerated to 4°C and protected from light prior to use in testing to maintain the integrity of the original sediment.

The sediment toxicity tests will be used to evaluate whether chemicals in sediments within HBHA pond and HBHA wetland are toxic to benthic invertebrates. Acute toxicity tests will be conducted at all 13 sampling locations with the amphipod *Hyallela* and the insect larvae *Chironomus* in accordance with analytical methods presented in Section 7 of this QAPP and Appendix B. Tests of reference sediments will be initiated first. It is anticipated that these sediments will not be acutely toxic and will proceed to chronic testing. A Reference Location will not proceed to a chronic test only if toxicity is substantial (> 75%) and significantly greater less than the control sediment. For stations in HBHA and downstream locations, acute toxicity results will be compared to both the Reference Locations and the control sediments. If acute toxicity for HBHA and downstream locations is significantly greater than that in the Reference Locations and the control sediments, then it will be concluded that the sediments are toxic to benthic invertebrates and chronic tests are not needed to confirm the finding. At no time will the integrity of the testing program be put in jeopardy. Therefore, if there is a question concerning the need for a chronic test, that test will be performed. The sequential testing (acute followed by chronic) will eliminate the need to set up and run long-term tests for sediments in which the organisms can not survive. The chronic test methods are described in Section 7 and Appendix B. Numbers, preservation, and containers are summarized in Table 4-7.

**Table 4-7. Samples for Toxicity Tests: Number, Preservation, Container Specification, and Holding Time Requirements in Support of the Environmental Assessment.**

Parameter	Number of Samples	Sample Container(s)	Preservative	Holding Time
Chironomus acute test	13	(1) wide-mouth glass jar, pre-cleaned, capacity of 1.25 L of sediment	Cool, 4°C	14 day holding time
Chironomus chronic test	13	(1) wide-mouth glass jar, pre-cleaned, capacity of 1.25 L of sediment	Cool, 4°C	14 day holding time
Amphipod acute test	13	(1) wide-mouth glass jar, pre-cleaned, capacity of 1.25 L of sediment	Cool, 4°C	14 day holding time
Amphipod chronic test	13	(1) wide-mouth glass jar, pre-cleaned, capacity of 1.25 L of sediment	Cool, 4°C	14 day holding time

#### 4.7 Vegetation Sample Collection

Plant species to be collected for chemical analysis include the cattail (*Typha latifolia*) as emergent vegetation and submergent vegetation such as pondweed (*Potamogeton* sp.) or coontail (*Ceratophyllum*). Each plant sample used for tissue analysis will consist of a single species. Plants can uptake chemicals in sediments to different degrees and a composite sample of more than one species could confound interpretation of the results. Submergent vegetation shall be evaluated in the field during fishing and sediment sampling activities. If no submergent vegetation is present at HBHA Pond, submergent vegetation will be collected either at Pond 1 (SD-09), or downgradient of HBHA Pond at SD-08.

##### 4.7.1 Collection of Emergent Vegetation

During the Reconnaissance Survey, the emergent cattail species *Typha latifolia* was observed both in HBHA wetlands and in the Reference Ponds (Phillips and North). In follow-up discussions with Joe LeMay and Patti Tyler of USEPA, it was agreed that this species would be the target species for emergent vegetation because it is known to be favored as food by muskrat, the predominant aquatic mammal in HBHA wetlands. Samples will be obtained by digging up individual plants with a trowel. The roots below the plant/soil interface will be cut off, washed free of sediment and/or soil and kept to form the required sample. Lower stems (1-foot length) above the roots will also be cut off and kept as a sample. Samples will be placed in ziplock bags, labeled, and kept on ice for shipment to the laboratory. The collection strategy of sampling roots and lower stems separately is based on the feeding habits of muskrat that are known to eat the roots and/or lower stems of cattails. It also reflects the possibility that metals may differ in concentration between the roots and lower stems.

Each composite sample of cattail roots or lower stems will consist of five plants. Composite samples will be collected in each of the following locations if plants are available: HBHA Pond, HBHA Wetland Pond #1, and HBHA Pond #3. During the Reconnaissance Survey, cattails were observed in HBHA Wetland Ponds #1 and #3 but were not observed in HBHA Pond. If, during the Main Sampling Program, cattails are not observed in HBHA Pond, the next most downstream stand of cattails will be chosen for sampling (perhaps from the stream segment between HBHA Pond and Wetland Pond #1). This yields a total of 3 locations x 2 composites/location x 2 parts of plants (roots and lower stems) = 12 composite samples for HBHA Pond and wetlands.

Two composite samples of five plants each will also be collected from each of the two Reference Locations: Phillips Pond and North Pond for a total of 2 locations x 2 composites/location x 2 parts of plants (roots and lower stems) = 8 composite samples for emergent vegetation. The collections and analyses are summarized in Table 4-8.

#### **4.7.2 Collection of Submergent Vegetation**

Submerged aquatic plants are used as food by many species of aquatic birds and mammals. Some species favor eating roots while others feed on stems and leaves. Some species eat entire plants. In addition, submerged aquatic plants can take up chemicals either through the roots or through the leaves and stems. For these reasons, it is important to measure chemical concentrations in roots and leaves/stems.

During the Reconnaissance Survey a variety of submerged aquatic plants was observed. However, based on limited observations in April 1999, the species of plants differ among ponds. The plan for collection of plants is to first collect from the HBHA to determine the plant species to be sought in the Reference Ponds. Preference will be given to the most common species present in a particular pond. Ideally, this would be the same species for all ponds. However, field observations indicate that species may be restricted to particular locations. For example a monospecific stand of *Ceratophyllum* was observed in North Pond during the Reconnaissance Survey while it was not seen in HBHA. Decisions on which species to sample will be made in the field based on consultation between the Menzie-Cura Field Operations Manager and the representative from USEPA.

Samples will be obtained by digging up individual plants with a trowel. The roots below the plant/sediment interface will be cut off, washed free of sediment and kept to form the required sample. The entire plant above the roots will also be kept as a sample. Samples will be placed in ziplock bags, labeled, and kept on ice for shipment to the laboratory.

Each composite sample of roots or upper plant will consist of five plants. Composite samples will be collected in each of the following locations if plants are available: HBHA Pond, HBHA Wetland Pond #1, and HBHA Pond #3. If, during the Main Sampling Program, submerged aquatic plants are not observed in one of these locations, one of the HBHA stream locations (e.g., SD-8 or SD-10) will be used. During the Reconnaissance Survey submerged aquatic plants were observed at SD-8. This yields a total of 3 locations

x 2 composites/location x 2 parts of plants (roots and lower stems) = 12 composite samples for HBHA Pond and wetlands.

Two composite samples of five plants each will also be collected from each of the two Reference Locations: Phillips Pond and North Pond for a total of 2 locations x 2 composites/location x 2 parts of plants (roots and lower stems) = 8 composite samples for submerged aquatic vegetation. Samples will be placed in ziplock bags, labeled, and kept on ice for shipment to the laboratory. The collections and analyses are summarized in Table 4-8.

**Table 4-8. Plant tissue analysis samples: Number, Sample Preservation, Container Specification, and Holding Time Requirements in Support of the Environmental Assessment.**

Parameter	Number of Samples	Sample Container(s)	Preservative	Holding Time
Metals	10 composite samples of cattail roots/tubers	Clean Ziplock Bags	Cool, 4°C, protected from light; store frozen < -10°C	28 d mercury 180 d all other metals
Metals	10 composite samples of cattail lower stems	Clean Ziplock Bags	Cool, 4°C, protected from light; store frozen < -10°C	28 d mercury 180 d all other metals
Metals	10 composite samples of roots of submerged aquatic plants	Clean Ziplock Bags	Cool, 4°C, protected from light; store frozen < -10°C	28 d mercury 180 d all other metals
Metals	10 composite samples of leaves and stems of submerged aquatic plants	Clean Ziplock Bags	Cool, 4°C, protected from light; store frozen < -10°C	28 d mercury 180 d all other metals

#### 4.8 Fish Sample Collection

Fish sampling will focus on four ponds: HBHA Pond, HBHA Wetland Pond #3, Phillips Pond (reference), and North Pond (reference). The goals of the fish-sampling program are to:

1. identify the composition and general abundance of fish in the ponds to determine if HBHA ponds are depauperate in species composition and or relative abundance in comparison to the Reference Ponds;
2. examine the age structure and the weight and length relationships for species in the ponds; again, comparisons will be made between the HBHA ponds and the Reference Ponds;
3. evaluate the habitat quality of the ponds with respect to supporting different fish species;
4. determine the potential of the ponds for supporting recreational fishing;
5. measure body burdens of chemicals in fish tissues for use in ERA and HERA; and,

6. examine fish for gross histopathological anomalies and compare these between HBHA Ponds and Reference Ponds.

#### **4.8.1 Collection of Fish and Fish Habitat Assessment**

U.S. Fish and Wildlife Service (USFWS) will conduct the fish-sampling program. Sampling with an electroshocker boat will be the primary sampling method. A SOP for this sampling is provided in Appendix B. Other methods that may be used by USFWS if needed include gill nets, leaded lines, trout lines, rod and reel, and traps. Sampling will be conducted in the HBHA Ponds first (HBHA Pond and Wetland Pond #3) to determine the species of fish that are present. This is most important for selecting species for tissue analyses because the Reference Pond species will be the same as the species collected in the HBHA. USFWS and Menzie-Cura have discussed the implementation of the field program and will coordinate sampling efforts in the field. A biologist working for Menzie-Cura will participate in the effort and will discuss the observations with the USFWS biologists. Menzie-Cura and USFWS will select fish from the field collections for tissue analyses. The selected fish will be weighed and measured by USFWS and their scales taken (for largemouth bass). The animals will be placed in labeled ziplock bags, placed into a second bag, and placed in a cooler with dry ice. It is anticipated that more fish than will be needed will be selected for analysis in order to insure that there are comparable species among the various sampling ponds. In other words, if there are two bottom fish species collected in HBHA Wetland Pond #3, 5 individuals of each will be kept for possible tissue analysis. The decision concerning which fish to analyze will be made after all ponds have been sampled.

The USFWS sampling protocol involves maintaining the fish alive until decisions have been made on which fish to process. USFWS will be responsible for making all observations on fish (identification, age, length, weight, and presence of gross histopathological anomalies). USFWS will record these data on data sheets and in logs. Copies of these data entries will be made available to Menzie-Cura. USFWS will remove scales from largemouth bass and selected sunfish for analysis of fish age and they will make determinations of age at their laboratory. The age of selected brown bullheads will be determined by examining spines present in the pectoral fins. The analytical USFWS will also be responsible for assessing the habitat quality of the ponds for supporting fish as well as the potential of the ponds for recreational fishing. Menzie-Cura and USEPA will participate in a discussion of these habitat features. This assessment will be qualitative and based on a combination of experience in similar water bodies, a qualitative assessment of the physical and water quality conditions provided by the habitat, and the use of a method for assessing recreational fishing potential.

Menzie-Cura and the contract laboratory – Woods Hole Group - will be responsible for obtaining tissues from the selected fish. Fish will be kept frozen until just prior to analysis. All dissections and inspections of the fish will be made at the laboratory by Dr. George Hampson, a fishery biologist with the Woods Hole Oceanographic Institute. Dr. Menzie of Menzie-Cura will coordinate with Dr. Hampson.

During the sampling program, the habitat features of each of the four ponds will be documented. Information pertinent to fish populations include: water depth, physical sediment characteristics, type and extent of submerged and emergent vegetation, area, nature of contiguous aquatic environments, general water quality conditions (dissolved oxygen, conductivity, pH, and temperature), and characteristics of shoreline. These will be documented in the field and recorded in logbooks and by using photographs and video.

USFWS will evaluate the four ponds' ability to provide a sustainable fish population that supports recreational fishing. This evaluation will be based on the results of the fish collection. For example, successful collection of adult edible fish species such as largemouth bass and yellow perch would be an indication that the Site ponds contain fish that are sought for recreational fishing. The presence of large sunfish may also indicate this potential. The USFWS plans to use the number of fish caught, species composition, and proportional stock density (PSD) to assess fish stocks. PSD is a categorization and comparison of species-specific size classes that is used to evaluate fishing potential.

#### **4.8.2 Fish Collection for Tissue Analysis**

The selection of specific fish for analysis will be based on in-field discussions between Menzie-Cura, USEPA representative, and USFWS. The selection will be made in accordance with the general criteria presented later in this section that have been developed through discussions between Menzie-Cura, USFWS, and USEPA. Menzie-Cura and Woods Hole Group will be responsible for dissecting fish to obtain tissue samples for chemical analyses. This will be conducted at the Woods Hole Group Laboratory and will be performed in accordance with the SOP provided in Appendix B.

The workplan for collecting and analyzing fish tissues for chemicals is slightly different from that described in the USEPA letter of August 25, 1998. That initial scope called for the following:

- Small fish: analyze whole fish for metals
- Medium fish: analyze offal and fillet for metals
- Large fish: analyze target organs (liver and kidneys) and fillets for metals

Instead of the designations of small, medium, and large, it is more useful to obtain fish that represent different feeding strategies (trophic levels). To support the ERA and HERA, fish from three trophic levels (forager, bottom feeder, and piscivore) will be collected from HBHA and from the Reference Ponds for tissue analyses of chemicals. Forager species such as minnows, shiners, and small sunfish, which feed primarily on invertebrates, are eaten by wildlife species and, in the case of larger sunfish, may be eaten by people. Bottom fish such as bullheads, suckers, and eels are in the most intimate contact with sediments and are therefore useful species to examine for judging potential effects of sediments. People also sometimes eat these species. Piscivorous fish such as

adult largemouth bass, yellow perch, and chain pickerel are those most likely to be eaten by humans. They are also eaten by wildlife species.

The tissues that will be analyzed also differ somewhat from that identified in the USEPA August 25, 1998 letter. The following target tissues will be analyzed:

Forager Fish:	analyze whole fish
Bottom Fish:	analyze liver, remaining offal, and fillet
Piscivorous Fish:	analyze liver, remaining offal, and fillet

The USEPA and USFWS have concurred with these tissue categories. All fish for possible analysis will be stored frozen. Following the completion of the sampling program, Menzie-Cura and USEPA will determine the specific analyses that will be performed. The following reflects the general plan and is dependent upon the types and numbers of fish that are collected.

The goal of the sampling effort is to collect at least five fish from each trophic category from each of the four ponds for tissue analysis of metals. This would yield a total of 3 trophic categories x 5 fish/category x 4 ponds = 60 fish. It is recognized that this goal may be difficult to meet because some of the trophic categories may not be present or fewer than five fish may be collected. In this case, the effort will focus on those fish that are collected within each of the target categories. If no piscivorous fish are obtained in HBHA (i.e., no adult largemouth bass, yellow perch, crappies, or chain pickerel), large individuals of sunfish species (e.g., bluegills) will be substituted for this category. This substitution is made because some people do eat these larger sunfish. If bluegill or other larger sunfish is used as a substitute for largemouth bass, then a second forager species (e.g., golden shiners) will be used as the forager species. Fish selected for tissue analyses in the Reference Ponds will be defined by what is collected within the HBHA. More fish species than needed for chemical analyses will be collected in the HBHA to help insure that there are species matches between the HBHA and Reference Ponds. The final decision on which fish to analyze will be made after the collections are complete. This decision will involve a discussion with the USFWS biologists and will take into account the criteria identified above. The decision will also be discussed with the USEPA RPM or other USEPA representative designated by the RPM.

All fish samples will be placed in ziplock bags and stored on dry ice for shipment to the analytical laboratory. A summary of collections for tissue analyses is provided in Table 4-9.

**Table 4-9. Fish Tissue Analysis Samples: Number, Preservation, Container Specification, and Holding Time Requirements in Support of the Environmental Assessment**

Parameter	Number of Samples	Sample Container(s)	Preservative	Holding Time
Metals including determination of organic and inorganic arsenic	20 piscivore fish (e.g., bass)  will yield 20 x 3 = 60 tissues	Clean Ziplock Bags	Cool, 4°C, protected from light; store frozen < -10°C	28 d mercury, 180 d all other metals
Metals including determination of organic and inorganic arsenic	20 bottom-feeding fish (e.g., bullheads)  will yield 20 x 3 = 60 tissues	Clean Ziplock Bags	Cool, 4°C, protected from light; store frozen < -10°C	28 d mercury, 180 d all other metals
Metals including determination of organic and inorganic arsenic	20 forager fish (e.g., golden shiners)  will yield 20 tissues	Clean Ziplock Bags	Cool, 4°C, protected from light; store frozen < -10°C	28 d mercury, 180 d all other metals
Pesticides/PCBs	Taken from above collection of 20 piscivore fish (e.g., bass) for possible future analysis	Same as above for delivery to the lab	Cool, 4°C shipment, stored at < -10°C, protected from light	1 year frozen; Extraction: within 14 d of thawing Analysis: within 40 d of extraction
Pesticides/PCBs	Taken from above sample of 20 bottom-feeding fish (e.g., bullheads) for possible future analysis	Same as above for delivery to the lab	Cool, 4°C shipment, stored at < -10°C, protected from light	1 year frozen Extraction: within 14 d of thawing Analysis: within 40 d of extraction
Pesticides/PCBs	Taken from above sample of 20 forager fish (e.g., golden shiners) taken for possible future analysis	Same as above for delivery to the lab	Cool, 4°C shipment, stored at < -10°C, protected from light	1 year frozen Extraction: within 14 d of thawing Analysis: within 40 d of extraction

**Table 4-10. Field and Trip Blanks: Preservation, Container Specification, and Holding Time Requirements in Support of the Environmental Assessment**

Matrix	Parameter	Sample Container(s)	Preservative	Holding Time
<b>Aqueous Field Blanks</b>	Semivolatile Organics	1-L Amber Glass, Teflon-lined cap	Cool, 4°C, protected from light	Extraction: within 7 days of collection Analysis: within 40 days of extraction
	Metals (other than Arsenic)	(2) 500-mL Polyethylene bottles	(1) Nitric Acid, pH < 2 (1) unpreserved for lab filtering/dissolved metals; Cool, 4°C	28 d Mercury 180 d all other metals
	Arsenic – total and species	500-mL Ultra-clean polyethylene bottle, covered with aluminum foil	Cool, 4°C, protected from light	48 hours
	Pesticides	1-L Amber Glass, Teflon-lined cap	Cool, 4°C, protected from light	Extraction: within 7 days of collection Analysis: within 40 days of extraction
	PCB Aroclors	1-L Amber Glass, Teflon-lined cap	Cool, 4°C, protected from light	Extraction: within 7 days of collection Analysis: within 40 days of extraction
<b>Aqueous Trip Blanks</b>	Volatile Organics	40-mL glass vials with Teflon-lined septum	Cool, 4°C, protected from light, HCl to pH<2	14 days
<b>Sediment Trip Blanks</b>	Volatile Organics – Low Level Analysis	(3) 40-mL glass vials	5mL Organic-free water, teflon-coated stir bar, Cool, 4°C, protected from light	14 days
	Volatile Organics – High Level Analysis	(1) 120-mL wide mouth glass jar	30-mL purge-and-trap grade Methanol, Cool, 4°C, protected from light	14 days

## **5.0 SAMPLE CUSTODY**

Chain-of-Custody (COC) procedures for the collection of surface waters, sediments, and biota in support of the Environmental Risk Assessment will follow custody protocols as described in "NEIC Policies and Procedures", EPA-330/9-78DDI-R, Revised June 1985. This custody is compliant with EPA Region I requirements for sample custody and is divided into three parts: field-specific sample collection, laboratory custody, and final evidence files.

A sample or evidence file is under your custody if:

- the item is in your possession;
- the item is in your view, after being in your possession;
- the item is in your possession and you place it in a secured location; or
- the item is in a designated secure area.

### **5.1 Field Chain of Custody Procedures**

The sample packaging and shipment procedures summarized below will insure that the samples will arrive at the laboratory with the chain of custody intact. The protocol for specific sample numbering is described in Section 4 of this QAPP.

#### **5.1.1 Field Procedures**

- (a) The field sampler is personally responsible for the care and custody of the samples until they are transferred or properly dispatched. To preserve the integrity of the samples, as few people as possible should handle the samples.
- (b) All bottles will be identified with unique sample numbers and locations on secure bottle labels. The labels will include the sample identification number, location, date of collection, time of collection, and type of analysis required.
- (c) Sample labels are to be completed for each sample using waterproof ink.
- (d) Samples will be accompanied by a properly completed COC form. The sample numbers and locations will be listed on the COC. See section 5.1.3 for further field custody transfer procedures.

### 5.1.2 Field Logbooks/Documentation

Field logbook will provide the means of recording data collecting activities performed. As such, entries will be described in as much detail as possible so that persons going to the site could re-construct a particular situation without reliance on memory.

Field logbooks will be bound, field survey books or notebooks. Logbooks will be assigned to field personnel, but will stored in the document control center when not in use. Each logbook will be identified by the project-specific document number.

The title page of each logbook will contain the following:

- Person to whom the logbook is assigned.
- Logbook number.
- Project name.
- Project start date, and
- End date.

Entries into the logbook will contain a variety of information. At the beginning of each entry, the date, start time, weather, names of all sampling team members present, level of personal protection being used, and the signature of the person making the entry will be entered. The names of visitors to the site, field sampling or investigation team personnel and the purpose of their visit will also be recorded in the field logbook.

Measurements made and samples collected will be recorded in the field logbook and/or the appropriate field form. An example field calibration documentation form is included in Section 6, Figure 6-1. All entries will be made in ink and no erasures will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark. Whenever a sample is collected, or a measurement is made, a detailed description of the location of the station, which includes compass and distance measurements, shall be recorded. The number of the photographs taken of the station, if any, will also be noted. All equipment used to make measurements will be identified, along with the date of calibration.

Samples will be collected following the sampling procedures documented in Section 4.0 and the field SOPs in the Appendices of this QAPP. The procedure and equipment used to collect samples will be noted, along with the time of sampling, sample description, depth at which the sample was collected (if applicable), amount and number of containers. Sample

identification numbers will be assigned prior to sample collection. Field duplicate samples, which will receive a unique sample identification number, will be noted under sample description.

Figure 5-1 is an example COC that will be completed in the field during sample collection of surface water, sediment, and biota samples.

### **5.1.3 Transfer of Custody and Shipment Procedures**

The sample packaging and shipment procedures summarized below will ensure that the samples will arrive at the laboratory with the COC intact. The protocol for sample identification is included in Section 4 of this QAPP. An example of a field custody document is Figure 5-1.

- (a) Samples are accompanied by a properly completed chain of custody form. The sample numbers and locations will be listed on the chain of custody form. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents transfer of custody of samples from the sampler to another person, to a mobile laboratory, to the permanent laboratory, or to/from a secure storage area.
- (b) Samples will be properly packaged for shipment, including ice to preserve the samples at  $\leq 4$  °C and dispatched to the appropriate laboratories for analysis, with a separate signed custody record enclosed in each sample box or cooler. Shipping containers will be locked and secured with strapping tape and custody seals for shipment to the laboratory.
- (c) All shipments will be accompanied by the Chain of Custody Record identifying the contents. The original record will accompany the shipment, and copies of the COC will be retained by the field sampler for documentation. It is recommended that a copy of the COC be faxed to the laboratory on the date of collection to give the laboratory forewarning of the shipment and analytical requirements.
- (e) If the samples are sent by common carrier, a bill of lading should be used. Receipts of bills of lading will be retained as part of the permanent documentation. Commercial carriers are not required to sign off on the custody form as long as the custody forms are sealed inside the sample cooler and the custody seals remain intact.

## **5.2 Laboratory Chain of Custody Procedures**

Laboratory custody procedures for sample receiving and log-in; sample storage; tracking during sample preparation and analysis; and storage of data are described in the laboratory SOP and laboratory QAPP.

## **5.3 Final Evidence Files Custody Procedures**

The final evidence files for the data supporting the Environmental Risk Assessment will be maintained by Menzie-Cura to be purged at a later date to ISRT and/or EPA Region I. The content of the evidence file will include, at a minimum, all relevant records, reports, correspondence, logs, field logbooks, laboratory sample preparation and analysis raw data, original laboratory data packages, pictures, subcontractor's reports including data validation reports, assessment reports, progress reports, and chain of custody records/forms. The evidence file will be under custody of the Ecological Risk Assessment Project Manager in a limited access, secured area.



## **6.0 CALIBRATION PROCEDURES AND FREQUENCY**

All instruments used to perform chemical measurements must be properly calibrated prior and during use to ensure acceptable and valid results. This section describes the procedures necessary for maintaining the accuracy of all the instrumentation used in the field tests and the laboratory analyses. The accuracy and traceability of all calibration standards used must be properly documented. The procedures described herein are to be used in conjunction with specific instrument manufacturer's instructions, applicable analytical methodology requirements, and specific laboratory/field procedures for instrument operation.

### **6.1 Field Instruments/Equipment**

The field measurements defined for this project will include the following instrumentation: combination YSI meter to measure pH, temperature, specific conductance, and dissolved oxygen and a turbidometer to measure turbidity. Quantitative field measurements will be taken for pH, temperature, specific conductance, and dissolved oxygen. Qualitative measurements ("screening level") will be taken for turbidity as this parameter is to be used as an indicator of light penetration and not as a quantitative measurement. Secchi disc measurements may also be taken for light penetration in some locations.

All field equipment for quantitative measurements will be calibrated using verified standards (traceable to appropriate NIST standards where possible), at least daily prior to initiating field activities or at the frequencies recommended by the manufacturer, whichever is more frequent. Calibration of field equipment for quantitative measurements will be performed as described in U.S.EPA Region I's Draft Calibration of Field Instruments, where appropriate (Appendix B-7). Calibrations will be checked based on the manufacturer's recommendations, following the daily calibration process. Specific procedures for field measurements are described in the Field SOPs included in Appendix B-7. Project reporting limits for field measurements are presented in Table 7-1.

Balances, if used, will be calibrated with class C weights and inspected by a certified technician at least annually or at the start of the field program. Daily checks will confirm balance calibration. All instruments will be maintained and repaired in accordance with the manufacturer's specifications. Calibration procedures, including date of calibration, type of measurement, concentration of standards, and identity of field personnel performing measurement, should be recorded in the field log.

### **6.2 Laboratory Instruments**

The methodologies selected for use in this investigation specify the types and frequency of calibrations. For all analytical procedures, the lowest calibration standard analyzed must be at or

below the project required reporting limit for the specific media being tested to ensure accurate reporting limit determinations. The specific methods to be used are provided in Section 7.0.

Accessory analytical equipment such as refrigerators, balances and ovens required for the storage and preparation of samples must be calibrated using manufacturer's instruction with the following guidelines:

- Calibrations of equipment must be checked daily and these records kept in a logbook or calibration-specific log.
- The laboratory must document clearly the acceptance criteria for all such equipment (*e.g.*, refrigerator temperature must be  $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ) and corrective actions must be taken for any out-of-control situation as described in the laboratory's quality assurance manual.
- The equipment must not be used after corrective action until it has been re-calibrated or verified through the successful analysis of an independent-source check standard.
- Calibrations of other miscellaneous analytical equipment (*e.g.*, automatic pipettes) must be performed according to manufacturer's recommendations or laboratory QA protocols.

Implementation of the laboratory calibrations will be the responsibility of the Laboratory Director and the analysts performing the procedures.

## 7.0 ANALYTICAL PROCEDURES

This section describes a brief overview of the analytical methodologies to be used during the Environmental Risk Assessment. Field measurement reporting limits are listed in Table 7-1. Laboratory chemistry reporting limits for the project are listed in the tables included in Section 1 of this QAPP.

### 7.1 Field Analytical Procedures

Field measurements on surface waters and sediments will be conducted in accordance with the EPA methods summarized in Table 7-1 and described in Section 4 and the field measurement SOPs included in the Appendix B-7.

At each location, the following water quality parameters will be measured in the field: dissolved oxygen, specific conductivity, temperature, pH, and turbidity. Light penetration into the water may also be measured using a sechi disc. Water quality measurements will be recorded at the surface, within and below the thermocline (if one exists), and above the bottom using a YSI 600XL meter for quantitative measurements of dissolved oxygen, specific conductivity, temperature, and pH. The Horiba U-10 will be used for the qualitative measurement of turbidity. Operation and calibration of field equipment will be performed as described in Section 6.0, the appropriate field measurement SOPs (Appendix B), and U.S.EPA Region I's Draft Calibration of Field Instruments, where appropriate (Appendix B).

**Table 7-1 Field Measurement Methods and Reporting Limits.**

Field Measurement Parameter	Measurement Method Surface Water	Reporting Limit
Temperature	YSI 600 XL manufacturer's SOP	± 0.2 °C
pH	YSI 600 XL manufacturer's SOP and EPA 150.1	± 0.2 pH units
Dissolved Oxygen	YSI 600 XL manufacturer's SOP and EPA 413.1	200 µg/L
Conductivity	YSI 600 XL manufacturer's SOP and EPA 120.1	1.0 µS/cm
Turbidity	Horiba U-10 manufacturer's SOP and EPA 180.1	qualitative measurement ~1.0 NTU

EPA methods in: EPA-600/4-79-020, 1983

## 7.2 Laboratory Analytical Procedures

Laboratory analyses in support of surface water, sediment, and biota data will be performed by Woods Hole Group Environmental Laboratory, Raynham, Massachusetts, for all analyses except arsenic speciation. Frontier Geosciences, Inc. of Seattle, Washington, will perform the arsenic speciation analyses.

### 7.2.1 Sediment and Surface Water Methods

The off-site laboratories, using the EPA methods and laboratory Standard Operating Procedures (SOPs) summarized in Table 7-2, will perform analysis of surface waters and sediments. The corresponding media and analytical parameters are listed in Tables 1-2 through 1-10. The project required reporting limits are provided in the specific parameter tables. Additional guidance is provided as follows.

- Parameters will be analyzed according to analytical procedures set forth in the EPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3<sup>rd</sup> Edition, Final Update, December 1996 and in the specialty methods and SOPs referenced in Table 7-2.
- Samples that have significant matrix interferences may require specialized cleanup procedures and/or reanalysis in order to eliminate interferences and to permit analysis to proceed with a reporting limit at or closer to the project required reporting limits. The laboratory must report any matrix interferences that result in elevated reporting limits without positive results for target analytes. Cleanup protocols, if required, will be drawn from the EPA SW-846, 3<sup>rd</sup> Edition manual or as suggested in the specialty methods and SOPs listed in Table 7-2 and included in Appendix C.
- Surface water samples will be filtered through 0.45 $\mu$ m filter, and then acidified to pH <2, upon receipt in the laboratory for analysis of dissolved metals.
- Based on the results of the Reconnaissance Survey performed in April 1999, the sediment samples will be freeze-dried by the laboratory upon receipt and prior to analysis for the following parameters: SVOC, PCBs, pesticides, and metals. The protocol for freeze-drying sediments is presented in Appendix C-1.
- Percent solids will be performed for all sediments prior to freeze-drying and after freeze-drying. The percent solids of the freeze-dried sediments (after freeze-drying) will be used to calculate final chemical results on a dry-weight basis for SVOC, PCB, pesticides, and metals.
- Sediment samples for VOC analysis will be preserved according to a modification of EPA Method 5035 where 5-mL of DI water will replace the sodium bisulfate to cover the sediment

sample for low-level analysis. This modification was approved verbally on a conference call with the EPA QAO, Andy Belleveau.

### **7.2.2 Biota Methods – Chemical Analysis of Benthic Invertebrates, Fish, and Vegetation**

The analytical laboratories will conduct analysis of benthic organisms, plants, and fish in accordance with the EPA methods and laboratory Standard Operating Procedures (SOPs) specified in Table 7-2 and the appropriate appendices. The corresponding analytical parameters are listed in Tables 1-2 through 1-10. The project required reporting limits are provided in the specific parameter tables. Additional guidance is provided as follows.

- Parameters will be analyzed according to analytical procedures set forth in the EPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3<sup>rd</sup> Edition, Final Update, December 1996 and in the specialty methods and SOPs referenced in Table 7-2.
- Sample preparation for biota samples prior to solvent extraction or digestion will include homogenization of each sample using a tissuemizer or blender. This procedure will ensure a uniform sample aliquot for analysis.
- Samples that have significant matrix interferences may require specialized cleanup procedures and/or reanalysis in order to eliminate interferences and to permit analysis to proceed with a reporting limit at or closer to the project required reporting limits. The laboratory must report any matrix interferences that result in elevated reporting limits without positive results for target analytes. Cleanup protocols will be anticipated for the biota sample analyses and procedures for cleanup will be drawn from the EPA SW-846, 3<sup>rd</sup> Edition manual or as suggested in the specialty methods and SOPs listed in Table 7-2.

The laboratories will maintain current SOPs for extraction, cleanup and analysis of surface waters, sediments, and biota material and must have on file current Method Detection Limit (MDL) studies to demonstrate their ability to meet the project required reporting limits within these matrices. Laboratory SOPs for non-standard or modified EPA methods are presented in Appendix C-2 for chemistry laboratory extraction and cleanup protocols. These protocols include method 3545 pressurized fluid extraction, sulfur cleanup method 3660B, amino-propyl cleanup, gel permeation chromatography (GPC) modified methods 3640A and 8000B, method 8082 PCBs, method 8081A pesticides, leaching of inorganic arsenic species from tissue samples, total inorganic arsenic methods and method 9060 TOC.

The MDLs must be performed by the laboratories on a yearly basis to ensure their ongoing ability to perform the methods as specified. The MDLs will be performed in accordance with EPA guidance described in 40 CFR 136, 1986, Appendix B, "Definition and Procedure for the Determination of the Method Detection Limit - Revision 1.11".

### 7.2.3 Biota Methods – Benthic Invertebrate Community Composition

The field-preserved benthic grab samples will be sorted at the laboratory using techniques described in the SOP for processing of benthic invertebrate samples for taxonomic identification and community evaluation (Appendix C-4). Benthic invertebrates will be identified to the lowest practical taxonomic level and counted. A voucher collection of the identified animals will be maintained. The data will be analyzed for taxa richness, abundance, percent dominant taxon/taxa, and community composition.

### 7.2.4 Biota Methods – Fish Processing and Filleting

Forager fish will be processed as whole fish in the laboratory. Bottom fish and piscivorous fish will be filleted using procedures described in Section 4.8.2 and Appendix B-5. The target organ (liver) will be removed from filleted fish for separate analysis. Fillets, livers, and offal (the remains of filleted fish) and whole fish samples will be first analyzed for metals listed in Table 1-7. Fillets will also be analyzed for organic and inorganic arsenic species (Table 1-8). Fish samples that will undergo organic analysis will also be analyzed for lipid content, since there is a documented correlation between bioaccumulation of certain organic contaminants (e.g., PCBs) and the lipid content of fish. Metals are the primary chemicals of concern for this Site; however, if the analytical results of sediment samples indicate the presence of organic chemicals (PCBs, pesticides and SVOCs), sufficient fish tissue will be stored frozen for analysis at a later date for PAHs, PCBs, pesticides, and percent lipid determinations.

### 7.2.5 Sediment Toxicity Methods

Sediment toxicity testing will be performed using Site sediments collected during the Main Sampling Program as described in Section 4. Acute and chronic toxicity testing will be performed on *Hyallorella azteca* and *Chironomus tentans*. Acute toxicity tests will include EPA Test Method 100.1 *Hyallorella azteca* 10-d survival and growth test for sediments and EPA Test Method, *Chironomus tentans* 10-d survival and growth test for sediments. Chronic toxicity tests will include draft EPA Test Method 100.4 *Hyallorella azteca* 42-d growth and reproduction test and draft EPA Test Method 100.5 *Chironomus tentans* test for measuring chronic survival, growth, emergence, and reproduction. Aquatic Biological Sciences, Inc.'s laboratory SOPs for the sediment toxicity tests are presented in Appendix C-3. Eight laboratory replicates will be conducted for each acute test. Twelve laboratory replicates will be conducted for the chronic test with *Hyallorella azteca*. Sixteen laboratory replicates including 4 auxiliary male replicates will be conducted for the chronic test with *Chironomus tentans*.

When whole sediment samples are removed from storage, test sediment will be prepared following procedures cited in the laboratory SOP (Appendix C-3). Indigenous organisms removed from the test sediment will be identified and recorded. Control sediment (artificial sediment) will be hydrated before distribution into test chambers. The sediments will be then distributed to individual replicate test chambers, overlying water will be added, and the automated overlying water renewal system will be activated. In addition to measurements of

initial overlying water chemistry cited in the sediment toxicity SOP (Appendix C-3), ammonia and hydrogen sulfide will be measured in sediment pore water.

**Table 7-2. Laboratory Methods of Analysis of Surface Water, Sediment, and Biota Samples in Support of the Environmental Assessment**

Parameter Type	Methods
<b>Laboratory Measurements – Woods Hole Group Environmental Laboratory</b>	
Semivolatile Organic Analytes	3545 (pressurized fluid extraction) and 8270C (GC/MS): SW-846, 3 <sup>rd</sup> Edition, December 1996
Metals	3050 (soil/sediment digestion) and 6010B (ICP) or 6020 (ICP/MS), or 7000 series (GFAA), and 7470A (CVAA-water) or 7471A (CVAA-sediment/tissue) : SW-846, 3 <sup>rd</sup> Edition, December 1996 <sup>1</sup>
Volatile Organic Analytes	5035 and 8260B (GC/MS): SW-846, 3 <sup>rd</sup> Edition, December 1996
Pesticide Analytes	3545 (pressurized fluid extraction) and 8081A (GC/ECD) modified per lab SOP: SW-846, 3 <sup>rd</sup> Edition, December 1996
PCB Aroclor Analysis	3545 (pressurized fluid extraction) and 8082 (GC/ECD) modified per lab SOP: SW-846, 3 <sup>rd</sup> Edition, December 1996
Tissue and Sediment Cleanup Methods for Organic Analyses	Sulfur Cleanup: 3660B SW-846, 3 <sup>rd</sup> Edition, December 1996. GPC: 3640A, 8000B in: SW-846, 3 <sup>rd</sup> Edition, December 1996; NOAA 1993; OLM03.1 USEPA CLP 1991. Amino-propyl Cleanup: NOAA 1993 Status and Trends – Mussel Watch Project.
Acid Volatile Sulfides and Simultaneously Extracted Metals (AVS/SEM)	USEPA Draft Method "Determination of Acid Volatile Sulfide and Selected Simultaneously Extractable Metals in Sediment", 1991 and method 6010B for analysis of metals by ICP: SW-846, 3 <sup>rd</sup> Edition, December 1996
Total Organic Carbon (TOC)	9060 modified for sediments (duplicate analyses): SW-846, 3 <sup>rd</sup> Edition, December 1996.
Percent Lipids	For biota only: EPA-600/4-81-055
Grain Size	ASTM Method D-422 for sediments
Freeze-Drying Sediment Preparation	Laboratory SOP Appendix C-1
<b>Laboratory Measurements – Frontier Geosciences Inc.</b>	
Arsenic Speciation in Surface Water – As III and V	Laboratory modification of EPA method 1632: Frontier Geoscience SOPs FGS-054 (total As by ICP-MS) and FGS-022 (inorganic As by cryogenic trapping hydride generation AA).
Arsenic Speciation in Fish Tissue – organic As inorganic As	Laboratory SOPs Frontier Geoscience "Leaching of Inorganic Arsenic species from Tissue Samples," FGS-058 (oxidative total tissue digestion), FGS-022 (total inorganic As by cryogenic trapping hydride generation AA), FGS-054 (total As by ICP-MS)
<b>Biotoxicity Testing – Aquatec Biological Sciences</b>	
Sediment Bioassay Toxicity Testing	See Appendix C-3 for Sediment Bioassay Protocols and references.

<sup>1</sup>See Section 7.2.1 for the full analytical scheme for preparation and analysis of surface water samples for total and dissolved metals analysis.

## **8.0 INTERNAL QUALITY CONTROL CHECKS**

### **8.1 Field Measurements**

Field Quality Control (QC) samples are collected in the field to verify the performance of the sampling activities. These field QC checks are submitted to the laboratory to demonstrate the overall effectiveness of the sampling protocols. The type and frequency of field-generated QC samples are described in Section 3 of this QAPP. Primarily, equipment rinsate blanks, trip blanks, and field duplicates are employed to verify the field sampling approach.

### **8.2 Laboratory Analysis**

Laboratory QC checks include the analysis of initial and continuing calibration checks, blanks, spiked samples (matrix spikes and matrix spike duplicates, laboratory control samples and/or Standard Reference Material (SRM) analysis, cleanup check samples), surrogates (organic analyses only), laboratory duplicate samples (inorganic analyses), and retention time window determination (applicable organic methods). The type and frequency of laboratory-generated QC samples are described in Section 3 of this QAPP. A brief description of these check samples is given below. Criteria that the laboratory must meet for these are based on the specific analytical methods used and are summarized in Section 3, Tables 3-1 through 3-6. Laboratory QC will be checked against the analytical methods and data usability criteria during the data generation and review process.

#### **8.2.1 Calibration Criteria**

Calibration checks will be performed according to the method-specific requirements as summarized below. The specifics for the calibrations are detailed in the individual analytical methods.

##### *Organic Analyses*

- Multilevel initial calibrations (usually 5-level) will be performed to establish the instrument's response to the targets of interest across a range of concentrations (calibration curves). The lowest level calibration standard must be at or below the project required reporting limit
- Calibration verification will be performed at least once every 12 hours of gas chromatograph/mass spectrometer (GC/MS) analysis. For gas chromatographic (GC) analyses, verification will occur every 10 samples of GC instrument analysis to ensure continued accurate quantitation.

- Instrument tuning of GC/MS systems will be performed every 12 hours using the method-appropriate tuning standard and acceptance criteria.

### *Inorganic Analyses*

- Multilevel calibration curves generated by analyses of individual or mixed standards
- Initial calibration verification at the beginning of each run and continuing calibration verification at a minimum of 1 every 10 samples to verify ongoing instrument performance
- Inductively coupled plasma (ICP) interference check standards after initial calibration and after sample analysis (within 8-hours) to verify interelement and background corrections

#### **8.2.2 Blanks**

Method blanks are generated by the laboratory as they are processing field samples. These method or preparation blanks are analyte-free matrices that are processed using all of the reagents and procedures that are used on the field samples to evaluate whether or not contamination occurred during sample preparation and analysis. Method blanks will be analyzed at a minimum of 1 per 20 field samples per matrix per preparation batch. Contamination found in the method blank and similarly in the field samples may be an indication of cross-contamination and may not be indicative of the samples taken from the field. Additional method blanks, such as cleanup method blanks, may be generated to independently verify the cleanup technique, if used. Criteria for acceptance of method blanks is method-specific and is included in Section 3.

Analytical blanks are required for inorganic analyses during initial and continuing calibration verification. These blanks are analyzed at the beginning, during and at the end of the analytical sequence to assess contamination and instrument drift. The initial calibration blank (ICB) is run after the initial calibration verification (ICV) and prior to sample analysis. The continuing calibration blank (CCB) is analyzed every 10 samples, following the ICB, throughout the analytical run and at the end of the sequence. These blanks are prepared by acidifying reagent water to the same concentrations of acids found in the samples and standards. Criteria for acceptance of the analytical blanks are the same as for method blanks and are included in Section 3.

### **8.2.3 Matrix Spikes and Matrix Spike Duplicates**

Matrix Spike (MS) samples are prepared by spiking known concentrations of target analytes into an aliquot of field sample. The MS is processed in exactly the same manner as all other field samples. The percent recovery of a target spike compound is an indication of the ability of the methods of analysis and of the laboratory to accurately quantitate the target analyte in the sample that was spiked. The recovery of the MS may aid the analyst in determining whether a matrix effect or interference exists in the analysis of the unspiked sample. For organic analyses in particular, the recovery of the MS does not necessarily reflect the ability to accurately determine the target analyte, or analytes of similar chemical nature, in other field samples. MS target compounds and criteria are method specific and are summarized in Section 3.

Matrix Spike Duplicates (MSD) are prepared for organic analyses and are handled in the same exact manner as the MS. The relative percent difference (RPD) is a measure of comparability between the MS and MSD and provides a measure of analytical precision. For all organic analyses, an MS/MSD pair will be prepared and analyzed at a frequency of 1 per 20 samples per matrix per analytical batch. RPD acceptance criteria for the MS/MSD are analyte and method specific and are summarized in Section 3.

### **8.2.4 Surrogate Spikes**

All samples, including field and QC samples, analyzed for organic components will have surrogates added to the samples during the preparation procedures. The surrogates used are method-specific and are similar in chemical nature to the targets of interest; however, they are not normally found in environmental samples. The recoveries of the surrogate compounds assist the analyst and data user in the determination of the accuracy of the measurements for the target compounds of interest. Tables in Section 3 summarize the surrogate identities and criteria by method.

### **8.2.5 Laboratory Control Samples and Standard Reference Material**

Laboratory Control Samples (LCS) are prepared by spiking known concentrations of target analytes into analyte-free matrices (blank matrices). Standard Reference Material (SRM) contain the analytes of interest in a matrix of interest and are purchased from a standard's vendor. LCS and SRM are prepared and analyzed concurrently with the field samples. The recovery of the targets from the LCS or SRM is a measure of the ability of the preparation and analysis methods to accurately quantitate target analytes in the absence of matrix effects or interferences. LCS will be analyzed at a minimum of 1 per 20 field samples per matrix per preparation batch. LCS criteria are analyte and method specific and are summarized in Section 3. The SRM criteria are based on the manufacturer's accuracy limits or 80-120% recovery.

### **8.2.6 Cleanup Check Samples**

Whenever a cleanup technique (e.g., gel permeation chromatography (GPC), alumina column cleanup, etc.) is employed to eliminate interferences which may prevent accurate determination of the targets of interest at the project required reporting limit, the cleanup procedure must be verified through the analysis of check standards. A standard containing some or all of the target analytes must be processed through the cleanup procedure and analyzed. The recovery of the target analytes in this check will indicate if the cleanup procedure was effective in elimination of interferences without undo elimination of the targets of interest.

### **8.2.7 Laboratory Duplicates**

For inorganic analyses, a laboratory matrix duplicate (MD) is a separate aliquot of sample taken from the same sample container as a field sample, which is prepared and analyzed independently. Comparison of all positive results between the sample and MD, through determination of the RPD, provides a measure of the analytical precision and accuracy of the quantitation. A sample/MD pair will be prepared and analyzed at a frequency of 1 per 20 samples per matrix per analytical batch. RPD acceptance criteria for the sample/MD are analyte and method specific and are summarized in Section 3.

### **8.2.8 Retention Time Window Determination**

For organic analyses, determination of the target analyte retention time window will be made based on the procedure specified in the method of analysis. Positive identification of an analyte will be made when it's retention time falls within the window established during calibration.

## **9.0 DATA REDUCTION, VALIDATION, AND REPORTING**

All data generated through field activities or by the laboratories, shall be reduced, reviewed, and evaluated prior to use in the Ecological and Human Health Risk Assessments using the following procedures. Reconciliation with risk assessment requirements is described in Section 12.

### **9.1 Data Reduction**

#### **9.1.1 Field Data Reduction Procedures**

Field measurements for quantitative analyses include pH, temperature, specific conductance, and dissolved oxygen. Qualitative measurement of turbidity will be taken to assess light penetration. In addition, field activities include observations and sample collection information. Raw data consist of instrument responses in the form of meter, recorder, or printer output. The technician/operator performing the analysis will enter the data in a field logbook or form for each parameter. All reductions of data must follow the procedures and equations provided in the respective testing protocols (see Table 7-1). The reduction of field data will consist of summarizing the raw field data, which may be presented in the form of tables, logs, illustrations, and graphs, as deemed appropriate.

#### **9.1.2 Laboratory Data Reduction Procedures**

Laboratory data reduction procedures will be performed according to the following general protocols and laboratory-specific protocols as described in the laboratory QAPP. All raw analytical data will be recorded and documented using laboratory standard procedures. Laboratory data will include, at a minimum, the unique sample identification number, analytical method used, name of analyst, the date of analysis, matrix sampled, reagent and standard concentrations, and instrument settings. Periodic review of laboratory notebooks (logbooks) and data reports shall be performed by the Lab QA Manager as described in the laboratory QAPP.

Analytical results for sediment samples will be reported on a dry-weight basis. Results for tissue (biota) analyses will be reported on a wet-weight basis. QC data (*e.g.*, laboratory duplicates, surrogates, MS/MSDs) will be compared to the acceptance criteria defined in this QAPP in Sections 3 and 7. Case narratives will be prepared which will include information concerning data that fell outside acceptance limits, and any other anomalous conditions encountered during sample analysis. After the laboratory submits the laboratory data package to the Ecological Project Manager, the data are considered approved by the laboratory and ready for third party data review or validation.

## 9.2 Data Validation

All data used in the ERA and HHRA will be evaluated for usability for project goals using the procedures described in this section and in the SOP included as Appendix D.

### 9.2.1 Procedures Used to Validate Field Data

The procedures to evaluate field information for the Environmental Risk Assessment include checking for transcription errors and review of field logbooks for completeness and field measurements based on the criteria in Section 6 and field SOPs. Historical data from previous Site assessments may be compared to the data generated during this assessment as part of the verification process. These reviews will be performed by the Ecological Project Manager and the Chemistry QA Team.

### 9.2.2 Procedures Used to Validate Laboratory Data

Procedures to evaluate laboratory data are detailed in the SOP included in Appendix D, and were derived from the USEPA *Region I, EPA-NE Data Validation Functional Guidelines for Evaluating Environmental Analyses; Part II. Volatile/Semivolatile Data Validation Functional Guidelines* (1996), USEPA *Region I Laboratory Data Validation Functional Guidelines for Inorganic Analyses* (1989), USEPA *Guidance for Data Useability in Risk Assessment* (9285.7-09A, April 1992), and USEPA quality assurance guidance document QA/G-9. The Chemistry QA Team, New Environmental Horizons, Inc., have modified the EPA protocols to include the criteria in this project QAPP as listed in Sections 3 and 8 (see Appendix D).

Data generated from the April 20, 1999 Preliminary Reconnaissance Survey (USEPA Region I), April 29-30, 1999 Reconnaissance Survey (Menzie-Cura), and June 4, 1999 Supplemental Reconnaissance Sediment Sampling (USEPA Region I) were reviewed to make decisions about sediment sample preparation procedures and Site locations. Also, the QC data were reviewed to ensure that the methods and laboratory's performing the work are meeting the data quality objectives of this QAPP. This is a pro-active approach to generation of valid data for this program. In this way, any issues that may affect the usability or validity of the data for use in risk assessment can be uncovered and corrective actions implemented prior to the start of the Main Sampling Program.

One hundred percent of the data generated during the Main Sampling Program will be assessed for usability, completeness, and adherence to key QA/QC objectives for this project. This data assessment review will follow guidance in USEPA's *Guidance for Data Useability in Risk Assessment*, (PB9285.7-09A, April 1992) and will include a review of all technical holding times, instrument performance check sample results, initial and continuing calibration results, and all batch and matrix QC including field blanks, field duplicates, MS/MSD, matrix duplicates, surrogate recoveries, method blanks, laboratory control samples, standard

reference material results, and the identification and quantitation of specific compounds of interest.

Data Assessment in support of Industri-Plex requires the review and evaluation of chemical data based upon EPA Region I guidance for data assessment of inorganic and organic and site-specific requirements as defined in this QAPP. The purpose of the data usability assessment is to provide information to the data users (e.g., regulators, risk assessors) of the uncertainty and bias in the data for decision making.

For the Industri-plex project, approximately 10% of the data (one data package, or SDG, per chemical fraction) will undergo the Region I Tier III-type Data Usability Review. The remainder of the data will undergo the Region I Tier II-type Data Usability Review. Data usability assessment will be performed using the project-specific protocols detailed in Appendix D and briefly summarized below.

#### *Data Usability Review Process*

A two-stage process for assessment will be performed. The first stage is equivalent to a Region I Tier III validation in scope. The laboratory will submit one full deliverable (Tier III type), including raw data, results, and QC summaries, for each type of analysis they are performing (e.g., Semivolatile Organics Compounds by Method 8270C). This data package will undergo an in-depth evaluation of all of the quality control information provided, as well as a review of the raw data on instrument calibrations, extraction procedures, qualitative and quantitative determinations to ensure that the laboratory is producing data in a manner which is compliant with the methods and with the QAPP. NEH will use a project-specific checklist to conduct the Data Usability Reviews (an example is included in Attachment A of Appendix D) and a project-specific Data Usability Summary Report (included in Attachment B of Appendix D) to document this Tier III-type data usability review. Data summary spreadsheets, with standard data qualifiers applied to the results, will also be generated, as required by the data users. This process combines the functions of third-party validation with usability assessment for a comprehensive review and evaluation of the data for risk assessment. This Tier III-type data usability review will provide a measure of "insurance" of the comparability, accuracy, precision, and sensitivity of the results for the project.

Any deficiencies in performance of the work by the laboratory that are uncovered during the Data Usability Review will quickly be brought to the laboratory's attention for corrective action. If these deficiencies prove to be major, the reviewer may request that the laboratory submit another Tier III package of data after all corrective actions have been taken to ensure the integrity of the project.

Once the first stage has been successfully completed, the second stage of the assessment process involves an abbreviated, project-specific Data Usability Checklist Review (an example is provided in Attachment C of Appendix D) which is equivalent in scope to a Region I Tier II validation. The laboratory will provide a Tier II deliverable for assessment, which includes sample results and QC summary data (but no raw data). The checklist will be used to evaluate the key data quality indicators for the samples. The data users will be provided with these Data Usability Checklists and a Data Usability Summary Report (as included in Attachment B). Data summary spreadsheets, with standard data qualifiers applied to the results, will also be generated, as required by the data users.

In addition to the precision, accuracy, and sensitivity criteria as defined in Section 3 and 8 of this QAPP, the overall completeness of the data package will also be evaluated. Completeness checks will be administered on all laboratory data packages to determine whether deliverables specified in the QAPP Section 9.3, below, are present. The reviewer will determine whether all required items are present and request copies of missing deliverables using resubmittal request documentation *via* facsimile or email. Such documentation will be included in the Data Usability Summary reports (see Appendix D).

Additionally, method detection limit studies (MDL) for all chemicals of concern in the matrices of interest will be performed by the analytical laboratory. These MDLs must support the project reporting limit requirements and have been performed within one year of the analysis of samples collected for the Environmental Risk Assessment. The laboratory shall follow the MDL procedures as outlined in the Federal Register, Vol. 49, no. 209, October 26, 1984, pp.198-199 and associated laboratory QAPP SOPs.

## **9.3 Data Reporting**

### **9.3.1 Field Data Reporting**

Field data reporting for measurements are described in Sections 4.0, 5.0, 6.0, and Appendix B-7 of this QAPP.

### **9.3.2 Laboratory Data Reporting**

The Laboratory will provide at least two hard-copies of each laboratory data report, an original and a copy for the Data Usability Review, to the Ecological Project Manager. Electronic deliverables may be required for the project database. Specific formats for electronic deliverables shall be determined by the Ecological Project Manager in discussions with the analytical laboratory prior to the start of the program.

The laboratory data reports for the environmental chemical results must include the following, at a minimum:

1. Case Narrative

- Date of issuance
- Laboratory analysis performed
- Any deviations from intended analytical strategy
- Numbers of samples and respective matrices
- QC procedures utilized and also references to the acceptance criteria
- Project name and number
- Condition of samples 'as-received'
- Discussion of whether or not sample holding times were met
- Discussion of technical problems or other observations which may have created analytical difficulties
- Discussion of any laboratory QC checks which failed to meet project criteria
- Signature of the Laboratory QA Manager and/or Laboratory Director or designee

2. Chemistry Data Package

- Summary page indicating dates of analyses for samples and laboratory QC checks
- Cross referencing of laboratory sample to project sample identification numbers
- Description of laboratory data qualifiers used
- Sample preparation and analyses summary or form with dates of preparation/extraction/analysis and methods used for samples
- Sample results on a dry-weight basis for sediments and on a wet-weight basis for biota, with units clearly labeled and dilutions clearly marked.
- Sample-specific reporting limits for all compounds
- QC summaries including: MS/MSD recoveries, laboratory control samples/standard reference material recoveries, surrogate recoveries, method blank results

In addition, the laboratory data package that will undergo the Region I Tier III-type Data Usability Review must also include the following:

- Raw data for sample results and laboratory QC samples
- Results of (dated) initial and continuing calibration checks, and GC/MS tuning results
- Calibration check compounds, system performance check results
- Chromatograms/spectra or other raw data of sample results and QC checks
- Example result calculations

## **10.0 PERFORMANCE AND SYSTEM AUDITS**

Performance and system audits of both field and laboratory activities may be conducted to verify that sampling and analysis are performed in accordance with the procedures established in this QAPP. The audits of field and laboratory activities will include two independent parts: internal and external audits.

### **10.1 Field Performance and System Audits**

#### **10.1.1 Internal Field Audit Responsibilities, Frequency, and Procedures**

Internal audits of field activities including sampling and field observations will be conducted by the Ecological Project Manager. These audits will verify that all established procedures are being followed.

Internal field audits should be conducted at least once at the beginning of the Site sample collection activities and potentially during the course of sampling activities if problems in the field are encountered.

Internal field audits will include examination of field sampling records, field observation records, sample collection, handling and packaging in compliance with the established procedures, maintenance of QA procedures, chain of custody, and any other procedures defined in this QAPP Sections 4 and 5. These audits will occur at the onset of the project to verify that all established procedures are followed. Follow-up audits may be conducted to correct deficiencies, and to verify that QA procedures are maintained throughout the project.

#### **10.1.2 External Field Audit Responsibilities, Frequency, and Procedures**

USEPA Region I project team personnel will provide field surveillance and oversight during both the Survey and the Main Sampling Event. Formal external audits are not planned for this project because USEPA Region I RPM and QAO are involved in a pro-active role during all Site activities.

## **10.2 Laboratory Performance and System Audits**

### **10.2.1 Internal Laboratory Audit Responsibilities, Frequency, and Procedures**

The internal laboratory audit will be conducted by the laboratory QA Officer. The internal system audits will be done on an annual basis while the internal performance audits may be conducted on a quarterly basis according to the laboratory QAPP procedures.

The internal system audits will include an examination of laboratory documentation on sample receiving, sample log-in, sample storage, chain-of-custody procedures, sample preparation and analysis, instrument operating records, etc. The auditor should ensure that all Standard Operating Procedures (SOPs) and Method Detection Limits (MDL) are current and appropriate for the matrices and analyses being conducted for the project. The laboratory internal auditor will follow procedures described in the laboratory QAPP for internal system audits.

The performance audits may involve preparing blind QC samples and submitting them along with project samples to the laboratory for analysis throughout the project. The laboratory QA Officer will evaluate the analytical results of these blind performance samples to ensure the laboratory maintains acceptable QC performance. The laboratory auditor will follow procedures for the performance audits as described in the laboratory QAPP.

Data package review, as discussed in Section 10.2.2, below, may also be performed.

### **10.2.2 External Laboratory Audit Responsibilities, Frequency, and Procedures**

Oversight of laboratory activities will be performed by the Chemistry QA Team via conference calls, real-time review of data generated, and technical assistance during analysis. A formal external laboratory audit is not planned for this project because the laboratories chosen have been previously used, successfully, by the project team members for the respective analyses. The Chemistry QA Team plans to work very closely with Woods Hole Group Environmental Laboratory, who is performing the majority of the chemical analyses for this project, to assist with any technical issues that may arise from the complex Site matrices.

If required by USEPA, or requested by project team personnel, an external laboratory audit may be conducted at any time during the analytical operations. The audit may or may not be announced and is at the discretion of U.S. EPA Region I.

External audits may include: review of laboratory analytical procedures; laboratory on-site visits; and results of performance evaluation samples submitted to the laboratory for analysis. Failure of any or all audit procedures chosen can lead to laboratory disqualification, and the requirement that another suitable laboratory be chosen.

An external on-site review can consist of: sample receipt procedures, custody and sample security and log in procedures, sample storage procedures, review of instrument calibration records, instrument logs and statistics (number and type), review of QA procedures, log books, sample preparation procedures, analytical Standard Operating Procedure (SOP) review, Method Detection Limit (MDL) review, instrument reviews, personnel interviews, review of glassware preparation procedures, and corrective action protocols.

It is common practice when conducting an external laboratory audit to review one or more data packages from sample lots recently analyzed by the laboratory. This review will most likely include but not be limited to:

- Comparison of resulting data to the SOP or method, including deviations.
- Verification of initial and continuing calibrations within control limits.
- Verification of surrogate recoveries and instrument timing results, where applicable.
- Review of extended quantitation reports for comparisons of library spectra to instrument spectra, where applicable.
- Recoveries on laboratory control samples and/or SRM analyses.
- Review of run logs with run times, ensuring proper order of runs.
- Review of spike recoveries/QC sample data.
- Review of suspected manually integrated GC data and its cause, where applicable.
- Review of GC peak retention times and resolution for compounds as compared to reference spectra, where applicable.
- Assurance that samples were run within holding times.

Ideally, the data should be reviewed while on the premises, so that any data called into question can be discussed with the staff.

## **11.0 PREVENTIVE MAINTENANCE**

### **11.1 Field Instrument Preventative Maintenance**

All field equipment and supplies will be routinely maintained, stocked and cared for by the field personnel. An inventory of equipment, including model and serial number, quantity, and condition will be maintained. Routine checks will be made on the status of the equipment, and spare parts will be stocked. Preventive maintenance of the equipment, as outlined in the manufacturer's instructions will be followed.

Field sampling personnel will be familiar with the calibration, operation, and maintenance of the equipment, and will perform the prescribed field operating procedures outlined in the manufacturer's instructions, in Section 4, and the field SOPs in the Appendices of this QAPP. All equipment will be inspected at least twice, once at the beginning of each day of sampling and again at the end of the days sampling. All preventive maintenance will be documented in the field logbook.

### **11.2 Laboratory Instrument Preventative Maintenance**

As part of the laboratory QA Plan, a routine preventative maintenance program is conducted by the laboratory to minimize the occurrence of instrument failure and other system malfunctions. Designated laboratory employees regularly perform routine scheduled maintenance and repair of (or coordinate with the vendor for the repair of) all instruments. All laboratory instruments are maintained in accordance with manufacturer's specifications. The preventive maintenance program should include:

- An inventory of replacement and spare parts for instruments that are maintained.
- Maintenance logbooks for each instrument will be kept along with information on routine and non-routine procedures. The logbook records must include the instrument number, date of maintenance activity, and the type of activity performed.
- Training of laboratory staff in the maintenance requirements of the instruments used in this project. Preventive maintenance schedules and activities will be outlined in the laboratory's SOPs and will be adhered to.

#### **11.2.1 Inductively Coupled Plasma Spectroscopy**

The Inductively Coupled Plasma (ICP) Spectrometer should be maintained under service contract with the manufacturer. Routine preventive maintenance should include:

- Checking pump tubing and replacing when necessary.
- Checking nebulizer for even "spray" and cleaning as necessary.
- Checking the torch for plasma height and shape and cleaning as necessary.
- Checking sensitivity of photomultiplier and replacing as necessary.

### **11.2.2 Gas Chromatograph Instruments**

The GC and GC/MS systems will be maintained on a service contract or undergo in-house maintenance to provide routine preventive maintenance. Spare parts for the GC and GC/MS systems should include: filaments, electron multiplier, source parts, o-rings, ferrules, septa, injection port liners, and columns. Routine preventive maintenance for the systems should include:

- Checking the data systems (disk drives, tape readers, etc.) and servicing, as necessary
- Changing oil and traps on mechanical and turbo pumps
- Conditioning of moisture traps, every two months or when the gas source is changed
- Carrier gas evaluation and leak checking of electron capture detector when the gas or column is changed
- Servicing the MS source through cleaning, replacement of filaments and other source parts, as necessary
- Replacement of Injection port septa and liners, as necessary
- Clipping front end of GC column or replacement of GC column, as necessary

### **11.2.3 Thermometers**

Thermometers for refrigerators and ovens are calibrated yearly against National Institute of Standards and Technology (NIST) certified thermometers. The laboratory QA manager will be responsible for the safekeeping of the NIST thermometers and for the documentation asserting the accuracy of their measurements.

### **11.2.4 Analytical Balances**

Virtually every analytical procedure requires the use of side-loading and/or top-loading balances. Many of these requirements involve standards preparation and are, therefore, crucial to accurate determination. Balances should be maintained on a service contract. A calibration status label is affixed to each balance after calibration during servicing.

## 12.0 SPECIFIC ROUTINE PROCEDURES TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

The purpose of this section is to indicate the methods by which it will be ensured that the data collected for this investigation falls in line with the data quality objectives (DQOs) as described in Section 3 of this QAPP. To meet these DQOs, a combination of statistical procedures and qualitative evaluations will be used to check the quality of the data. These procedures will be used by the laboratory in generating the data, and by the Chemistry QA Team in the evaluation of the surface water, sediment, and biota results for ultimate use in the Environmental and Human Health Risk Assessments.

Results for QC samples, including field and laboratory blanks, spikes, and duplicates as previously described in Sections 3, 6, and 8 of this QAPP, will be evaluated using the equations described below to determine the validity and usability of the data. In addition, the data will be reviewed for indications of interferences to results caused by sample matrices, contamination during sampling, contamination in the laboratory, and sample preservation and storage anomalies (*i.e.*, sample analysis performed outside of method holding time or analytical instrument problems). Along with the specific equations-detailed in this section, all project data will undergo a usability review as described in Section 9 and Appendix D.

### 12.1 Precision Assessment

The relative percent difference (RPD), as a measure of variability, between the matrix spike and matrix spike duplicate for organics, or sample and matrix duplicate in the case of inorganics, and field duplicate pair will be calculated to compare to precision and representativeness DQOs. The RPD of duplicate measurements is calculated according to the following formula.

$$\text{RPD} = \frac{(\text{Result in Sample 1} - \text{Result in Sample 2})}{\frac{(\text{Result in Sample 1} + \text{Result in Sample 2})}{2}} \times 100$$

where:

Sample 1 = Initial Sample or spiked sample result

Sample 2 = Duplicate sample or duplicate spiked sample result

### 12.2 Accuracy Assessment

Accuracy, as a measure of bias, will be evaluated based on the percent recoveries of the matrix spike sample (organics and inorganics), matrix spike duplicate sample (organics), surrogates (organics), internal standards (organics), laboratory control samples and/or standard reference materials (organics and inorganics), initial and continuing calibration check samples (organics and inorganics). These QC results will be compared to the project DQOs for accuracy.

The increase in concentration of the analyte observed in the spiked sample, due to the addition of a known quantity of the analyte, compared to the reported value of the same analyte in the unspiked sample determines the percent recovery.

Percent recoveries for spiked samples and QC are determined using the following equation:

$$\% R = \frac{(\text{Result in Spiked Sample} - \text{Result in original/unspiked Sample})}{\text{Known amount of spike added}} \times 100$$

Percent recoveries for LCS and SRM are determined using the following equation:

$$\% R = \frac{\text{Result for compound in LCS or SRM}}{\text{Verified amount of compound in LCS or SRM from vendor information}} \times 100$$

Additionally, field and laboratory blanks will be used to evaluate whether field or laboratory procedures represent a possible source of contamination in the biota samples. Unmonitored contamination can allow false positive results to be reported and treated as true sample components when, in fact, they are not. This type of error will adversely affect the accuracy of the reported results. Several types of blanks, including field blanks, method blanks, and instrument blanks, will be used in this project as described in Sections 3, 6, and 8.

Specific DQOs for blanks have been defined for this program in Sections 3, 6, and 8. In general, the procedure for assessing blank samples for potential contamination is as follows.

1. Tabulate blank compound results.
2. Identify blank samples for which compounds are reported above the project-required reporting limits.
3. If no compounds are detected above the reporting limits in any blanks, the associated data are reported unqualified and no blank actions are taken.
4. If compounds are detected above the reporting limits in the blanks, the associated sample compounds will be qualified during data validation. This qualification may result in the negation of results at raised reporting limits due to blank actions.

### **12.3 Completeness Assessment**

Completeness is the ratio of the number of valid sample results to the total number of results planned for collection. Following completion of the sampling, analysis, and data validation, the percent completeness will be calculated and compared to the project DQO of  $\geq 90\%$  (Section 3 of this QAPP) using the following equation.

$$\% \text{ Completeness} = \frac{\text{number of valid/usable results obtained}}{\text{number of valid/usable results planned}} \times 100$$

#### **12.4 Overall Assessment of Environmental Data**

Data assessment will involve data evaluation and usability to determine if the data collected are of the appropriate quality, quantity and representativeness to support the Environmental Risk Assessment. The affect of the loss of data deemed unacceptable for use, for whatever reason, will be discussed and decisions made on corrective action for potential data gaps. The QC results associated with each analytical parameter for each matrix type will be compared to the objectives presented in Sections 3, 6, and 8 of this QAPP. Only data generated in association with QC results meeting these objectives and the data validation criteria will be considered usable for the Environmental Risk Assessment.

Factors to be considered in the overall data assessment based on the DQOs in this QAPP and the data evaluation by the third-party validator will include, but not necessarily be limited to, the following.

- Were all samples obtained using the methodologies and SOPs proposed in the QAPP?
- Were all proposed analyses performed according to the SOPs provided in the QAPP?
- Were samples obtained from all proposed sampling locations planned?
- Do any analytical results exhibit elevated detection limits due to matrix interferences or contaminants present at high concentrations?
- Were all laboratory data evaluated according to the validation protocols, including project-specific QC objectives as defined in this QAPP?
- Which data sets were found to be unusable (qualified as "R") based on the data evaluation results?
- Which data sets were found to be usable as estimated data, (qualified as "J" or "UJ") based on the data evaluation results?
- Has sufficient data of appropriate quality been generated to support the Environmental Risk Assessment?
- Were all issues requiring corrective action, if any, fully resolved?
- Have any remaining data gaps been identified and summarized in the final report?

## **12.5 Reconciliation with Data Used to Assess Precision, Accuracy, Representativeness, Completeness, Comparability for Quality Objectives Measurement**

The goal of this project is to produce an Ecological and Human Health Risk Assessment. As such, the data generated must meet the risk assessor's needs as defined in Section 1 and the project DQOs in Section 3 of this QAPP. In summary from Section 3, the primary objectives for assessing the usability of the data are (1) to collect data that are representative of Site conditions and comparable with prior data; (2) to produce data that meet the project reporting limit requirements for Ecological and Human Health Risk Assessment; (3) to produce data of the highest quality possible in order to accurately and precisely characterize the Site ecological conditions.

The Chemistry QA Team during Data Usability Review will apply the standard EPA data validation qualifiers to the data to indicate the level of uncertainty in the associated result. In general, for the purposes of the Environmental Risk Assessment, data that are left unqualified, data qualified "U" (non-detected), data qualified "J" (detected as an estimated result), and data qualified "UJ" (non-detected at an estimated detection reporting limit) are considered valid and usable for project objectives. Data that are qualified "R" (rejected), due to severe exceedances of QC requirements, will be considered invalid and unusable for the Environmental Risk Assessment. See Section 9 and Appendix D for a more detailed explanation of the Data Usability Review process planned for this project.

To meet the needs of this program, field sampling personnel, the analytical laboratory, the data validator and the risk assessors (human health and ecological) will work together on a frequent and regular basis to ensure that the project RLs (or PQLs) are as low as feasible for the media being sampled and that sample analytical results will achieve RLs within the limits of the selected analytical methods. The usability of such data with higher RLs will be evaluated during the risk assessment activities. In general, one half of the sample-specific detection levels may be used in risk calculations as a conservative estimate for compounds that do not meet the project RLs.

The goal of this QAPP program is to generate valid, usable data for the risk assessment activities. However, in environmental sampling and analysis, some data may be lost due to sampling location logistics, field or laboratory errors, or matrix effects that may cause the rejection of results for some compounds. The overall completeness of collection of valid and usable data, as defined in Section 3 of this QAPP, is 90%. The Chemistry QA Team will assess the completeness of the overall data generation against the project goal of producing 90% of the planned data as valid and usable results for the Ecological Risk Assessment. If this goal is not met, data gaps may exist that may compromise the risk assessment.

## **13.0 CORRECTIVE ACTIONS**

Corrective action is the process of identifying, recommending, approving, and implementing measures to counter unacceptable procedures or out of QC performance which can affect data quality and usability. Corrective actions may be required for two classes of problems: analytical and equipment problems and noncompliance problems. Analytical and equipment problems may occur during sampling and sample handling, sample preparation, laboratory instrumental analysis, and data review.

For noncompliance problems, for example, non-compliance with EPA methods or QC defined in this QAPP, a formal corrective action will be implemented at the time the problem is identified. The person who identifies the problem is responsible for notifying the Ecological Project Manager. A description of the problem and the corrective action implemented will be confirmed in writing *via* email, facsimile, or technical memorandum.

Any nonconformance with the established quality control procedures in this QAPP will be identified and corrected.

Corrective actions in the field will be implemented and documented in the field logbook.

### **13.1 Field Sample Collection**

Technical staff and field project personnel will be responsible for reporting all suspected technical or QA nonconformance or suspected deficiencies of any field collection or observation activity by reporting the situation to the Ecological Project Manager or designee. If it is determined that the situation warrants a reportable nonconformance requiring corrective action, then a nonconformance report will be initiated by the field personnel.

The manager will be responsible for ensuring that corrective action for nonconformance are initiated by:

- evaluating all reported nonconformance;
- controlling additional work on nonconforming items;
- determining disposition or action to be taken;
- maintaining a log of nonconformances;
- reviewing nonconformance reports and corrective actions taken; and
- ensuring nonconformance reports are included in the final site documentation in project files.

If appropriate, the Ecological Project Manager will ensure that no additional work that is dependent on the nonconforming activity is performed until the corrective actions are completed.

If a corrective action warrants a change in the program protocols, this change will be documented and signed by the Menzie-Cura Field Team Leader for the Environmental Risk Assessment, the Ecological Project Manager, the Chemistry QA Team, and the EPA RPM.

### **13.2 Laboratory Analysis**

The laboratories participating in this program are required to have a written SOPs specifying corrective actions to be taken when an analytical error is discovered or the analytical system is determined to be out of control. The SOP requires documentation of the corrective action and notification by the analyst about the errors and corrective procedures.

Corrective actions are required whenever an out-of-control event or potential out-of-control event is noted. The investigative action taken is dependent on the analysis and the event. Laboratory corrective actions may be necessary if:

- QC data are outside the warning or acceptable windows for precision and accuracy
- Blanks contain compounds of interest, as listed in tables in Section 1 of this QAPP, above acceptable levels
- Undesirable trends are detected in spike recoveries or RPD between duplicates
- There are unusual changes in detection limits
- Deficiencies are detected by the Laboratory QA Department during internal or external audits or from the results of performance evaluation samples
- Inquiries concerning data quality are received

Corrective action procedures are often handled at the bench level by the analyst, who reviews the preparation or extraction procedure for possible errors, checks the instrument calibration, spike and calibration mixes, instrument sensitivity, and so on. If the problem persists or cannot be identified, the matter is referred to the laboratory supervisor, manager and/or QA department for further investigation. Once resolved, full documentation of the corrective action procedure is filed with the QA department.

Corrective action may include:

- Re-analyzing the samples, if holding time criteria permits;
- Re-sampling and analyzing;
- Evaluating and amending analytical procedures;
- Accepting data and acknowledging the level of uncertainty as documented in the laboratory data package case narrative.

If re-sampling is deemed necessary due to laboratory problems, the Ecological Project Manager must identify the necessary approach including cost recovery for the additional sampling effort.

## **14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT**

The deliverables associated with the tasks identified in the Environmental Risk Assessment Work Plan will contain QA sections in which data quality information collected during the task is summarized. The Environmental Risk Assessment report will include the results of the data usability evaluation of the samples as a documentation of the quality of the data collected for assessing environmental risk.

The QA section of the Environmental Risk Assessment report will contain information generated during the project on the achievement of project-specific DQOs, uncertainties in the data used and their affect on the risk assessment, and a summary of corrective actions implemented, as necessary, as it may have affected the evaluation of risk.



**A-1**

**RECONNAISSANCE SAMPLING AND ANALYSIS SCHEME**

## Reconnaissance Sampling and Analysis Scheme

### Objectives of Reconnaissance:

- a. To determine sampling locations for the main event;
  - b. to determine Sediment types and correct sampling procedures for these sediments;
  - c. to determine whether high- or low-level volatiles preservation will be used during the main sampling event for sediments;
  - d. to determine the effectiveness of the Pesticide/PCB cleanup procedure;
  - e. to determine the analysis requirements for the main sampling event; and
  - f. to determine whether laboratory freeze-drying of the sediments is appropriate to the main sampling event.
1. **Location of Sampling Sites:** The team will locate reference and contaminated locations through visual inspections and by taking limited samples for indicator parameters (percent solids, TOC and grain size). Based on these inspections, a reference site and a contaminated site will be chosen for sediment sampling.
  2. **De-watering of Sediments for Semivolatiles, Metals, Pesticides, and PCBs:** Sampling will be done in accordance with the Region I Sediment Sampling Guidance (Draft September 1998). The team will define the Sediment Type (I, II, III, or IV) for the reference and contaminated site and will use the field de-watering technique described in the guidance document, for all sample aliquots other than volatiles, to minimize the water content of the sediments. Two sediments (duplicates) will be taken for each sampling location. The general process for field de-watering is as follows:
    - Sediment core is taken. If Type I sediment is sampled, each layer must be discretely handled through the process (i.e., each layer must be de-watered, homogenized, and placed into it's own sample container).
    - Sediment is placed into a Stainless Steel colander, which has been lined with Whatman #4 filter paper. The sediment is spread out across the filter paper (to up to 1 inch thick) and any extraneous debris is removed from the sample.
    - As the sediment settles, filter paper is placed on top of the sediment to absorb any standing water (this may be repeated several times using new dry paper)
    - Let the sediment stand for >5min but <10 min and transfer it to a clean stainless steel mixing bowl, removing any filter paper.
    - Repeat process until sufficient sample (~1000 grams) has been taken for all of the analytical tests required. Homogenize the sediment collected in the bowl using a stainless steel spoon. Once homogenized, half-fill containers for analysis.
    - Clean the colander, mixing bowl and spoon between samples. After the two sediments have been taken, clean the equipment and then pour 4 liters of reagent-free water through the colander and into the mixing bowl (This can be done in 1-L aliquots). Stir the water with the spoon and then fill up (3) 1-L bottles as Field Blanks for Semivolatiles, Pesticides, and PCBs. Pour the remaining 1-L aliquot into the Metals RB bottle with HNO<sub>3</sub> preservative. Pour the pre-preserved Metals

Field Blank water (from Frontier GeoScience) through the de-watering set-up and refill the Metals field blank bottle (for Arsenic speciation). In addition, for metals, a 1-L Bottle of reagent-free water, preserved with HNO<sub>3</sub> to a pH < 2, which is left unopened during sampling and is not exposed to the Stainless Steel colander, bowl and spoon will be used as a secondary field blank (called "Metals Trip Blank") to ensure that the de-watering process, using the stainless steel, is not a source of metals contamination.

3. **Sediment Sampling for Volatile Organic Compound Analysis:** During reconnaissance, the low-level and high-level volatiles preservation technique, as well as a modified low-level volatiles sampling (per authorization from EPA Region I QA Officer Andy Beliveau on 4/23/99), will be used to establish the correct method of preservation for the main sampling event. The guidance from Region I on Sediment Sampling for Volatiles will be employed; however, addition of the surrogate in the field will not be done (i.e., modified plastic syringes will be used: 60-mL for high-level sampling and 10-mL for low-level sampling). The laboratory will provide pre-preserved and pre-weighed sampling containers for the two low- and one high-level preservation methods. Standing water should be removed from the sample (through the syringe) if possible; however, it is imperative that the samples be taken quickly to prevent loss of volatiles. In addition, a sample of the same type of sediment used to fill the volatiles containers must be taken for percent solids determination (termed non-de-watered percent solids). Two sediments (field duplicate pair) will be taken for each sampling location. It is imperative that the samples be completely covered with preservative. For the low-level methods, 5g of sediment should be taken while the high-level method requires 25g of sediment be sampled.
4. **Sampling Quantities:** Table 1 shows the samples that are expected from the reconnaissance. In general, 2 sediments from the Reference and 2 sediments from the Contaminated site will be taken (2 Field Duplicate Pairs) with additional QC consisting of Field Blanks and Trip Blanks. Several other sites will be tested only for TOC, Grain size, and percent solids. Table 3 contains the exact sample containers, preservation, and holding times for the analyses to be conducted on these samples.
5. **Cooler Shipment:** Table 2 indicates the coolers required for this reconnaissance evaluation.
6. **Laboratory Analysis:** Table 4 shows a generalized scheme for the laboratory analysis. In addition to the samples and QC received from the field, the laboratory will perform QC in the form of Method Blanks and Standard Reference Material Analysis. During sample handling and analysis, it will be important that the laboratory communicate any observations or anomalies as quickly as possible to NEH and Menzi-Cura.
7. **Evaluation of Results:** Type II deliverables are expected from the laboratory (data sheets, volatile sample weights, %solids determination, and summary information for all Quality Control). The results will be evaluated in the following manner:

- Accuracy of the results will be judged based on the surrogate recovery, SRM recovery, and holding time, for each method of analysis, as applicable.
- Field Duplicate Precision between the Reference Site Sample 1 and 2 and the Contaminated Site Sample 1 and 2 will be evaluated. Acceptable field duplicate precision for Inorganics and Organics will have been obtained if the Relative Percent Difference (RPD) between detected results is  $\leq 50\%$ .
- The volatile results will be looked at to determine whether the low-level or high-level analysis is appropriate for the main sampling event. Recalculation of volatiles for the high-level preservation technique may be performed if the percent solids in the de-watered sediments are  $\leq 25\%$  (if required, the sediment water content will be added to the methanol preservative amount to obtain a total extract amount in the volatiles sample).
- The Metals Trip Blank and Field Blanks will be evaluated to determine whether or not contamination in the field is a problem and if the main sampling event for Metals will require alternate de-watering techniques (e.g., use of plastic rather than stainless steel).
- The SRM recoveries will aid in determining if the analytical approach was accurate in determination of the analytes of concern. The SRM after reconstitution and subsequent freeze-drying, will be evaluated to determine the impact of the freeze-drying process on the analytes of concern.
- The analytical results using the sediment as received from the field will be compared to those obtained from the freeze-dried sediment aliquots. Indicator parameters will be Naphthalene, Mercury, and Arsenic. The comparison of the non-freeze-dried results and freeze-dried results for these three compounds will determine whether the freeze-drying process is acceptable for use in the main sampling event.
- The full scan Semivolatile Analyses and the PAH-SIM will be evaluated to determine whether or not the main sampling event should include the analysis of full scan Semivolatiles or just the PAHs by 8270C-SIM.
- The SRM analysis for Pesticides will be used to verify that the WHGEL cleanup procedure using Copper and Alumina only impacts the analysis of Endrin Aldehyde (i.e., that all other Pesticides and PCBs are recovered well)

**Table 1 Full-range Sediment Sampling in Support of the Reconnaissance at Industri-Plex**

Sample-type	Containers	Analysis-type	
• Reference Site- Sediment	(3) Low-level VOA vials	VOCs	
	(2) Low-level preserved VOA vials	VOCs	
	(1) High-level preserved VOA Jar	VOCs	
	(2) 8-oz Jars of De-watered Sediment	Metals, Pesticides, PCBs, full-scan Semivolatiles, and TOC on sample as prepared in field. Percent solids should be done on the metals aliquot.	
	(1) 4-oz Jar of De-watered Sediment	Arsenic Speciation and Organic vs. Inorganic Arsenic	
	(6) 8-oz Jars of De-watered Sediment - each jar half-full	Sediment combined and freeze-dried by laboratory. Freeze-dried sediment aliquoted for SVOC, Pest, PCB, Metals, and %solids determination	
	(1) 4-ounce glass jar of non-de-watered sediment	Percent solids of non-de-watered, non-freeze-dried sediment for VOC analysis	
	(1) Zip-lock bag	Grain Size	
• Reference Site- Sediment – Field Duplicate	(3) Low-level VOA vials	VOCs	
	(2) Low-level VOA preserved vials	VOCs	
	(1) High-level preserved VOA Jar	VOCs	
	(2) 8-oz Jars of De-watered Sediment	Metals, Pesticides, PCBs, full-scan Semivolatiles, and TOC on sample as prepared in field. Percent solids to be done on metals aliquot.	
	(1) 4-oz Jar of De-watered Sediment	Arsenic Speciation and Organic vs. Inorganic Arsenic	
	(6) 8-oz Jars of De-watered Sediment - each jar half-full	Sediment combined and freeze-dried at laboratory. Freeze-dried sediment aliquoted for SVOC, Pest, PCB, Metals, and %solids determination	
	• Contaminated Site- Sediment	(3) Low-level VOA vials	VOCs
		(2) Low-level VOA preserved vials	VOCs
(1) High-level preserved VOA Jar		VOCs	
(2) 8-oz Jars of De-watered Sediment		Metals, Pesticides, PCBs, full-scan Semivolatiles, and TOC on sample as prepared in field. Percent solids to be done on metals aliquot	

**Table 1 Full-range Sediment Sampling in Support of the Reconnaissance at Industri-Plex**

Sample-type	Containers	Analysis-type
	(1) 4-oz Jar of De-watered Sediment	Arsenic Speciation and Organic vs. Inorganic Arsenic
	(6) 8-oz Jars of De-watered Sediment - each jar half-full	Sediment combined and freeze-dried at laboratory. Freeze-dried sediment aliquoted for SVOC, Pest, PCB, Metals, and %solids determination
	(1) 4-ounce glass jar of non-de-watered sediment	Percent solids of non-de-watered, non-freeze-dried sediment for VOC analysis
	(1) Zip-lock bag	Grain Size
• Contaminated Site- Sediment – Field Duplicate	(3) Low-level VOA vials	VOCs
	(2) Low-level VOA preserved vials	VOCs
	(1) High-level preserved VOA Jar	VOCs
	(2) 8-oz Jars of De-watered Sediment	Metals, Pesticides, PCBs, full-scan Semivolatiles, and TOC on sample as prepared in field. Percent solids to be done on metals aliquot.
	(1) 4-oz Jar of De-watered Sediment	Arsenic Speciation and Organic vs. Inorganic Arsenic
	(6) 8-oz Jars of De-watered Sediment - each jar half-full	Sediment combined and freeze-dried by laboratory, aliquoted for SVOC, Pest, PCB, Metals, and %solids determination
• Overall Reconnaissance- Semivolatile, Pesticide, PCB, and Metals Quality Control	(4) 1-L bottles reagent-water passed through de-watering process	SVOCs, Pest, PCB, and Metals (metals preserved after process with HNO <sub>3</sub> )
	(1) 1-L bottle of preserved "Metals Trip Blank"	Metals
	(1) 1-L bottle of pre-preserved reagent water for Arsenic Speciation Field Blank passed through de-watering process	Arsenic Speciation
• Overall Reconnaissance- Volatile Sample Quality Control	(3) 60-mL Vials each containing 5mL Organic-free water and Teflon-coated stir bar	Low-level VOC Trip Blank
	(2) 60-mL Vials each containing 5mL Organic-free water, 1g Sodium Bisulfate, and Teflon-coated stir bar	Low-level preserved VOC Trip Blank
	(1) 60-mL bottle with 25-mL Methanol	High-level VOC Trip Blank
• Alternate site evaluations	(1) 4-ounce glass jar	Percent Solids and TOC
	(1) Zip-lock bag	Grain Size

**Table 2. Cooler Requirements in Support of the Reconnaissance Sampling at Industri-Plex**

Cooler Identity	Bottle Content	Analyses
Reference Site Cooler	(4) 8-oz jars with no preservatives for de-watered sediment	For Metals, SVOC, Pesticides, PCBs, TOC and %solids. (2) jars for sediment and (2) jars for field duplicate
	(6) 40-mL VOA vials each with 5mL of Organic-free water and a Teflon-lined stir bar	Low-level Volatiles. (3) Vials for sediment and (3) vials for field duplicate
	(4) 40-mL VOA vials each with 5 mL Organic-free water, 1g Sodium Bisulfate, and a Teflon-lined stir bar	Low-level preserved Volatiles. (2) Vials for sediment and (2) vials for field duplicate
	(2) 120-mL Bottle with 25-mL Methanol	High-level Volatiles. (1) bottle for sediment and (1) bottle for field duplicate
	(12) 8-oz jars with no preservative for de-watered sediment	For freeze-drying analysis. Each jar is filled half full. (6) jars for sediment and (6) jars for field duplicate
	(1) 4-oz Jar of Non-de-watered Sediment	Percent solids of non-de-watered and non-freeze-dried sediment for VOC
	(1) Zip-lock bag	Grain Size
	(4) 1-L Bottles of Reagent Water unpreserved – (3) Bottles will be refilled for SVOC, Pesticides, and PCBs as Field Rinsate Blanks	For equipment Rinsate Blanks
	(1) 1-L Bottle with HNO <sub>3</sub> preservative	1-L of equipment RB is poured into this Bottle for metals analysis
	(1) 1-L Bottle of Reagent water preserved to pH<2 with HNO <sub>3</sub>	Metals Trip Blank
	(3) 60-mL Vials with 5-mL Organic Free water and Teflon-lined stir bar	Low-level VOA Trip Blank
	(2) 60-mL Vials with 5-mL Organic Free water, 1g Sodium Bisulfate, and Teflon-lined stir bar	Low-level preserved VOA Trip Blank
	(1) 60-mL Bottle with 25-mL Methanol	High-level VOA Trip Blank
Contaminated Site Cooler	(4) 8-oz jars with no preservatives for de-watered sediment	For Metals, SVOC, Pesticides, PCBs, TOC and %solids. (2) jars for sediment and (2) jars for field duplicate
	(6) 40-mL VOA vials each with 5mL of Organic-free water and a Teflon-lined stir bar	Low-level Volatiles. (3) Vials for sediment and (3) vials for field duplicate
	(4) 40-mL VOA vials each with 5 mL Organic-free water, 1g	Low-level preserved Volatiles. (2) Vials for sediment and (2) vials for

**Table 2. Cooler Requirements in Support of the Reconnaissance Sampling at Industri-Plex**

Cooler Identity	Bottle Content	Analyses
	Sodium Bisulfate, and a Teflon-lined stir bar	field duplicate
	(2) 120-mL Bottle with 25-mL Methanol	High-level Volatiles. (1) bottle for sediment and (1) bottle for field duplicate
	(12) 8-oz jars with no preservative for de-watered sediment	For freeze-drying analysis. Each jar is filled half full. (6) jars for sediment and (6) jars for field duplicate
	(1) 4-oz Jar of Non-de-watered Sediment	Percent solids of non-de-watered and non-freeze-dried sediment for VOC
	(1) Zip-lock bag	Grain Size
	(4) 1-L Bottles of Reagent Water unpreserved – (3) Bottles will be refilled for SVOC, Pesticides, and PCBs as Field Rinsate Blanks	For equipment Rinsate Blanks
	(1) 1-L Bottle with HNO <sub>3</sub> preservative	1-L of equipment RB is poured into this Bottle for metals analysis
	(1) 1-L Bottle of Reagent water preserved to pH<2 with HNO <sub>3</sub>	Metals Trip Blank
	(3) 60-mL Vials with 5-mL Organic Free water and Teflon-lined stir bar	Low-level VOA Trip Blank
	(2) 60-mL Vials with 5-mL Organic Free water, 1g Sodium Bisulfate, and Teflon-lined stir bar	Low-level preserved VOA Trip Blank
	(1) 60-mL Bottle with 25-mL Methanol	High-level VOA Trip Blank
Arsenic Speciation Cooler	(7) 4-oz Jars	(2) jars for Reference Site and (2) for Contaminated Site de-watered sediment. (3) additional samples from alternate sites may be taken for speciation analysis
	(1) 1-L of Reagent Water preserved with HCl	Metals field blank for Arsenic Speciation
Alternate Site evaluation Cooler	(12) 4-oz jars	For percent solids and TOC
	(12) Zip-lock bags	For Grain Size

**Table 3. Sample Preservation, Container Specification, and Holding Time Requirements in Support of the Reconnaissance Sampling at Industri-Plex**

Matrix	Parameter	Sample Container(s)	Preservative	Holding Time
Sediment	Semivolatile Organics	(2) 4-ounce glass jar	Cool, 4°C, protected from light	Extraction: within 14 days of collection Analysis: within 40 days of extraction
	Metals and Percent solids	(2) 4-ounce glass jar	Cool, 4°C	28 days
	Volatile Organics – Low Level Analysis	(3) 40-mL glass vials	5mL Organic-free water with Teflon-lined stir bar. Cool, 4°C, protected from light <sup>1</sup>	7 days
	Volatile Organics – Low Level preserved Analysis	(2) 40-mL glass vials	5mL Organic-free water, 1g Sodium Bisulfate, and Teflon-lined stir bar. Cool, 4°C, protected from light	14 days
	Volatile Organics – High Level Analysis	(1) 120-mL wide mouth glass jar	25-mL purge-and-trap grade Methanol, Cool, 4°C, protected from light	14 days
	Pesticides	(2) 4-ounce glass jar	Cool, 4°C, protected from light	Extraction: within 14 days of collection Analysis: within 40 days of extraction
	PCBs	(2) 4-ounce glass jar	Cool, 4°C, protected from light	Extraction: within 14 days of collection Analysis: within 40 days of extraction
	Total Organic Carbon (TOC)	(1) 4-ounce glass jar	Cool, 4°C	28 days
	Percent Solids	(1) 4-ounce glass jar	Cool, 4°C	14 days
	Grain Size	(1) Zip-lock bag	Cool, 4°C	NA

<sup>1</sup> On 4/23/99, EPA Region I QA Officer, Andy Beliveau, authorized omission of Sodium Bisulfate preservation for sediment sampling for low-level volatile analysis to prevent formation of acetone during analysis. The holding time for analysis was reduced from 14 days to 7 days per Andy Beliveau's recommendation based on this preservation change.

NA = Not Applicable

**Table 3. Sample Preservation, Container Specification, and Holding Time Requirements in Support of the Reconnaissance Sampling at Industri-Plex**

Matrix	Parameter	Sample Container(s)	Preservative	Holding Time
<b>Aqueous Field Blanks</b>	Semivolatile Organics	(1) 1-L Amber Glass Bottle	Cool, 4°C, protected from light	Extraction: within 7 days of collection Analysis: within 40 days of extraction
	Metals	(1) 1-L Bottle	HNO <sub>3</sub> to pH < 2, Cool, 4°C	28 days
	Arsenic Speciation	(1) 1-L Bottle	HCl to pH < 2, Cool, 4°C	28 days
	Pesticides	(1) 1-L Amber Glass Bottle	Cool, 4°C, protected from light	Extraction: within 7 days of collection Analysis: within 40 days of extraction
	PCBs	(1) 1-L Amber Glass Bottles	Cool, 4°C, protected from light	Extraction: within 7 days of collection Analysis: within 40 days of extraction
<b>Sediment Trip Blanks</b>	Volatile Organics – Low Level Analysis	(3) 60-mL glass vials	5mL Organic-free water and Teflon-lined stir bar, Cool, 4°C, protected from light <sup>1</sup>	7 days
	Volatile Organics – Low Level preserved Analysis	(2) 60-mL glass vials	5mL Organic-free water, 1g Sodium Bisulfate, and Teflon-lined stir bar, Cool, 4°C, protected from light <sup>1</sup>	14 days
	Volatile Organics – High Level Analysis	(1) 60-mL wide mouth glass jar	25-mL purge-and-trap grade Methanol, Cool, 4°C, protected from light	14 days

**Table 4. Laboratory QC and Sample Processing Protocol in Support of the Reconnaissance Sampling at Industri-Plex**

Sample Type	Analysis-Type	Lab Processing
• Sediment	Low-level VOCs - unpreserved	Vials weighed to determine sample size, spiked with Surrogates and then analyzed by 8260B. Concentrations in sample use the non-de-watered and non-freeze dried %solids determination.
	Low-level VOCs - preserved	Vials weighed to determine sample size, spiked with Surrogates and then analyzed by 8260B. Concentrations in sample use the non-de-watered and non-freeze dried %solids determination.
	High-level VOCs	Bottle weighed to determine sample size, spiked with Surrogates, 100 uL aliquot of methanol analyzed by 8260B. Concentrations in sample use the non-de-watered and non-freeze dried %solids determination.
	Semivolatiles, Pesticides and PCBs	Sediment is extracted, as received from the field, using WHGEL's Method 3545 procedure. The Semivolatiles are analyzed by 8270C in the full scan mode for the TCL list. The Pesticides and PCBs undergo WHGEL's copper/alumina cleanup and then are analyzed by 8081A and by 8082. Concentrations in sample use the de-watered non-freeze dried %solids determination.
	Metals and TOC	Sediment for metals is digested as received from the field and analyzed for metals using 6010B and 7471A. Concentrations in sample use the de-watered non-freeze dried %solids determination. The TOC aliquot is analyzed by Method 9060 – single analysis technique.
	Percent Solids of de-watered non-freeze-dried sediment	Sediment, as received from the field after de-watering process, undergoes percent solids determination using the metals aliquot.
	Percent solids of non-de-watered and non-freeze-dried sediment	Sediment sampled for volatiles analysis (non-de-watered) undergoes percent solids determination for use in reporting VOC results.
	Semivolatiles, Pesticides, PCBs, and Metals	Sediment is freeze-dried and aliquoted for SVOC, Pest, PCB, Metals, and %solids determination. The freeze-dried aliquots are extracted/digested and, for Pest/PCB also cleaned up, in the same way as the non-freeze dried aliquots. Semivolatile analysis will be conducted by 8270C-SIM for the PAHs, Pesticides by 8081A, Metals by 6010B/7471A, and PCBs by 8082. Concentrations will be based on the freeze-dried %solids determination
	Percent Solids of de-watered and freeze-dried sediment	Sediment, after freeze-drying, undergoes percent solids determination.
• Field Blanks	Semivolatiles, Pesticides and PCBs	The field blank is extracted and analyzed using water-equivalent protocols
	Metals	The field blank that was exposed to the de-watering equipment is digested and analyzed for Metals

**Table 4. Laboratory QC and Sample Processing Protocol in Support of the Reconnaissance Sampling at Industri-Plex**

Sample Type	Analysis-Type	Lab Processing
	Arsenic Speciation	The field blank that was exposed to the de-watering equipment is digested and analyzed for Arsenic Speciation
• Trip Blanks	Low-level VOC	Vials weighed, spiked with Surrogates and then analyzed by 8260B.
	Low-level preserved VOC	Vials weighed, spiked with Surrogates and then analyzed by 8260B.
	High-level VOC	Bottle weighed to determine loss of methanol, spiked with Surrogates, 100 uL aliquot of methanol analyzed by 8260B.
	Metals	Metals Trip Blank analyzed for Metals
• Lab QC		
⇒ Method Blanks	VOC	1 Analyzed for each analytical batch/method type
	SVOC, Pesticides, PCBs, Metals	1 Extracted/digested per preparation batch and analyzed by appropriate methods
⇒ Laboratory Control Spike	VOCs, Semivolatiles, Pesticides, PCBs, and Metals	1 Analyzed/extracted/digested per analytical batch and analyzed by the appropriate methods
⇒ Standard Reference Material (SRMs)	SVOC, Pesticides, PCBs, and Metals	2 Analyzed as obtained from the standards vendor per each analytical batch per method
⇒ Freeze-Dried Standard Reference Material (SRMs)	SVOC, Pesticides, PCBs, and Metals	2 SRM reconstituted to similar % solids content as sediments. Reconstituted SRMs then freeze-dried, extracted/digested, and analyzed by the appropriate methods.

# Standard Operating Procedures

---

A-2

**ECOLOGICAL FIELD RECONNAISSANCE SURVEY AND  
OBSERVATIONS AND PICTURES**

## **Ecological Field Reconnaissance Survey For Industri-Plex**

The Ecological Reconnaissance Field Survey (Survey) was completed on April 29-30, 1999. The objectives of this Survey were to:

1. Select a downstream sampling location in the Aberjona River that exhibited depositional characteristics;
2. Visit potential Reference Locations and select locations appropriate for comparison to Halls Brook Holding Area (HBHA) and HBHA Downstream locations (including Ponds 1-3);
3. Field-test sediment sampling equipment to determine what will be needed for the main sampling event;
4. Field-test de-watering methods for sediment sample collection;
5. Evaluate modifications of analytical methods including the use of freeze-drying techniques; and
6. Qualitatively evaluate biological conditions and physical habitat structure with respect to the collection of benthic invertebrates (for assessment and for tissue analysis), emergent and submergent vegetation (for tissue analysis), and fish (for assessment and tissue analysis).

In addition to the above, the U.S. Environmental Protection Agency (USEPA) collected sediment for evaluation of acid volatile sulfides and simultaneously extracted metals (AVS/SEM) and the U.S. Fish and Wildlife Service (USFWS) and National Oceanographic and Atmospheric Administration (NOAA) personnel examined sites for electroshocker boat access and for use as fish Reference Locations.

This memorandum summarizes my field observations. USEPA, NOAA, and USFWS may have additional observations. The results of the chemical analysis of sediment samples will be reviewed in a separate technical memorandum to evaluate the applicability of the proposed analytical methods to producing data that will meet the project data quality objectives (DQOs).

I first provide a synopsis of our activities and then discuss our findings with respect to the stated objectives. Lastly, I list several important issues that need to be considered and resolved.

Logistics for the survey benefited from field observations made over the previous few weeks by Joe LeMay (USEPA) and Kevin O'Neil (USEPA).

## Synopsis

Project personnel involved in the Survey are listed in Table 1 along with a brief description of field-related activities.

**Table 1**  
**Project Personnel Involved in Ecological Field Reconnaissance Survey**  
**April 29-30, 1999**

Person	Affiliation	Dates Present	Field Survey Activities
Charlie Menzie	MCA	4/29 4/30	Visited all locations and provided oversight of sediment sampling.
Peter Kane	MCA/WHG	4/29	Participated in collection of sediment samples for chemistry; Pete is Laboratory Director at WHG and is overseeing analytical methods for this project.
Mark Avaikian	MCA/TG&B	4/29 4/30	Provided field support for sediment sampling at all locations.
Joe LeMay	USEPA	4/29	Provide field team with orientation including identification of potential downstream sediment locations.
Patti Tyler	USEPA	4/29	Primary agency person involved in examining sediment sampling locations on 4/29 with respect to ecological risk considerations; sampled for AVS/SEM; site visit to downstream Aberjona River, HBHA, Phillips Pond, and North Pond (involved in discussion of sampling options).
Andy Beliveau	USEPA	4/29	Provided information on nature of sediments and dewatering methods; observed MCA's collection and sample handling methods for chemical analysis of sediments from HBHA Pond.
Ken Finkelstein	NOAA/EPA	4/29	Worked primarily with USFWS on examining ponds for deployment of boats and for use in fish sampling; participated in sediment sampling at Phillip's Pond (along with P. Tyler).

**Table 1**  
**Project Personnel Involved in Ecological Field Reconnaissance Survey**  
**April 29-30, 1999**

Person	Affiliation	Dates Present	Field Survey Activities
Kevin O'Neil	USEPA contractor	4/29 4/30	Provided all navigation support; primary agency representative involved in examining sediment sampling locations on 4/30 with respect to ecological risk considerations; In addition to sites visited on 4/29, K. O'Neil visited the following on 4/30: North Pond and North Pond option, Aberjona at West St., Aberjona at Arcadia, Halls Brook (upstream location), HBHA Pond, and HB sampled for SEM/AVS; site visit to downstream Aberjona River, HBHA, Phillips Pond, and North Pond (involved in discussion of sampling options).
Ken Munney	USFWS	4/29 4/30	Qualitatively evaluated survey locations for fish sampling and boat deployment.
Joe McKeon	USFWS	4/30	Qualitatively evaluated survey locations for fish sampling and boat deployment.

MCA: Menzie-Cura & Associates, Inc.

WHG: Woods Hole Group Environmental Laboratories

## Survey Observations

Survey locations were visited and examined by boat using either a zodiac or canoe. The order in which the Survey location observations were made is given in Table 2 along with a brief description of the observations. A site Survey Map is also included as an attachment to this memorandum.

**Table 2**  
**Observations Made at Various Survey Locations**  
**April 29-30, 1999**

Location	Observations and Comments
SD-13	Located in Aberjona River downstream of Olympia Ave. We took a sediment sample in 1.5' of water. Sediments further upstream were observed to be too sandy to be classified as depositional. This location was adjacent to a marsh and characterized by soft sediment. This segment of the Aberjona supports a variety of wildlife including muskrat. Skunkweed was a predominant plant species. Amphipods were observed in the sediment sample. Sediment was sampled for physical characteristics. The sediment was peaty; therefore, it is likely that de-watering will not be needed.
SD-11	This is Pond 3 in HBHA Downstream. The bottom sediments were soft. Cattails were prevalent. No submergent vegetation was observed. Sediment was sampled for physical characteristics. It is likely that de-watering will be needed.
HBHA Pond Deep	This sample location was in about 8' of water near the north end of HBHA Pond. The location was selected near the north end because it was thought by USEPA that this would be near the area where groundwater was most likely to enter. The location is also north of the point where Halls Brook enters HBHA Pond. Sediment samples were taken for chemistry and physical characterization. The Eckman sampler worked well and is the sampling device of choice for this area. We applied a method for de-watering sediments and it worked well (slight modification of the USEPA <i>Region 1 Sediment Sampling Guidance</i> , September 1998 Draft). We took three Eckman samples, removed 5 cm from the top using a scoop and a ruler to judge depth, and de-watered each in separate funnel-shaped filters and stainless steel bowls. Samples sieved through a 400 um mesh sieve revealed no benthic invertebrates. The sediment was black with a very thin oxidized layer on the surface.
SD-3	This is the Phillips Pond Reference Location. The sediment sample location is approximately 8' and is intended to match the depth sampled in HBHA Pond Deep. Sediments were soft and anaerobic. It appears that Phillips Pond acts as a depositional area. A few chironomid insect larvae were observed in a sediment sample collected and sieved. Sediments were also collected for chemistry and for physical determination. De-watering will probably be required. Based on subsequent discussions with USEPA, the sampling team shall attempt to relocate SD-03 away from the shoreline to a deeper, more depositional location within the pond. If a deeper more depositional location can not be located, then the proposed location may be used.

**Table 2**  
**Observations Made at Various Survey Locations**  
**April 29-30, 1999**

Location	Observations and Comments
SD-2 (south)	This pond is the one favored by USFWS for fish sampling and we designated it as "south" to distinguish it from the pond immediately north and referred to as North Pond on our maps. Water depth was at or less than 3' throughout the pond. We may need to use a core for sampling the main event because of the dense growth of aquatic plants. A mono-specific stand of <i>Ceratophyllum</i> appears to be present. Algal mats ( <i>Cladophora</i> ) were developing. Many turtles and wildlife were observed. A school of small fish (perhaps golden shiners) was observed. Cattails were present and would serve as a good species for sampling for emergent plant tissue. The sediment was characterized by black fine particulate matter. This pond is depositional and sediment would probably require de-watering. Sediment was sampled for physical characteristics and total arsenic. Based on subsequent discussions with USEPA, for the purpose of this work plan/ QAPP, this pond is denoted as the South Pond. The sampling location needs to be relocated further northeast towards the north/ northeastern center of the pond, away from the West Hide Pile and downgradient discharge of North Pond culvert.
SD-2 (north)	This pond was the one initially selected for SD-2 but is smaller than the pond described above and offers less habitat for fish and wildlife. As a result, USFWS and NOAA suggested that SD-2 be changed from North Pond to the larger pond immediately south, i.e. SD-2 (south) – referred to now as South Pond. North Pond is highly eutrophic and a dense mat of <i>Cladophora</i> -like algae had developed and was coating submergent vegetation (again a mono-specific stand of <i>Ceratophyllum</i> ). We sampled about 10 feet off the culvert connecting this pond with the one to the south. The sediment was fine particulate and black. We observed turtles, wildlife (blue heron), amphipods and chironomids. Sediment would probably require dewatering. Sediment was sampled for physical characteristics and total arsenic. Based on subsequent discussion with USEPA, this pond was not selected for the main sampling program.
Aberjona @ Arcadia – Station SD-01	This potential Reference Location is located a few hundred feet from Arcadia road where it crosses what we now believe to be the edit - North branch of the Aberjona. The area was reminiscent of the conditions we observed in the downriver portion of the Aberjona near SD-13. For this reason, we thought this was a potentially good Reference Location. The location was characterized by skunk cabbage. There was good water flow in this small (5-12' wide) stream. Sediment was comprised of black fine mud with leaf matter. A small pickerel (~ 6") was observed dying. Sediment was sampled for physical characteristics. A location about 400' further downstream on this branch of the Aberjona was eventually selected for sampling during the main sampling program. This selection was based on sampling performed by the USEPA.

**Table 2**  
**Observations Made at Various Survey Locations**  
**April 29-30, 1999**

Location	Observations and Comments
Aberjona @ West	This potential Reference Location is located a few hundred feet upstream from where the South edit Branch of the Aberjona River passes under West Street. The land bordering the Aberjona is residential on one side and municipal on the other. There is a sub-station and a storage area where large creosote-treated poles are stored. It is apparent that creosote has dripped from the poles. We selected a sample location that was upstream from this pole storage area. The sediments were silt with some sand. Skunk cabbage was abundant. Amphipods were observed. Sediment was sampled for physical characteristics. In follow up visits to this location, the creek was observed to be dry. This resulted in a final decision to select the Aberjona at Acadia as the sampling location for SD-01.
SD-4	This Reference Location is in Halls Brook. This stream drains an open field. We sampled at the edge of the field just upstream of where Halls Brook began its course through residential and commercial areas. The stream ranges in width from 4 to 10' at this point. Because of the open character of this stream, it could have different ecological characteristics from the other Reference Location stream (i.e., the Aberjona) as well as locations in the HBHA Downstream. The sediments are characterized by silt with much plant material. Sediment was sampled for physical characteristics. We observed mallards, frogs, and amphipods.
SD-12	This sediment location is in the stretch of the Aberjona that runs behind the former DEP office location. It is taken at the most upstream corner of the parking lot behind the office. The area is characterized by dense <i>Phragmites</i> . Amphipods and chironomid larvae were present. Sediments were sampled with a Ponar grab and exhibited high silt content with some fine sand and vegetative matter. Based on subsequent discussion with USEPA, this sampling location shall be relocated to a upgradient reference location, representing a higher content of sand. The final location will be determined in the field. That location turned out to be upstream of SD-04 on Halls Brook.
HBHA Pond S.E.	This potential sediment location is located in the southeast corner of HBHA Pond. We observed that all-shallow locations (less than 3') in the pond were characterized by silty-sand to coarse-sand sediments. It is possible to stand and walk on these sediments. The deeper basin in HBHA Pond forms a distinctly different environment characterized by anaerobic soft depositional sediment. Shores are bordered by <i>Phragmites</i> . Sunfish nests were observed in the shallows. These species are unlikely to use the deeper soft-bottom sediments for nesting sites. Sediment was sampled for physical characteristics.
HBHA Downstream	Observations were made of the stream bed downstream of HBHA Pond. No sediment sample was taken. Sediments were firm with a high sand content. Occasional sunfish nests were observed. There was evidence of muskrat. Cattails bordered the stream. A large snapping turtle was resting on a bank. There was a thin grass-like submerged aquatic plant (leaves ~ 6") growing in the sandy bottom.

**Table 2**  
**Observations Made at Various Survey Locations**  
**April 29-30, 1999**

Location	Observations and Comments
HBHA Downstream at SD-08	This is the first distinct depositional area downstream of HBHA Pond. It was bordered by cattails. Sediment was sampled for physical characteristics.
HBHA Pond Central West Bank	This location is on the west side of HBHA Pond downstream of where Halls Brook enters. It is the most distinct shallow water habitat in the HBHA Pond. It is approximately 20 to 50 feet wide and runs along the shore. Sediment was similar to that reported for HBHA Pond S.E. Sediment was sampled for physical characteristics.

Two sites – SD-9 and SD-10 – are not specifically described above. We visited SD-8 which is an open area within the stream bed below HBHA Pond. Prior to reaching this location, the stream bed is characterized by silty-sand sediment (non-depositional). The stream along this stretch does provide habitat for fish and wildlife. We did not visit SD-9 or SD-10. These locations may be difficult to sample. We will need to make our way through the *Phragmites* marsh by foot to reach these locations.

## Physical and Chemical Testing of Sediments

Sediments collected from most of the 13 locations were sampled for physical parameters including total organic carbon (TOC), percent solids, and grain size distribution. Sediments from two locations, HBHA Pond Deep and Phillips Pond, were collected in duplicate for chemical analysis including volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, PCBs, and metals (including arsenic species III and V).

Sediment sample aliquots were split for freeze-drying preparation to compare the accuracy of the methods for analysis of these chemicals from freeze-dried sediment vs. non-freeze dried sediments. The goal of the freeze-drying protocol is to elevate the percent solids of the samples, without altering the chemistry, and therefore improve the achievable sediment reporting limits on a dry-weight basis.

For VOCs, both low-level (sodium bisulfate preserved) and high-level (methanol preserved) sediment samples were collected to evaluate the method 5035 options for these sediments in meeting the project DQOs.

### **Sediment Types for Sampling Locations**

The HBHA Pond, HBHA Downstream and Aberjona River are characterized by both depositional sediments and silty-sand sediments. Ecological receptors (fish and wildlife) utilizing these areas will encounter both to varying degrees depending on location and the ecology of the species. In some areas, exposures to depositional areas will predominate while in others the exposure will be to contaminants that may be present in silty-sand sediments. The relationship between sample locations and sediment type for the Reconnaissance Survey is described in Table 3.

**Table 3**  
**Sediment Type for Various Site Survey Sampling Locations**

Location	Pond-like Depositional	Pond-like Silty-sand	Stream-like Depositional	Stream-like Silty Sand
SD-01 Aberjona River Reference Location			X	
SD-02 "North Pond" Reference Location	X			
SD-03 Phillips Pond Reference	X			
SD-04 Halls Brook Reference			X	
SD-05 HBHA Pond, deep location	X			
West Central HBHA Pond in shallow water		X		
SE Corner of HBHA Pond in shallow water		X		
SD-08 Streambed south of HBHA Pond			X	
SD-09 Pond 1 in HBHA Downstream)	Not visited but reported by USEPA as depositional			
SD-10 Streambed between Ponds 2 and 3 in HBHA Downstream			Not visited but reported by USEPA as depositional	
SD-11 Pond 3 in HBHA Downstream	X			
South Branch of Aberjona River upstream of HBHA Downstream			X	
SD-13 Aberjona River downstream of Olympia Ave.			X	

## Meeting Survey Objectives

*Objective 1: Select a downstream sampling location in the Aberjona River that exhibited depositional characteristics.*

We agreed upon a location for SD-13. We needed to travel downstream from Olympic Ave. before finding a location that the group judged to be depositional. Most of the upstream segment from the selected SD-13 location to Michiwaum Ave. is characterized by a firm sandy bottom. This portion of the stream does provide habitat for various species but did not meet the depositional sediment criterion.

*Objective 2: Visit potential Reference Locations and select locations appropriate for comparison to Halls Brook Holding Area (HBHA) and HBHA Downstream locations (including Ponds 1-3)*

We did visit and select locations for all potential Reference Locations. Our field visit indicated that streams and ponds throughout the area are influenced by many local factors including physical modification, runoff, and nutrient enrichment. These factors also influence the HBHA Pond and downstream locations and therefore all water bodies being evaluated can be considered to be strongly influenced by anthropogenic factors. This is a reasonable basis for considering the selected Reference Locations appropriate for use.

Final decisions need to be made concerning sediment locations SD-2 (North Pond) and SD-1 (the upper Aberjona River). In addition, thought should be given to moving the Hall Brook sampling location from a depositional area to a sandy area. The following recommendations are made:

1. SD-2 should be located in the pond immediately north of the berm bordering the Site and immediately south of what is designated on the map as North Pond. Rationale: this location is favored because of habitat characteristics. However, we need to establish that this pond is not in the influence of the Site. This will involve a review of available data and an analysis of sediment for arsenic (selected as an identifier for the Site). USEPA has subsequently concurred with this decision and identified where in the South Pond this station should be located.
2. SD-1 should be located upstream of West Street to represent the North branch of the Aberjona. Upstream of West St. is favored over downstream because of the presence of creosote poles adjacent to the river at West St. Subsequent visits to this location indicated that it has run dry. A alternative sampling location was selected on the South Branch of the Aberjona near Acadia St.
3. At least one shallow location in HBHA Pond (designated SD-06 in the Main Sampling Program QAPP) is characterized by sandy-silt sediments. It would be useful to have at least one Reference Location characterized by a sandy-silt sediment. As a result of this observation and subsequent sampling by USEPA, a decision was made to relocate SD-12 to a sandy-silt stream location upstream of SD-04.

*Objective 3: Field-test sediment-sampling equipment to determine what will be needed for the main sampling event*

The Eckman sampler will be the primary sampling device for obtaining sediment samples for chemistry and for bioassays. We established a field method for sub-sampling surface sediments. The method involved taking a sample of sediment to a depth of at least 10 cm, decanting surface water from the Eckman by gently pouring off the water, placing a decontaminated plastic ruler into the sediment along the side of the Eckman, determining the depth-to-sample to obtain the upper 5 cm, and scooping out the upper 5 cm with a decontaminated stainless steel spoon. Samples for VOCs are taken from within the first grab immediately after decanting the water overlying the sediment. The Ponar Grab and hand-held piston corer will be used as back-up sampling systems. We may need to use a corer at locations where plant growth is especially thick (e.g., SD-2).

*Objective 4: Field-test de-watering methods*

We used the sediment de-watering method recommended by USEPA Region I (*Sediment Sampling Guidance*, Draft September 1998) with slight modifications that were observed by Andy Belivieu of the USEPA. Our major modification was to set up a series (three were used) of drying systems on the boat. We used large fluted filter paper in stainless steel colanders to hold the sample and patted it down. Three people are needed to make this part of the operation efficient. Within the HBHA Pond, sampling will best be done from the zodiac. In smaller ponds we will need two small boats.

*Objective 5: Evaluate modifications of analytical methods including the use of freeze-drying techniques.*

All samples were collected according to our field sampling and analysis protocols. Analytical work is currently underway and data should be available shortly for the evaluation of freeze-drying methods, project-specific cleanups for organics, low vs. high-level Method 5035 for VOCs, and arsenic speciation method results in meeting project DQOs (with specific emphasis on achievable sediment sample reporting limits on a dry-weight basis).

*Objective 6: Qualitatively evaluate biological conditions and physical habitat structure with respect to the collection of benthic invertebrates (for assessment and for tissue analysis), emergent and submergent vegetation (for tissue analysis), and fish (for assessment and tissue analysis).*

1. Benthic Invertebrates: Amphipods were the most common benthic invertebrates observed and easily recognizable at most stations in the Aberjona River system. This group of organisms is important in the diet of many species and would be a good candidate for collection and analysis of tissues if sufficient sample amounts can be obtained. Small insect larvae (chironomids) and worms also occur but will be difficult to sort from the sediments. A kick-net approach would be useful for streambeds and for the shallow areas within HBHA Pond and downstream. During the summer we may also expect to see larger aquatic insects such as Odonata. If these are present, they would be a good

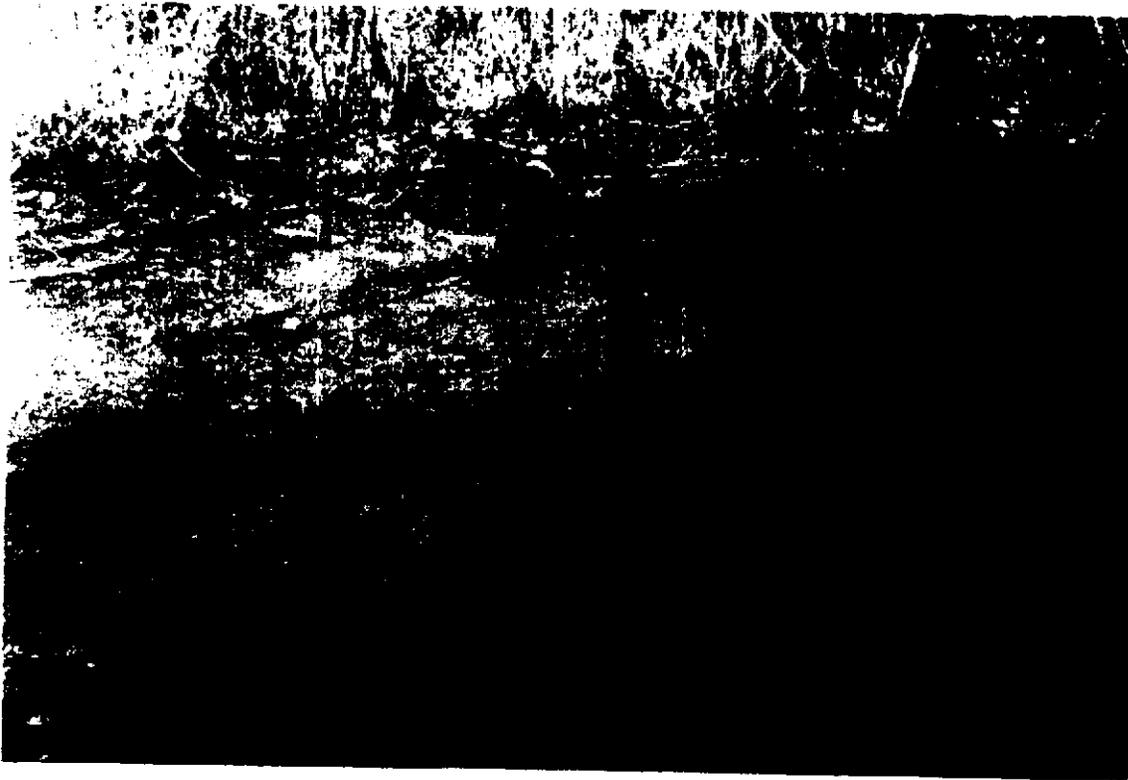
candidate for collection. I do not think we will be able to collect invertebrates at the deep station in HBHA Pond (SD-5) because they will not live there. It may also be difficult to find invertebrates in sediments from the Reference Locations at Phillips Pond and from North Pond because these locations may become anoxic. A recommended approach was discussed with the USEPA. A plan was developed to sample chironomid insect larvae and amphipods. This plan is described in the QAPP.

Fish: USFWS will be making recommendations on fish collection; however, here are my observations and comments. Fish are present in the Reference Ponds and in the HBHA. Sunfish species have nested in shallow waters in HBHA and I think we saw a school of golden shiners in the "North Pond" location north of the Site berm. Water depths are shallow in "North Pond". A few ponds may need to be sampled with trot lines, gill nets and traps.

**Table 4. Navigational Coordinates**

The following coordinates were derived from information provided by Kevin O'Neil

SD-01 candidate (Aberjona at Arcadia) – selected for SD-01 but actual location will be changed	71 07 24.462086159 W	42 31 45.488591304 N
SD-01 candidate (Aberjona at West St.)	71 07 50.931068228 W	42 31 52.500047 N
SD-02 candidate (north location above berm)	71 08 41.953628884 W	42 31 26.325050237 N
SD-02 candidate (South Pond) selected for sampling but actual location will be changed	71 08 40.623544758 W	42 31 22.853898689 N
SD-03 (Phillips Pond) – location will be changed	71 07 56.229135528 W	42 31 00.725264152 N
SD-04 (Halls Brook Reference Location)	71 08 52.727023489 W	42 30 47.270006017 N
SD-05 (deep station at northern end of HBHA Pond)	71 08 28.291937546 W	42 30 46.710953435 N
SD-06 (West Central HBHA Pond) location will be changed but station will remain shallow	71 08 27.677146399 W	42 30 43.714646282 N
SD-07 (SE Corner of HBHA Pond) – location will be changed to a deeper station	71 08 23.672934597 W	42 30 40.50810118 N
SD-08 (HBHA Downstream)	71 08 18.404373293 W	42 30 31.545846368 N
SD-11 (Pond 3 in HBHA Downstream)	71 08 07.044307109 W	42 30 14.902602803 N
SD-12 (Aberjona River west of Commerce Way next to parking lot) – location is being changed to a reference area near SD-04	71 08 05.225517473 W	42 30 27.928570935 N
SD-13 (Aberjona south of Olympia)	71 08 03.409536975 W	42 29 57.463215787 N



← North End of HBHA Pond  
Where Surface Drainage Enters



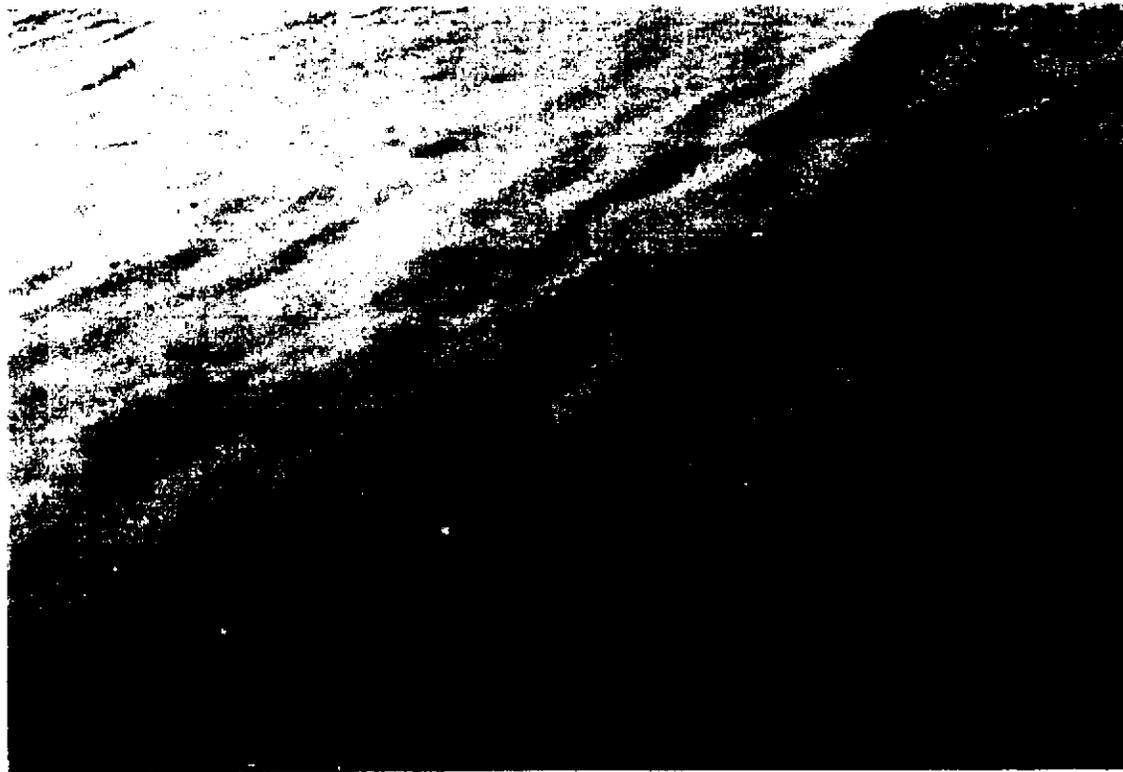
Standing on Firm Substrate in S.E.  
Corner of HBHA Pond. (Silty-Sand) →



West "Cove" of HBHA Pond. Water Depths are less than 3' Deep



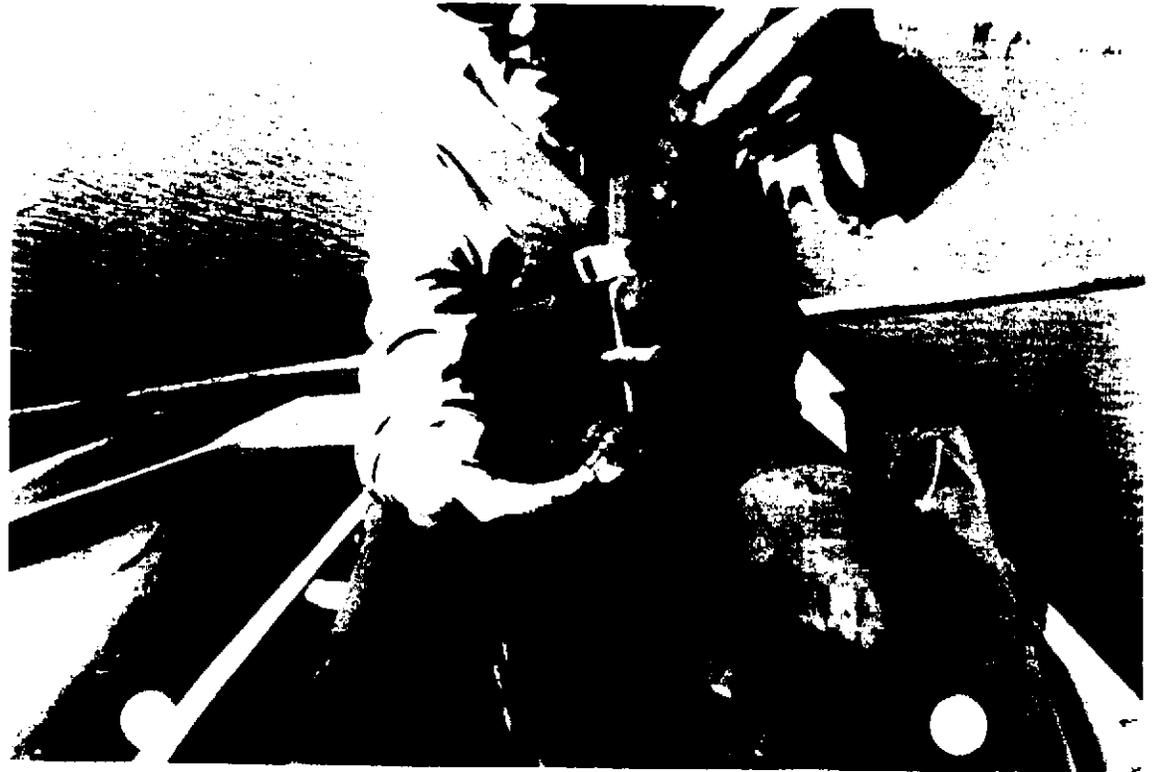
SD-12 Aberjona River Upstream of HBHA Downstream



North Pond - Plant Growth in this Shallow Pond



SD-2 Shoreline of Pond,  
North of Berm ←



SD-2 Pond North of Site Berm  
Monospecific Submergent Vegetation →  
*Ceratophyllum*



SD - 4 Halls Brook Draining a Field is  
Immediately Downstream



SD - 4 Halls Brook Reference Location



**SD-1 North Branch of Aberjona - Water is Shallow**

**A-3**

**SUMMARY OF ENVIRONMENTAL RECONNAISSANCE  
SURVEY RESULTS CHEMICAL RESULTS**

## **Summary of Environmental Reconnaissance Survey Results and Recommendations Industri-Plex Site, Woburn, MA**

The following three tables, to be included in the Industri-Plex Site QAPP, Section 4, summarize some of the chemical and physical parameter results for the sediment samples collected during the Ecological Reconnaissance Survey sampling performed April 29-30, 1999.

### **1. Sample Location Information**

Table 1 is a summary of the sediment characteristic results for percent solids, total organic carbon (TOC) and grain size distribution for the locations sampled. This summary can aid in the final decision for sediment sample locations for the Main Sampling Program. Note that three locations, West Central HBHA Pond, SD-07 which is the SE Corner of HBHA Pond (shallow location), and SD-12 which is the South branch of the Aberjona River, have relatively high percentages of sand (>50%) compared to the other locations which are more depositional with higher percentages of silt and clay. On a conference call with EPA on May 14, 1999, the recommendation was made to replace the West Central HBHA Pond location with SD-05 at HBHA Pond North (shallow location).

### **2. Recommendation to perform freeze-drying in place of de-watering sample preparation technique.**

Table 2 shows the comparison of percent solids for the different preparation techniques. Based on these results, our recommendation is to collect sediment samples and ship them as-is to the laboratory for freeze-drying prior to analysis. The de-watering technique used in the field did not accomplish a significant improvement in the percent solids. We recommend that this field de-watering procedure not be used during the Main Sampling Program. The freeze-drying procedure accomplished a significant improvement in the percent solids of the sediment samples tested without affecting the chemistry of the sediments (see results Table 3).

Table 3 lists several chemical results for comparison between freeze-dried and non-freeze-dried (but field de-watered) sediment. The purpose of this experiment was to test the freeze-drying technique in maintaining the integrity of the sample, with special emphasis on evaluating potential loss of SVOCs. The results indicate that no loss of chemicals (metals or SVOCs) was observed between the freeze-dried and non-freeze-dried samples. An interesting outcome for the reference site samples for two SVOCs indicated that the freeze-drying might have enhanced the extraction of these chemicals. Possibly, by removing the water, the extraction efficiency was increased. Another potential explanation in the positive difference observed between two of the SVOC results in SD-03 is a difference in sample aliquots due to sample heterogeneity.

Nonetheless, the freeze-drying technique does not result in a loss of SVOCs. Furthermore, the detection limits for the SVOCs were significantly lower for the freeze-dried samples due to the higher percent solids. These detection limits would meet project requirements for risk assessment. Further discussion of the effect of freeze-drying on SVOCs can be found in Section 3 of the QAPP.

### **3. Chemical Methods Issues/Recommendations:**

#### *VOCs*

We recommend that the low-level method modification of method 5035 be used for the Main Sampling Program based on the Survey results. Several detected VOCs were low-level (e.g., dichloroethene, benzene) and if the high-level (methanol) method were used the detection levels would not meet risk needs. The modification used for the Survey, as approved verbally by EPA, used a substitution of 5 mL of DI water rather than sodium bi-sulfate. The sample holding time is then reduced to 7 days (from 14 days). High-level VOCs (methanol-preserved) may also be required at some locations and will be collected, as necessary.

#### *SVOCs*

Based on the Survey results, PAHs are the main contaminants in these sediments. Other than PAHs, the SVOC 8270 full scan only showed trace levels of phenols and dibenzofuran. For the Main Sampling Program, full-scan SVOC analysis by Method 8270 should be performed. Selected PAHs may also be analyzed by 8270-SIM to reach risk assessment RBCs.

**Table 1. Summary of Sediment Characteristic Results from the  
Reconnaissance Survey, Industri-Plex Site, Woburn, MA  
April 29-30, 1999**

Location	Description	Percent Solids (%)	TOC (mg/Kg dry wt)	Grain Size Distribution
SD-01	Aberjona River Reference Locations: Aberjona @ Arcadia Aberjona @ West	11.6 17.4	89,000 86,000	<b>Silt-Clay</b> 50% Silt; 33% Clay; 16% Fine Sand 62% Silt; 22% Clay; 15% Fine Sand
SD-02	Pond Reference: SD-02 North	11.4	110,000	<b>Clay-Silt</b> 17% Silt; 81% Clay; 1% Fine Sand
SD-02	Pond Reference: SD-02 South	4.9	100,000	<b>Clay-Silt</b> 23% Silt; 75% Clay; 1% Fine Sand
SD-03 *	Phillips Pond Reference	26	76,000	<b>Silt-Clay</b> 55% Silt; 30% Clay; 14% Fine Sand
SD-04	Halls Brook Reference	15	90,000	<b>Silt-Clay</b> 45% Silt; 36% Clay; 18% Fine Sand
SD-05	HBHA Pond North Shallow	NS	NS	NS
SD-06 *	HBHA Pond Deep	15	76,000	<b>Silt-Clay</b> 51% Silt; 43% Clay; 5% Fine Sand
[SD-06]	West Central HBHA Pond Sample ID was SD-06 for Survey; sample location may be deleted for Main Sampling Program per EPA	40	41,000	<b>Sand-Silt-Clay</b> 67% Fine Sand; 15% Medium Sand; 11% Silt; 7% Clay
SD-07	SE Corner of HBHA Pond Shallow	76	2,400	<b>Sand-Gravel</b> 59% Fine Sand; 35% Medium Sand; 2% Course Sand; 4% Gravel
SD-08	Streambed South of HBHA Pond	NS	NS	NS
SD-09	Pond 1 in HBHA Downstream	13	110,000	<b>Silt-Clay-Sand</b> 42% Silt; 42% Clay; 15% Fine Sand
SD-10	Streambed between Ponds 2 and 3 in HBHADownstream	NS	NS	NS
SD-11	Pond 3 in HBHA Downstream	16	50,000	<b>Silt-Clay-Sand</b> 48% Silt; 47% Clay; 4% Fine Sand
SD-12	South Branch of Aberjona River upstream of HBHA Downstream	35	51,000	<b>Sand-Silt-Clay</b> 51% Fine Sand; 36% Silt; 12% Clay
SD-13	Aberjona River downstream of Olympia Avenue	30	48,000	<b>Silt-Clay-Sand</b> 64% Silt; 27% Clay; 8% Fine Sand; 1% Medium Sand

\* Chemistry analysis performed at these stations. Several preparation techniques, including field de-watering techniques and laboratory freeze-drying techniques were employed on separate sample aliquots to increase percent solids and improve sample reporting limits. Results for percent solids and TOC are averaged from multiple analyses.

NS = Not Sampled

**Table 2. Comparison of Percent Solids for  
 Different Sample Preparation Techniques  
 Reconnaissance Survey Results  
 Industri-Plex Site, Woburn, MA  
 April 29-30, 1999**

<b>Sample ID</b>	<b>Percent Solids Non-De-Watered Sediment</b>	<b>Percent Solids De-Watered Sediment</b>	<b>Percent Solids Freeze-Dried Sediment</b>
HBHA Pond Deep Sample	13.2 %	13.9 %	69.4 %
HBHA Pond Deep Field Duplicate Sample	16.0 %	15.9 %	54.0 %
Phillips Reference Pond SD-03	27.0 %	28.5 %	65.6 %
Phillips Reference Pond SD-03 Field Duplicate Sample	23.7 %	24.0 %	72.8 %

**Table 3. Comparison of Selected Chemical Results for  
 Freeze-Dried and Non-Freeze-Dried Samples  
 Reconnaissance Survey Results  
 Industri-Plex Site, Woburn, MA  
 April 29-30, 1999**

Sample ID/Chemical	Non-Freeze-Dried Sediment (De-Watered) Sample/Duplicate Results (units dry wt)		Freeze-Dried Sediment Sample/Duplicate Results (units dry wt)		Relative Percent Difference Between Results (%)	
	Sample Result	Dup. Result	Sample Result	Dup. Result	Sample RPD	Dup. RPD
<b>HBHA Pond – Deep</b>						
Arsenic	1,500 / 890 mg/Kg		1,200 mg/Kg	830 mg/Kg	22	7
Phenanthrene	7,700 / 6,300 g/Kg		8,800 g/Kg	7,400 g/Kg	13	16
Benzo(a)pyrene	6,400 / 5,700 g/Kg		8,200 g/Kg	7,600 g/Kg	25	29
<b>Phillips Reference Pond SD-03</b>						
Arsenic	8.4 / 14 mg/Kg		11 mg/Kg	14 mg/Kg	27	0
Phenanthrene	1,100 / 1,400 g/Kg		2,800 g/Kg	3,300 g/Kg	87	81
Benzo(a)pyrene	810 / 1,000 g/Kg		2,600 g/Kg	2,900 g/Kg	105	97



**B-1**

**DECONTAMINATION OF FIELD EQUIPMENT**

# STANDARD OPERATING PROCEDURE

## DECONTAMINATION OF FIELD EQUIPMENT

### 1.0 GENERAL APPLICABILITY

This Standard Operating Procedure describes the methods to be used for the decontamination of all field equipment which becomes potentially contaminated during a sampling task. The equipment may include a small box corer, a petite ponar grab sampler, a discrete water depth sampler (e.g. Niskin) and any other type of equipment used during field activities.

Decontamination is mainly achieved by rinsing with liquids which include: soap, and/or detergent solutions, tap-water, deionized water, and methanol. Equipment will be allowed to air dry after being cleaned or may be wiped dry with chemical free cloths or paper towels if immediate re-use is needed.

Waste products produced by the decontamination procedures, such as waste liquids, solids, rags and gloves, etc. will be collected and disposed of properly. All decontamination materials and wastes will be stored at a central location on site.

### 2.0 EQUIPMENT DESCRIPTIONS

- Cleaning Liquids: Soap and/or detergent solutions, tap water, deionized water, methanol
- Personal safety gear: safety glasses
- Chemical free paper towels
- Disposable gloves
- Waste storage containers: drums, boxes, plastic bags
- Cleaning containers: plastic buckets, galvanized steel pails
- Cleaning brushes
- Procedure
- Remove any solid particles from the equipment or material by brushing and then rinsing with available tap-water. This initial step is performed to remove gross contamination.
- Washed with a non-phosphate detergent solution using a brush made of inert material and clean water (from a source of known chemistry). For equipment that, because of internal mechanisms cannot be adequately cleaned with a brush, the decontaminated solutions should be circulated through the equipment.
- Rinsed with clean water.
- Rinse with deionized water.
- Rinsed with reagent grade methanol.
- Rinsed with deionized water.
- Repeat entire procedure or any parts of the procedure if necessary.
- Allow the equipment or material to air dry before re-using.
- Dispose of any soiled materials in the designated disposal containers.
- If sampling equipment is to be used immediately at another location, wrap the equipment in aluminum foil and store in safe place.

### 3.0 REFERENCES

U.S.EPA, 1985. Guide for Decontaminating Buildings, Structures and Equipment at Superfund Sites. EPA/600/2-85/028

**B-2**  
**SURFACE WATER SAMPLING**

# STANDARD OPERATING PROCEDURE

---

## SURFACE WATER SAMPLING

### 1.0 GENERAL APPLICABILITY

This Standard Operation Procedure is to provide methods which will be used to obtain representative samples of surface water from selected locations.

### 2.0 EQUIPMENT DESCRIPTIONS

Selection of sampling equipment will be based on project requirements, distance from shore, and water depth. Several options are available. However, the following reflect our general procedure:

1. Sample volumes, preservation methods, shipment methods, and storage methods must be detailed in the FSP and QAPP and should be consulted for planning purposes.
2. Where water depths exceed a few feet and for the collection of deep water samples, a Niskin or Kemmerer water sample device will be used. For deep surface water samples from ponds, surface water samples should be collected within 2 feet of the bottom. These devices can be placed and or lowered to the desired depth and closed either by tripping the closure mechanism by hand or by sending a messenger (a weight) down the sample line (for deep samples). The samplers are equipped with spring loaded sealing ports and are deployed in the open position. The sampler is then lowered to the desired sampling depth using a rope or cable. Once the desired depth is reached, the messenger is sent down the line and a mechanism which causes the spring loaded ports to seal shut is actuated. Water from the desired depth is trapped inside the sampler, retrieved and transferred to the appropriate laboratory sample containers.
3. Surface water samples (i.e., within the upper few feet) can often be collected using either the sample container or a bottle that can be used to transfer the water to a container. The mouth of the bottle is orientated upstream to minimize the potential for contamination. For shallow surface water samples in streams or ponds that are less than 3 feet deep, the sample shall be collected from a point, which is  $\frac{1}{2}$  the surface water depth. The sampling device shall be lowered to  $\frac{1}{2}$  the shallow surface water depth and carefully collect a sample. The sampling method should minimize any potential for cross contamination. If water depths are less than 0.5', samples can be collected with a decontaminated wide mouth-sampling jar. A number of small samples may need to be collected in this manner and combined.
4. In all cases, the performance criteria for sampling are to collect water samples in a manner that prevents contamination from the sediments,

# STANDARD OPERATING PROCEDURE

---

minimizes the potential for contamination by the sampling system, and provides a representative sample of the water column.

Water samples may be obtained by wading (if water is shallow and the sediment bottom is firm) or from a boat using a hand held dippers or an actual sample container. The sample container may be attached to the end of an extension rod to extend the sampler's reach.

## 3.0 PROCEDURE

Sampling will begin at clean sediment locations and proceed to more contaminated locations. Cleaner locations may include the most downstream location from a source and/or selected Reference Locations for the study

- Identify the sampling location through use of GPS or line of sight as appropriate. Record field identification for sample location in the field notebook
- If sampling is performed from a boat, it may be necessary to anchor to insure that the boat remains on station. The anchoring configuration will depend on sampling needs and the physical nature of the environment (e.g., presence of wind and current).
- Pre-label sample containers using a water-proof marker. Identify sample number, location, and initials of sampler.
- Don protective gear as appropriate for the sampling program (i.e., as called out in the HASP).

For water samples collected using a Niskin or similar whole water sampler like Kemmerer:

- Sample collection bottles will be decontaminated in accordance with project requirements. Water sample bottles are deployed on the upstream side of boats or samplers to avoid potential contamination.
- When deep-water samples are being taken, water depth is checked either by using a marked line or by an electronic metering device. If a marked line is used care must be taken to insure that the line descends vertically through the water column and not at an angle. Deep pond surface water samples shall be collected within 2 feet of the bottom.
- When samples are taken off the bottom (i.e., within a few feet) care must be taken not to disturb the bottom. Therefore, water depth is determined for the area either electronically or using a measured line. The water sample is taken upstream of the location where depth was determined to insure that the area sampled remains undisturbed. The wire or line used to lower the sample must remain taut throughout the sampling event. A slack line at depth indicates that the sampler has hit the bottom. If the sampler is

# STANDARD OPERATING PROCEDURE

---

suspected to have hit the bottom (line has gone slack or debris is in the sample), then the collection location must be moved and the process repeated.

- Each sample container will be rinsed with water at the sample location before taking the water sample. The container will be filled, returned quickly to the surface, shaken to rinse the interior surface of the container, and the contents decanted away from the sampling area (down current, if possible).
- The sample is then collected by the same method.
- To ensure that VOC samples are properly preserved with no headspace, a separate VOC vial will be filled and acidified with HCl to pH <2. The same volume of HCl will then be added to the sample vial before collection.

For water samples collected using a pre-cleaned sample collection vessel or dipper:

- The sample vessel is lowered into the water at an approximate 45° angle to minimize sample aeration.
- Upon complete immersion, remove the sampler and decant the sample into the laboratory sample container.
- Place the lid on the container and complete sample label with depth of collection, and time.

All samples will be placed on ice to cool to 4° C immediately after collection. The use of a transfer device will be necessary in locations too shallow to accommodate sample containers. Transfer devices will be glass jars for VOCs, SVOCs, and pesticide/polychlorinated biphenyl (PCB) samples, and polypropylene jars for metal samples. When used, transfer devices will be thoroughly decontaminated between sites by The procedure for decontaminating field equipment is described in the SOP, *Decontamination of Field Equipment*.

## 4.0 DOCUMENTATION

Sample locations, time and date of collection, and initials of the collector will be inspected on each sample label. Sample location and description will be logged into the field notebook. A field notebook will be maintained into which all observations made, and methods used during sampling will be entered. Each page of the field notebook will be signed and dated on each page. Chain of Custody forms will be prepared following the sample custody procedures. A completed Chain of Custody form will be prepared for all samples in a cooler. One copy of the Chain of Custody is be retained in the event, a cooler is lost in shipping.

## 5.0 REFERENCES

U.S. EPA 1987. A Compendium of Superfund field Operations Methods, Section 10.2, EPA/540/P—87/001

**B-3**

**SAMPLING SOFT AND FINE-GRAINED SURFACE SEDIMENTS FOR  
CHEMICAL ANALYSIS USING AN EKMAN GRAB SAMPLER**

# STANDARD OPERATING PROCEDURE

---

## SAMPLING SOFT AND FINE –GRAINED SURFACE SEDIMENTS FOR CHEMICAL ANALYSIS USING AN EKMAN GRAB SAMPLER

### 1.0 GENERAL APPLICABILITY

This Standard Operating Procedure describes the methods used to obtain representative sediment samples with Eckman Sampling Devices from soft bottom areas that are found in lakes, ponds, and some stream environments.

### 2.0 EQUIPMENT DESCRIPTIONS

Several types of Eckman grab samples are manufactured. For most work, a tall Eckman grab sampler will be used for sampling soft sediment. This device can be deployed either on a line or by being attached to a pole.

The advantage in using an Ekman grab sampler for soft sediments is its stability and protection of the sample from washout. It maintains a near-perfect vertical descent into water column and stable stance on the bottom in most waters with weak currents.

A tall Ekman grab sampler is lighter than a petite ponar grab. It is designed to take sediment samples in soft, finely divided littoral bottoms that are free from vegetation and intermixtures of sand, stones, and other coarse debris. It samples particularly well those bottoms composed of finely divided muck, mud, ooze, submerged marl, or fine peaty material. It is composed of a stainless steel box with a pair of jaws and free-moving, hinged flaps. The spring-tension, scoop-like jaws are mounted on pivot points on opposite sides of the box. The jaws are held open by stainless steel wires that lead to an externally mounted trigger assembly, activated by a messenger. The jaws of the Ekman grab sampler can be triggered by line in deep water or a pole in shallow water.

### 3.0 PROCEDURE

The Ekman grab sampler is usually deployed over the side of a boat but can also be used while wading. Sampling should begin at the furthest downstream sediment location (the least contaminated location) and proceed upstream.

- Identify the sampling location and document it in the field notebook. Sample locations should be located or relocated in accordance with the Field Sampling Plan requirements.
- Position at the sample location should be based on the requirements of the Field Sampling Program. In flowing waters or in the presence of wind, it is often necessary to anchor boats. In some cases, anchors are needed at the bow and stern. Field judgement must be used to insure that samples are collected from within an acceptable radius for the station location. Key criteria are water depth and sediment type as these can change quickly in some areas. Usually, a small watch circle (e.g., on the order of 1 – 5

# STANDARD OPERATING PROCEDURE

---

meters) is acceptable for obtaining representative sediment samples from ponds. For stream sample locations, collections are usually made within a radius of 1 – 3 meters.

- Pre-label sample containers. Use a water-proof marker and include sample number, location, date collected, and initials of sampler.
- Fill plastic wash bottles with either deionized water or surface water in accordance with the requirements established in the Field Sampling Plan.
- Don protective gear (gloves, boots, glasses) as needed in accordance with the HASP.
- Carefully load the jaws of the Eckman. **Because these are spring loaded, this can be dangerous and care must be taken to avoid placing hands in the mouth of a partially or fully-loaded Eckman.**
- When the Eckman is deployed by hand, the sampler is lowered slowly hand over hand over the side of the boat or pressed by hand into shallow sediments.
- When the Eckman is deployed on a pole, the field person places the mouth of the Eckman over the area to be sampled and pushed the Eckman into the sediment (usually to a depth of 10 to 15 cm or as required in the Field Sampling Plan.)
- When the field person feels that the Ekman grab sampler has penetrated the bottom sediment to a sufficient depth, the Eckman is triggered.
- For an Eckman on a line this is done by sending a metal messenger down the wire (line) to activate the closure mechanism of the jaws. For an Eckman on a pole this is done by engaging the trigger mechanism on the pole.
- Retrieve the Eckman by drawing the it out of the sediment and out of the water slowly. The sampler should be kept erect until the next step in the process. Jerky or hard pulls can disturb the integrity of sample.
- When the grab sampler is visible and along side of the boat, have field assistant ready with the bin, carefully pull up grab sampler from the side of the boat.
- If the sample is being used for macroinvertebrate analysis, the entire sample can be emptied into a holding bowl or onto a sieve and processed in accordance with the SOP for sampling benthic invertebrates.
- If the sample is being used for sediment chemistry or toxicity tests, carefully decant excess water from the top of the Ekman sampler.

# STANDARD OPERATING PROCEDURE

---

- The flaps of the Eckman sampler can be held back to gain access to surface sediments.
- If particular depth strata are being sampled (e.g., upper 5 cm), measure the depth of sediments in the Ekman sampler using a decontaminated ruler. For best performance sediment should be sampled to a depth that is deeper than that that will be analyzed. For example, if the Field Sampling Program required the upper 5 cm, a sample depth of 10 – 15 cm should be obtained.
- Certain types of samples must be obtained directly from the sediment while it is still in the grab sampler. These are identified in the Field Sampling Program. Examples include VOCs and SEM/AVS.
- Remove sediment from the grab to the desired sample depth(s) (e.g., 0 – 5 cm).
- If large sample sizes are needed to provide sufficient material for all analytes, composites of several samples can be made by placing sediment into a decontaminated stainless steel bowl.
- For composite samples, homogenize sediments in the pan using a stainless-steel spatula or spoon.
- Using a decontaminated spoon, syringe or other device (as called for in the Field Sampling Plan), remove the required volumes of sample for each of the analyses.
- Complete sample label on container with depth of collection, and time
- Place samples in cooler with ice.
- After each station, decontaminate the sampling equipment according to the Field Sampling Plan and, as appropriate to that plan, the SOP for Decontamination of Field Equipment.

## 4.0 DOCUMENTATION

Sample locations, time and date of collection, and initials of the collector will be inspected on each sample label. Sample location and description will be logged into the field notebook. A field notebook will be maintained into which all observations made, and methods used during sampling will be entered. Each page of the field notebook will be signed and dated on each page. Chain of Custody forms will be prepared following the sample custody procedures. A completed Chain of Custody form will be enclosed for all samples in a cooler. One copy of the Chain of Custody is to be retained in the event, a cooler is lost in shipping.

# STANDARD OPERATING PROCEDURE

---

## 5.0 REFERENCES

U.S. EPA 1987. A Compendium of Superfund field Operations Methods, Section 10.2, EPA/540/P—87/001

**B-4**

**COLLECTION OF BENTHIC MACROINVERTEBRATES  
WITH A GRAB SAMPLER**

# STANDARD OPERATING PROCEDURE

---

## COLLECTION OF BENTHIC MACROINVERTEBRATES WITH A GRAB SAMPLER

### 1.0 GENERAL APPLICABILITY

This method is used to collect quantitative samples of benthic macrofauna from soft-bottomed environments for benthic community evaluation and chemical analysis. Menzie-Cura maintains a videotape of how to conduct this sampling. The tape is reviewed by all members of the sampling group associated with Menzie-Cura.

### 2.0 EQUIPMENT AND REAGENTS

The equipment used in benthic invertebrate sampling in soft sediments consists of: a grab sampler either a petite ponar grab or tall Eckman, and 0.5-mm mesh sieve, surface water in plastic squirt bottles is used to rinse the sample through the sieve. Plastic and/or glass sample jars, (see Table Section 4.0 of QAPP) and sample labels are provided by the laboratory. A preservative and rose bengal stain may be added to the samples collected for benthic community evaluation, according to the laboratory SOP.

The selection of a grab sampler is based on the depth, current, and sediment type present at the location. A sampler that opens from the top is more convenient to observe the top few inches of the sample for oxidation-reduction conditions, presence of vegetation, or other conditions.

### 3.0 PROCEDURES

Grab samplers are usually deployed over the side of a boat. They may also be used while wading in a small stream. A small sampler such as a petite ponar may be pulled by hand from a small, stable v-hulled or flat-bottomed boat.

Samples may be emptied into a sieve and sieved on board or emptied into clean buckets for sieving on the shore, depending on the room on board to hold unsieved samples and the proximity to the shore. Samples are rinsed through the 0.5-mm sieve using surface water. The sediment and organisms retained on the sieve are carefully transferred by hand into a labeled sample jar. A labeled tongue depressor is placed into the jar with the sample as well. Preservative and stain (as required by the analytical laboratory) is added to cover the sample for benthic community evaluation.

Samples are transferred to the analytical laboratory under chain of custody. Care is required in packing samples that contain preservative for shipping. Jar lids should be securely taped with electrical tape. Preserved samples should be packed in an absorbent, non-flammable material such as vermiculite.

# STANDARD OPERATING PROCEDURE

---

## 4.0 DOCUMENTATION

Sample locations, time and date of collection, and initials of the collector will be on each sample label and on the COC. This information will also be documented in a field note book or log sheet. Observations of sediment type, vegetation, oxidation-reduction status, or any unusual matter will also be recorded in field log.

**B-5**

**COLLECTION OF BENTHIC AND EPIPHYTIC INVERTEBRATES FOR  
CHEMICAL ANALYSIS OF TISSUE**

# STANDARD OPERATING PROCEDURE

---

## COLLECTION OF BENTHIC AND EPIPHYTIC INVERTEBRATES FOR CHEMICAL ANALYSIS

### 1.0 GENERAL APPLICABILITY

This method is used to collect quantitative samples of invertebrates from sediments and/or submerged aquatic vegetation found in freshwater environments.

### 2.0 EQUIPMENT DESCRIPTIONS

The equipment used in the collection of benthic invertebrates consists of grabs and kick nets. The equipment used to collect epiphytic invertebrate samples from submergent vegetation in ponds includes, cutting shears, stainless steel bowl, 0.5-mm sieve, white enamel pan, plastic syringes or forceps, wide mouthed sampling jars and plastic squirt bottles.

### 3.0 PROCEDURES

1. The sample team will usually consist of between two and four people depending on the anticipated work load.
2. Invertebrates to be collected will be determined in advance and described in the Field Sampling Plan for a Site. Selection of species is based on the following criteria: a) availability at the site, b) sample size requirements, c) purpose of the evaluation.
3. Taxa sorted from samples will be sorted by taxonomic family, order and/or class. Animals are picked live and placed in glass jars containing site water.
4. Invertebrates in stream sediments are typically collected using using a combination of kick nets and sediment grabs.
5. A special sediment sieving device with an extra large screen and running water is used to wash large quantities of sediment and thus support the sampling effort.
6. Sample size depends on laboratory requirements and the QAPP should be reviewed to determine sample needs. An example is provided here for illustration. A laboratory typically requires a minimum of 1 g per sample for metals and an additional 1 to 2 g for PAHs, pesticides, and PCBs. Additional sample would be needed to perform project-defined matrix QC including matrix spike and duplicate analyses. The number of organisms required to achieve sufficient sample size will depend on the size of the organism. Sample size requirements have been calculated for a range of body lengths that may be encountered and two sets of length to width ratios considered representative of the species expected (see Table). These estimates will be used by the field collection team to estimate

# STANDARD OPERATING PROCEDURE

sample size requirements. This method will be simpler to implement than in-field weighing because a considerable amount of water as well as debris adheres to the animals when they are picked and sorted from the sample.

## Example for Estimating Sample Size Requirements for Obtaining Sufficient Biomass for Tissue Analysis.

Body Length (cm)	Length:Width Ratio	Sample Requirements (# of organisms) to Achieve Specified Biomass Levels <sup>a</sup>		
		1 g	2 g	5 g
0.5	10	863	1725	4313
1	10	108	216	539
2	10	13	27	67
3	10	4	8	20
0.5	5	216	431	1078
1	5	27	54	135
2	5	3	7	17
3	5	1	2	5

a. The estimates assume a cylindrical body shape and a specific gravity of 1.1 g/cm<sup>3</sup>

7. In soft bottom areas, grab samplers are used to collect the desired invertebrates.
8. A determination must be made in advance of sampling concerning the amount of time that will be allotted for achieving sample size requirements.
9. Judgments concerning the abundance of invertebrates at a location will initially be made using grab samples and/or kick net samples.
10. If this initial sampling effort yields less than a critical target level (defined in the QAPP and Field Sampling Plan), sampling for benthic invertebrates will cease because the location would be unlikely to yield the sample-size requirement. For these locations, the invertebrate sampling effort is terminated or the effort reallocated as defined by the Field Sampling Plan.
11. The decision to reallocate sampling effort or to consider a sampling location complete will be made in the field after consultation with and concurrence from appropriate field leaders from the agency and/or other authority.
12. After the collection is complete at a location, the samples are washed and rinsed with site surface water to help remove debris. The sample is stored on ice in surface water and washed again at the end of the day's sampling effort.
13. Although invertebrates living on plants are usually collected by cutting submerged aquatic vegetation above the root system in this study, epiphytic

# STANDARD OPERATING PROCEDURE

---

vegetation will be collected in its entirety including the root system. The roots will not be cut. Where appropriate, benthic organisms will be removed from the roots. Invertebrates living on the plants will be collected for tissue analysis by washing the organisms off the plants and onto sieves. These will be processed as described above for benthic invertebrates.

- 14 Samples of benthic or epiphytic invertebrates for tissue analysis are placed in ziplock bags or glass jars and stored on ice for overnight courier shipment to the analytical laboratory. Information recorded in field logs and/or the chain-of-custody for benthic invertebrates samples will include: the client, site name, Sample Identification Number, sampling location, physical characteristics of the sampling station, estimated weight of the sample, date and time, and names of field personnel. Subsequent processing of the sample will be completed at the laboratory.

## 4.0 DOCUMENTATION

Sample locations, time and date of collection, and initials of the collector will be on each sample label and the COC. This information will also be documented in the field log.

**B-5a**

**HABITAT ASSESSMENT FIELD DATA SHEET**

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (FRONT)

STREAM NAME		LOCATION	
STATION #	RIVERMILE	STREAM CLASS	
LAT	LONG	RIVER BASIN	
STORET #		AGENCY	
INVESTIGATORS			
FORM COMPLETED BY		DATE	REASON FOR SURVEY
		AM PM	

Habitat Parameter	Category			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks stored with gabion or cement; over 80% of the stream reach channelized and disrupted; instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material; increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Habitat Parameter	Category			
	Optimal	Suboptimal	Marginal	Poor
<b>6. Channel Sinuosity</b> The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)	The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line.	The bends in the stream increase the stream length 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.	
<b>SCORE</b>	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
<b>7. Channel Flow Status</b> Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.	
<b>SCORE</b>	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
<b>8. Bank Vegetative Protection (score each bank)</b> More than 90% of the streambank surfaces covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.	
<b>SCORE (LB)</b>	Left Bank 10 9	8 7 6	5 4 3	2 1 0
<b>SCORE (RB)</b>	Right Bank 10 9	8 7 6	5 4 3	2 1 0
<b>9. Bank Stability (score each bank)</b> Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.	
<b>SCORE (LB)</b>	Left Bank 10 9	8 7 6	5 4 3	2 1 0
<b>SCORE (RB)</b>	Right Bank 10 9	8 7 6	5 4 3	2 1 0
<b>10. Riparian Vegetative Zone Width (score each bank riparian zone)</b> Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.	
<b>SCORE (LB)</b>	Left Bank 10 9	8 7 6	5 4 3	2 1 0
<b>SCORE (RB)</b>	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score \_\_\_\_\_

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (BACK)

# Standard Operating Procedures

---

**B-6a**

**FISH CAPTURE PROTOCOLS  
US FISH & WILDLIFE SERVICE**



## STANDARD OPERATING PROCEDURES

Industri-plex Superfund Site  
Woburn, Massachusetts  
June 1999

All fish sampling will be performed by personnel from the U.S. Fish and Wildlife Service (USFWS) Office of Fisheries Assistance, Laconia, New Hampshire; USFWS Office of Fisheries Assistance, Sunderland, Massachusetts; and USFWS Ecological Services, Concord, New Hampshire (including ES personnel from sub-offices in Massachusetts and Maine). Reference sites will be sampled before potentially contaminated sites. Bass, perch, bullhead, sunfish, and cyprinids are the species likely to be targeted for contaminant analysis. Fish may be captured using electrofishing boats, backpack electrofishers, gill nets, minnow traps, trot lines, or other methods. Electrofishing will be conducted in compliance with USFWS standard operating procedures and safety requirements per 24 AM 13 (attached).

### COLLECTION SITES

#### Potentially Contaminated

Halls Brook Holding Area  
Open water area above Mishawum Road

#### Reference

North Pond  
Phillips Pond

### FISH CAPTURE PROTOCOLS

Fish captured by boat electrofishing will be held in live wells on board the boat containing water from the collection location until transferred to appropriate EPA or contracted personnel. It is anticipated that each boat crew will include a boat operator, fish netter, and record keeper. In each pond, boat operators will fish in one-half hour intervals, recording data (e.g., minutes, voltage, run locations) for each interval until an appropriate number of target species are collected.

Fish captured by backpack electrofishing will be held in buckets containing water from the collection location or held in live cars placed at the location until transferred to appropriate EPA or contracted personnel. It is anticipated that each backpack electrofishing crew will include an operator, fish netter, and record keeper.

Minnow traps or trot lines will be baited only with bait from the site in which the trot line is deployed. Gill net sets will be closely monitored to minimize fish mortality.

Data sheets will be completed for all capture locations. For each fish and collection location, data entries and notations will include capture date, location, collection method, fish species, total length, total weight, abnormality descriptions (if applicable), and qualitative assessment of habitat conditions. If abnormal fish characteristics (e.g., lesions, neoplasia, eroded fins) are encountered, 35 mm slide photographs of the fish and close-up of the abnormality will be taken by USFWS, EPA, or contracted personnel. Approximate locations of gill nets, minnow traps, trot lines or electrofishing runs will be recorded on a site map.

### **FISH HANDLING PROTOCOL**

All fish captured for contaminant analyses will be held by USFWS until transferred to EPA or contracted personnel. Fish will be held at all times in water from the collection locations prior to processing. Containers of fish will be labeled with the capture location and any other information deemed appropriate by the EPA Remedial Project Manager.

USFWS personnel will extract and retain otoliths from predator fish (e.g., largemouth bass) for aging purposes.

Aeration in live wells will be provided by USFWS until fish can be processed. However, if there are delays in fish processing and USFWS fish collections are completed, EPA or contracted personnel will be responsible for providing live wells and aeration. EPA or contracted personnel will be responsible for processing all fish samples for contaminant analysis or histopathology examinations.

# Standard Operating Procedures

---

**B-6b**

**ELECTROFISHING**

---

**CHAPTER 13****Electrofishing****TABLE OF CONTENTS**

- 13.1 Purpose.
- 13.2 Scope.
- 13.3 Policy.
- 13.4 Authority.
- 13.5 Definitions.
- 13.6 Responsibilities.
- 13.7 Training and education.
- 13.8 Electrical equipment:  
specifications and operation.
  - A. General.
  - B. Portable electroshockers.
  - C. Electrofishing boats.

Exhibit 1 - Electrofishing Considerations Checklist

---

**Electrofishing**

---

13.1 **Purpose.** To ensure the safe conduct of electrofishing operations by establishing Servicewide competency requirements for electrofishing operations. This chapter also provides guidelines for the safe construction, modification, and operation of electrofishing equipment.

13.2 **Scope.** The provisions of this chapter apply to all Service activities using electricity (produced by gasoline powered generators/alternators or batteries) to sample animals in aquatic habitats.

13.3 **Policy.** The Service recognizes the electrofishing operation as a hazardous activity for which skills training is required in accordance with 24 AM 1.7 B (2).

It is, therefore, Service policy that all personnel serving as electrofishing team leaders demonstrate knowledge of the principles and techniques of electrofishing. Team leaders will be considered knowledgeable of the principles and techniques of electrofishing upon satisfactory completion of the National Fisheries Academy course, Principles and Techniques of Electrofishing. In lieu of course completion, Service personnel may satisfactorily complete a certifying examination by the Superintendent, National Fisheries Academy.

13.4 **Authority.**

- A. 29 CFR 1910 - General Industry Standards.
- B. Federal Boat Safety Act of 1971 as amended (46 U.S.C. 1451-89).
- C. National Fire Protection Association (NFPA) 70-1981, National Electric Code (NEC).

13.5 **Definitions.**

- A. **Anode.** The positive electrode.
- B. **Bonding.** The permanent joining of metallic parts to form an electrically conductive path which assures electrical continuity, with the capacity to safely conduct current.
- C. **Branch circuit.** The circuit conductors between the final overcurrent device protecting the circuit and the electrical load(s).
- Cathode.** The negative electrode.

---

**Electrofishing**

---

- E. Circuit breakers. A device designed to open and close a circuit by a non-automatic means, and to open the circuit automatically on the predetermined overcurrent without damage to itself when properly applied within its rating.
- F. Deadman switch. A switch which requires constant pressure to supply electrical current to the circuit.
- G. Electrofishing. The use of electricity to provide a sufficient electrical stimulus in fish to permit easy capture by netting.
- H. Electrofishing team leader. The individual in charge of the electrofishing operation. Only persons demonstrating knowledge of the principles and techniques of electrofishing in accordance with 13.6D can serve as electrofishing team leaders.
- I. Ground. A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth, or to some conducting body that serves in place of the earth.
- J. Isolation transformer. A transformer inserted into a system to separate one section of the system from undesired influences with other sections.
- K. Netter. The individual who nets the captured fish during electrofishing operations.
- L. Power control circuit. The circuit which interconnects and adjusts the power from the pulsator or generator to the electrodes.
- M. Raintight. Constructed or protected so that exposure to a beating rain will not result in the entrance of water.
- N. Variable voltage pulsator electroshocker. The device used to deliver the pulsed electric current.
- O. Watertight. Constructed so that moisture will not enter the enclosure.
- P. Weatherproof. Constructed or protected so that exposure to the weather will not interfere with successful operation.

**13.6 Responsibilities.** These responsibilities supplement those found in 24 AM 1.5.

- A. Chief, Office of Safety and Security. Will maintain a current listing of all Service personnel possessing an electrofishing certificate of competency, and provide regional safety managers with such listing.

---

Electrofishing

---

- B. Regional directors. Regional directors will ensure that all persons serving as electrofishing team leaders have received from the Superintendent, National Fisheries Academy, a certificate of competency for electrofishing.
- C. Superintendent, National Fisheries Academy.
- (1) Prepares electrofishing certifying examination for persons desiring to demonstrate knowledge of the principles and techniques of electrofishing by satisfactory completion of a certifying examination in lieu of completion of the National Fisheries Academy course, Principles and Techniques of Electrofishing. The certifying examination may be taken 3 times, in intervals of at least 30 days. Persons failing to satisfactorily complete the certifying examination in 3 attempts will be required to complete the National Fisheries Academy course, Principles and Techniques of Electrofishing, prior to serving as a team leader.
  - (2) Ensures sufficient scheduling of the course, Principles and Techniques of Electrofishing.
  - (3) Issues certificates of competency for individuals either completing the course, Principles and Techniques of Electrofishing, or satisfactorily completing the certifying examination.
  - (4) Provides the Office of Safety and Security with a listing of all personnel possessing an electrofishing certificate of competency and update such listing as appropriate.
- D. Electrofishing team leader. Only individuals demonstrating knowledge of electrofishing techniques can serve as electrofishing team leaders. Team leaders will be considered knowledgeable of the principles and techniques of electrofishing upon satisfactory completion of the National Fisheries Academy course, Principles and Techniques of Electrofishing. In lieu of course completion, Service personnel may satisfactorily complete a certifying examination prepared by the Superintendent, National Fisheries Academy. Training and education for electrofishing operations will otherwise be in accordance with section 13.7. As the individuals in charge of electrofishing operations, the team leaders will do the following:
- (1) Identify hazardous conditions associated with proposed electrofishing operations, determine measures to protect electrofishing team members, and appropriately brief team members (see section 13.7B).
  - (2) Ensure that employees have and utilize the proper safety equipment.
  - (3) Ensure adequate warning is provided to the public to avoid public exposure to the potential hazards of electrofishing operations.

---

**Electrofishing**

---

- (4) Ensure precautions are taken to avoid harm to pets, domestic animals, or wildlife.
  - (5) Ensure that all electrofishing operations cease and all crew members go ashore in the event of a thunderstorm.
  - (6) Ensure that only those persons necessary to conduct a safe and efficient operation, and observers being trained, engage in each electrofishing operation.
  - (7) Ensure the availability of a well equipped, water-tight first aid kit. Questions concerning the contents of the first aid kit may be directed to the regional safety manager.
  - (8) The team leader should review the electrofishing considerations checklist found in Exhibit 1, and ensure the addition of specialized items to the checklist that pertain to his/her region or operation.
- E. Project leaders. Ensure compliance with the provisions of this chapter.
- F. Employee. Report all potential work hazards/accidents/incidents and job related illnesses/injuries to his/her supervisor immediately.

**13.7 Training and education.**

- A. Team leader training and education will cover the areas identified below.
- (1) The basic principles of electricity and transmission of current in water.
  - (2) The basic concept and design guidelines for electrofishing equipment.
  - (3) Electrofishing equipment and the equipment's capabilities, limitations, and safety features.
  - (4) The safety precautions to employ while using electrofishing equipment.
  - (5) The team leader must have a current certification in cardiopulmonary resuscitation (CPR) training and first aid.

Completion of the course, Principles and Techniques of Electrofishing, at the National Fisheries Academy or at a field location, or successful completion of the certifying examination, will serve to satisfy competency for factors 1, 2, 3, and 4. A certificate from the Red Cross or other recognized institution will certify CPR and first aid training.

---

 Electrofishing
 

---

B. All members of the electrofishing crew will be briefed in the following areas:

- (1) Hazards involved in electrofishing.
- (2) Safe operation of electrofishing equipment.
- (3) Basic emergency procedures for drowning, unconsciousness, and electrical shock.
- (4) All members of the electrofishing crew will also be knowledgeable of defensive driving techniques, including towing and backing of boat trailers if an electrofishing boat is used, and safe boating operations.

13.8 Electrical equipment: specifications and operation.

A. General.

- (1) Isolation transformer. AC voltage from the generator will be isolated from ground either by removing the ground strap from the generator case or by adding an isolation transformer.
- (2) Voltage. Rated voltages of insulation of conductors used to deliver output current from the pulsator to the electrodes must exceed the maximum potential voltage of the pulsator or generator by the next higher rating as follows:

<u>Pulsator/generator</u>	<u>Minimum insulation rating of conductor</u>
0 - 249 volts	250 volts
249 - 599 volts	600 volts
599 - 899 volts	900 volts
900 - 12,999 volts	13,000 volts

- (3) Conductor size. Conductor size (i.e., current carrying wire) will be approved for rated amperage of equipment as follows:

<u>Maximum amperage</u>	<u>Minimum conductor size</u>
10	16 AWG
15	14 AWG
20	12 AWG
30	10 AWG

---

**Electrofishing**

---

**(4) Conductor type.**

- (a) Conductors will be of the stranded type for flexibility and be suitable for use in dampness.
- (b) All conductors in the boat will be enclosed in conduit or liquid-tight, flexible conduit; however, appropriate heavy duty rubber cord can be used where flexibility is desired.
- (c) Connectors used in association with flexible cords will be of the locking, waterproof type.

**(5) Connections.**

- (a) Splices in wiring will not be permitted. If connections are necessary, the rating of the connector must be the same or greater than the wire.
- (b) All equipment will be turned off before making any connections or replacing parts.

- (6) Junction boxes. Junction boxes will be cast iron, cast aluminum, fiberglass, plastic, or rubber. All types must either be weatherproof or raintight depending on use. All junction boxes with switching equipment must be weatherproof. Junction boxes without switches may be raintight.**

**(7) Circuit breakers.**

- (a) Power output conductors from the generator or alternator will include a circuit breaker or fuse to provide branch circuit protection.
- (b) Circuit breaker or fuses used for providing branch circuit protection will be enclosed in a weatherproof enclosure or cabinet that complies with National Electric Code, Article 373-2, which states the following:

"In damp or wet locations, cabinets and cutout boxes of the surface type will be so placed or equipped so as to prevent moisture or water from entering and accumulating within the cabinet or cutout box and will be mounted so that there is at least 1/4-inch air space between the enclosure and the wall or other supporting surface. Cabinets or cutout boxes installed in wet locations will be weatherproof."

- (8) Electrodes and net handles. Net handles will be constructed of a non-conductive material and will be of sufficient length to avoid hand contact with the water.**

---

**Electrofishing**

---

- (9) Noise. Noise levels will be maintained within the acceptable exposure of 85 dba for 8-hour exposure. Personal protective measures, such as use of earplugs, are described in 24 AM 8. The purchase of sound powered headphones is authorized through station funding. This type of headphone shuts out generator and motor noise and provides clear communication between the netter and equipment operator.
- (10) Exhaust from power source. The exhaust from gasoline powered engines and generator alternators will be directed away from the equipment operator. Exposed hot pipes will be enclosed in protective screening to reduce the potential of burn exposure to crew members. The use of galvanized pipe for exhaust is discouraged due to the potential release of toxic gases that are produced under extreme heating conditions.
- (11) Fuel storage. Gasoline will be stored and transported in approved metal containers. Such containers when used for storage on metal hull boats will be grounded.
- (12) Refueling. To refuel the generator/alternator, all equipment will be turned off. Hot surfaces will be allowed to cool. It is recommended that all tanks be filled prior to each operation to avoid the potential for explosion or fire while refueling hot gasoline engines.
- (13) Instruction sheets. Instruction sheets for boat, equipment, and operational procedures will be enclosed in waterproof plastic and be readily available for reference at all times during the electrofishing operation.
- (14) Preventive maintenance.
  - (a) All equipment used in electrofishing will be scheduled for an annual preventive maintenance inspection. In addition, all equipment will be inspected before each use.
  - (b) Any equipment deficiency which may present a safety hazard will be corrected before each field operation or when equipment damage occurs during actual use.

**B. Portable electroshockers.**

- (1) Electrodes.
  - (a) Electrode handles will be constructed of a nonconductive material and be long enough to avoid hand contact with the water.

Electrofishing

- (b) The positive electrode (anode) used with portable electroshockers will be equipped with a pressure switch that breaks the electric current upon release.
- (2) Netter position. Netters will work beside or behind the individual with the electrofishing equipment to ensure the electrical field is well in front of both workers.
- (3) Standard safety equipment.
- (a) All persons using portable electroshockers will wear rubber footwear which will insulate the wearer from electrical shock. All footwear will be equipped with nonslip soles.
- (b) Rubber linesman gloves, rated above the voltage being used in the electrofishing operation, will be worn. These gloves will be inspected for punctures before each use and will be replaced at adequate intervals.
- (c) Polaroid sunglasses will be worn when there is glare.
- (4) Portable electrical power source.
- (a) Batteries used as electrical power source for backpack shockers will be of the gel type that will not leak when tipped or overturned.
- (b) Backpacks will be equipped with a quick release belt (hip) and shoulder straps.
- (5) Power control.
- (a) The operator will have a switch to the pulsator or power control unit so that the electricity can be turned off quickly in an emergency.
- (b) All equipment purchased after October 1, 1985, must be equipped with a tilt switch that breaks the circuit if the operator falls. The switch must be a type that has to be manually reset after the operator has regained his/her footing.
- (6) Personal flotation devices. All persons will wear U.S. Coast Guard approved personal flotation devices (Type II) (i.e., life jackets or float coats) when operating in waters that are deep, high velocity, or turbid, to prevent drowning.

Note: Flotation devices constructed of materials such as ensolite are not bulky and are light weight. This material used in float coats can provide some protection against loss of body heat if the person accidentally falls into cold water.

---

**Electrofishing**

---

- (7) Hazard awareness. All persons will be aware of the hazards involved in using portable electroshockers in running waters such as slippery surfaces, swift water currents, deep areas, and obstacles such as logs or similar objects.

C. Electrofishing boats.

- (1) Design.
- (a) Electrofishing boats will provide adequate flotation and freeboard clearance consistent with equipment, cargo, and passenger weight when being operated. The boat will be equipped to meet U.S. Coast Guard or State boating regulations.
  - (b) The boat deck will be painted with a nonslip or skid resistant coating.
- (2) Clear working space. General boat housekeeping must provide adequate working space to conduct safe operations. Care will be exercised to prevent clutter that may result in safety hazards.
- (3) Boat inspection before each use. The boat and equipment will be visually inspected for safety by the supervisor or operator in charge prior to each use. Significant deficiencies, which could result in employee injury, will be corrected prior to operation or use of the equipment.
- (4) Controls for electrical equipment.
- (a) Electrical amp-volt meters will be installed to provide adequate monitoring of boat electrical power equipment.
  - (b) The boat operator should be able to operate an electrical control or switch to cut the power in case of an accident.
  - (c) The netter will have a deadman switch connected to the power control circuit from the pulsator or generator source. This allows the current between the electrodes to be broken in case of an accident.
  - (d) Power control circuits will not exceed 24 volts.
- (5) Grounding/bonding. All metal surfaces within a metal boat will be electrically connected, grounded, and bonded to the boat hull to eliminate differences in electrical potential that may result in electric shock. The metal boat hull may also be used as a cathode.

---

Electrofishing

---

To avoid possible electrolysis problems when the metal hull is being used as a cathode, zinc strips should be attached to the hull as "sacrificial anodes." The electrolysis will occur on the zinc strips which will preserve the integrity of the hull.

- (6) Battery enclosure. An acid proof, nonmetallic enclosure and holder will be provided for wet cell batteries.
- (7) Conductor protection. All conductors may be installed in a common raceway (conduit) provided each conductor installed is continuous (without connectors, breaks, or splicing), is independently and correctly insulated. All low voltage (24 volts or less) circuits will be contained in separate raceways from those containing high voltage conductors.
- (8) Auxiliary circuits. Lighting and other auxiliary circuits should not exceed 24 volts. Note: 110 volt lamps may be used if the lamp is shielded with a nonconductive cage.
- (9) Lighting.
  - (a) When the boat is to be operated at night, adequate on-board lighting (12-24 volts) will be provided for working areas.
  - (b) Adequate lighting will also be provided while electrofishing to avoid safety hazards such as striking logs, rocks, and overhead tree branches.
- (10) Safety rails. Safety rails will be provided around the outside of the netting area and will be at least 42 inches high and be constructed of at least 3/4-inch diameter heavy-walled steel pipe or 1 1/2-inch heavy wall aluminium pipe. Rails will be so designed to withstand a 200-pound side thrust. The work deck will be covered with nonskid material and sloped to allow drainage. The high gunnels of wooden draft boats are satisfactory as safety rails.
- (11) Fire extinguisher. Each boat will be equipped with at least one 5-pound type ABC fire extinguisher mounted in a holder for easy access to the boat operator and away from high fire potential sources.
- (12) Personal flotation devices. All occupants will wear U.S. Coast Guard approved personal flotation devices at all times. Life vests that meet the requirements of Type II are designed to turn an unconscious person in the water from a face downward position to a vertical or slightly backward position. Float coats may provide some protection against the loss of body heat if the person were to accidentally fall into the cold water.

---

Electrofishing

---

- (13) Standard safety equipment.
- (a) Hip boots will be worn so they can be easily removed in case the boat capsizes.
  - (b) Rubber chest waders will also be worn when necessary in order to remain dry as protection against electrical shock.
  - (c) Rubber gloves will be worn that are rated above the voltage being used. These will be inspected before each use and replaced at adequate intervals.
  - (d) Polaroid-type sunglasses will be worn to reduce glare from the water.
- (14) Color coding/labeling of significant hazards. To ensure visibility, the color red will be used to identify fire extinguishers, safety cans, and stop buttons for electrical equipment. The color fluorescent orange will be used to identify all other safety switches.

**B-6c**

**FISH FILLETING**

# STANDARD OPERATING PROCEDURE

---

## FISH FILLETING

### 1.0 GENERAL APPLICABILITY

This SOP applies to the preparation of fish samples for tissue analysis. Detail is provided on the procedure for obtaining selected tissues. However, the methodology can also be applied to analyses of whole fish.

### 2.0 EQUIPMENT DESCRIPTIONS

- Wet or blue ice
- Borosilicate glass Bench liners
- Borosilicate glass bottles
- Knives with titanium blades and PTFE Handles
- Glass or PTFE cutting boards
- Chemically-clean bottles for sample storage
- Camera for recording any histopathological anomalies

### 3.0 SAMPLE SHIPMENT AND STORAGE

Whole fish will be collected and shipped or brought to the off-site laboratory from the field within 24 hours of sample collection. If samples are to be immediately filleted or processed, fish will be maintained at  $4 \pm 2^{\circ}\text{C}$  during shipment and prior to filleting. If samples are not to be filleted or processed within 48 hours of collection, they will be stored frozen at  $-10^{\circ}\text{C}$ .

Samples will be sent by overnight delivery service (next morning delivery) or be delivered by courier. Shippers will notify the receiving laboratory or the USWS and notify that samples are being sent for next-day delivery. Samples need to be sent for arrival on a weekday only. Therefore, Thursday is the last day of the week to ship samples. Shippers will also call the receiving laboratory the day of delivery to verify the receipt of samples.

The fish will be unwrapped and inspected carefully to ensure that they have not been compromised in any way (i.e., not properly preserved during shipment.) Any specimen deemed unsuitable for further processing and analysis will be discarded and identified on the sample processing record.

### 4.0 FILLET , LIVER AND OFFAL SAMPLE PROCESSING IN THE LABORATORY

Because metals are one of the primary chemicals of concern, equipment used in processing samples for metals analyses will be of quartz, PTFE, ceramic, polypropylene, or polyethylene.

Fish samples for filleting will be placed in a pre-weighted decontaminated tray and weighed to the nearest one-tenth gram using balances that are properly calibrated and of adequate accuracy and precision to meet program data quality objectives (See

# STANDARD OPERATING PROCEDURE

of adequate accuracy and precision to meet program data quality objectives (See project QAPP). The following tissues will be obtained based on the requirements of the QAPP.

For whole fish – the entire fish is considered a tissue sample and no body parts are removed

- For fillets without skin – the fish is skinned, and the skins set aside if needed as part of the analysis of offal; the flesh on each side of the fish is cut free and set aside for weighing
- For livers – this large target organ is located at the anterior end of body cavity; it is cut free from mesenteric tissue and set aside for weighing
- For offal – this tissue material refers to the portions of the fish that are not included in specific target tissues (i.e., liver, fillets); the offal includes the skin, bones, head and internal organs. These tissues are set aside for weighing

After filleting the following fish parts will be weighed.

- Fillet Weight (g) for appropriate samples (same procedures as total weight).
- Liver Weight (g) for appropriate samples (same procedures as total weight).
- Offal Weight (g) For appropriate samples (same procedures as total weight)

While filleting, care must be taken to avoid contaminating fillet tissues with material released from inadvertent puncture of internal organs. **NOTE:** If the fillet tissue is contaminated by materials released from the inadvertent puncture of the internal organs during resection, the fillet tissue must be rinsed in contaminant-free, deionized distilled water and blotted dry. A notation should be made in the sample processing record.

## 5.0 DECONTAMINATION PROCESS

Filleting will be conducted by or under the supervision of an experienced fisheries biologist. If gloves are worn, they will be talc- or dust-free, and of non-contaminating materials. Prior to filleting, hands will be washed with Ivory soap and rinsed thoroughly in tap water, followed by distilled water (U.S. EPA, 1991). Specimens will come into contact with non-contaminating surfaces only. Fish will be filleted on glass or PTFE cutting boards that have been cleaned properly according to EPA Laboratory standards, (USEPA 1995) and will be cleaned properly between fish samples with a detergent solution, rinsed with tap water, and then rinsed with metal-free water.

# STANDARD OPERATING PROCEDURE

---

## 6.0 PROCEDURE

An external exam will be made of each fish to determine if there are any indications of gross histopathological anomalies. If any are observed these will be recorded and photographed.

An initial cut should be made from the dorsal fin to the pelvic fin, just behind the opercular flap. Run the tip of the knife along the dorsal side of the fish, from the initial cut to the caudal fin. Continue making successively deeper cuts, running the knife blade as close to the neural spines and ribs as possible. After the fillet is obtained, remove the skin. Place the skin side of the fillet down on the dissecting tray, hold on to the tail portion of the fillet, and run the knife between the skin and the muscle tissue. Remove any debris from the skinless fillet by rinsing with deionized water.

After a fillet is cleaned, place the sample in a pre-weighed decontaminated tray and record the weight to the nearest one-tenth gram. Borosilicate glass bench liners, or equivalent non-contaminating container, will be used to weigh the fillets. No aluminum foil will be used for wrapping or weighing fillets. Livers and offal samples (fish tissue remaining after fillets have been removed) will also be placed on decontaminated borosilicate glass bench liners in the same manner.

An internal exam will be made of each fish to determine if there are any indications of gross histopathological anomalies. If any are observed these will be recorded and photographed.

## 7.0 SAMPLE SIZE

Sample size requirements will depend on the analytes and the detection limits specified in the QAPP. The analytical laboratory must review these and provide information on the sample sizes required to meet the objectives of the program.

## 8.0 DOCUMENTATION

All sample documentation will follow project specific SOPs for field sample ID, data sheet, chain-of-custody, and custody seal procedures. In addition a log will be kept by the fisheries biologist to record the fillet and processing observations.

## 9.0 REFERENCES

U.S. EPA. (U.S. Environmental Protection Agency). Sept. 1995. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Vol 1. Fish Sampling and Analysis Second Edition. U.S. EPA, Office of Water.

U.S. EPA, (U.S. Environmental Protection Agency). 1991d . Environmental Monitoring and Assessment Program (EMAP) near Coastal Program Laboratory Methods for Filleting and Compositing fish for Organic and Inorganic Contaminant Analyses. Draft. U.S. EPA, Office of Research and Development, Environmental Research Laboratory Narragansett, RI.

**B-7**

**MACROPHYTE SAMPLING**

# STANDARD OPERATING PROCEDURE

---

## MACROPHYTE SAMPLING FOR TISSUE ANALYSES

### 1.0 GENERAL APPLICABILITY

Aquatic vascular plants (macrophytes) can accumulate chemicals for sediments and from surface waters. If taken up by the plant, these contaminants can come to be located in various parts of the plants depending upon the manner in which the contaminant is taken up and the location of storage tissue within the plant. Because information on chemical uptake is often used to support wildlife exposure analysis, it is important to identify the parts of plants that are eaten by these animals. All these factors are considered in the design of a study and are reflected in the Field Sampling Plan for a Site.

The following criteria are typically applied but may be modified by Site-specific needs as identified in the QAPP:

1. Plant species selected for analyses should support the purpose of the analysis; for example, if the data are being used to support a food-chain analysis, the selected species should be common and known to be important in the diet of the species;
2. Analysis is usually conducted on selected species rather than composites of species; the reduces inter-species variability within the sample and allows for comparisons between potentially affected and reference areas;
3. Because of the various ways in which plants can accumulate and store chemicals and because different parts of the plants are eaten by different types of animals, it is helpful to analyze different parts of the plants; usually this involves a separate analysis of roots and leaves/stems; if fruiting bodies or seeds are known to be important, they may also be identified as a separate tissue for analysis; for situations where metals are present in sediments, highest concentrations of these metals within the plants are usually found in the root systems;
4. Analysis of chemicals in aquatic plants should be supported by analysis of sediments and/or water; therefore it is useful to locate the plant samples at or near the location where sediment and/or water samples are being obtained;
5. Because of inter-plant variability (possibly reflecting small-scale spatial variability in sediments/water as well as plant uptake), plant samples should consist of composites of several plants from the same species and at the same location; this aspect of sampling is detailed in the QAPP and Field Sampling Program for a Site.

### 2.0 PROCEDURE

- Select a stand of the desired plant species approximately 5 - 10 meters in diameter at or near a sediment/surface sampling location
- Photograph the stand and note its general conditions.
- Record location of the stand in field notebook and the type of plant species present in the stand.

# STANDARD OPERATING PROCEDURE

---

- Don protective gear as required by the HASP. For plant sampling general safety measures include wearing gloves.
- Remove the specified number of individual plants (generally ranging between 3 and 10 depending on the plant species and QAPP specifications) from the stand by digging or gently pulling the plant free from the sediments. In most cases, it is necessary to obtain a substantial portion of the root system. Macrophytes represented by emergent and submergent plants are collected using appropriate devices for the water body and depth of the sample. Examples include a decontaminated stainless-steel trowel or shovel. The collection device may be attached to a clean wooden pole to reach plants growing in deeper depths. In some cases (e.g., lily roots) it is necessary to reach into the sediment to pull the root system out. This requires special safety precautions that should be dealt with in the HASP.
- After an individual plant with roots has been removed from the sediment. Wash the parts of the plant that will be used for tissue analysis with surface water to remove excess sediment and detrital material.
- Cut the plant into the required sampling parts. Typically, a sample is made of the root system and a sample made of the stem and/or leaves. The required sample parts are identified in the QAPP and Field Sampling Plan. The parts of the plant that will be analyzed are kept separate and placed in a pre-labeled Ziplock bag.
- The individual plants that form the composite should be selected in a manner that is representative of the stand being analyzed. This is best done by distributing sampling effort throughout the stand either along a transect or using a simple grid system.
- Place samples in cooler with ice.
- After sampling each stand, decontaminate the sampling equipment according to the procedures. After the final sample is collected and equipment is decontaminated

All plant samples will be stored on ice for overnight courier shipment to the analytical laboratory.

## 3.0 DOCUMENTATION

Sample locations, time and date of collection, and initials of the collector will be inspected on each sample label. Sample location and description will be logged into the field notebook. A field notebook will be maintained into which all observations made, and methods used during sampling will be entered. Each page of the field notebook will be signed and dated on each page. Chain of Custody forms will be prepared following the sample custody procedures. A completed Chain of Custody form will be enclosed for all samples in a cooler. One copy of the Chain of Custody is to be retained in the event, a cooler is lost in shipping.

# Standard Operating Procedures

---

## **B-8a**

### **YSI 600XL Multi-parameter Water Quality Monitor**

# **STANDARD OPERATING PROCEDURES**

---

## **HE YSI 600XL MULTI-PARAMETER WATER QUALITY MONITOR**

### **1.0 GENERAL APPLICABILITY**

The YSI 600XL Multi-parameter Water Quality Monitor is used to profile and monitor water conditions in lakes, rivers, wetlands, estuaries, and coastal waters. It measures dissolved oxygen, conductivity, specific conductance, salinity, total dissolved solids, resistivity, temperature, pH, Oxidation Reduction Potential (ORP), water depth and level.

### **2.0 EQUIPMENT DESCRIPTION**

This portable field water monitoring instrument has field replaceable sensors. It does not have internal battery and therefore, must be powered from an external power source such as an AC adapter, battery pack, or terminal device. This instrument can be used at 200 feet below the water's surface or in as little as a few inches of water.

### **3.0 PROCEDURE**

At beginning the day, the YSI 600XL water quality monitor should be calibrated at least once daily. If using the monitor for an extended period during the day, the YSI monitor should be re-calibrated every 4 hours or when taking water quality measurements in a different surface water body. Only basic D.O. percent saturation, conductivity, pH and depth sensors need to be calibrated. Temperature does not require calibration.

- Follow the detailed start-up procedure.
- Calibrate the YSI before entering the boat by following procedures detailed in the YSI manual.
- At each surface water sampling location, measure.....
- Record the readings in the field notebook at surface water sampling location.

### **4.0 REFERENCE**

YSI 600XL Multi-parameter Water Quality Monitor Instruction Manual

**B-8b**

**600XL  
MULTI-PARAMETER  
WATER QUALITY MONITOR  
INSTRUCTION MANUAL  
YSI INCORPORATED**

# 600XL

## Multi-Parameter Water Quality Monitor

### Instruction Manual

YSI Incorporated  
1725 Brannum Lane  
Yellow Springs, OH 45387  
(800) 765-4974 (513) 767-7241  
Fax (513) 767-9353



®

## **3. BASIC OPERATION**

---

In the previous Section, you learned how to install probes and set up the PC6000, EcoWatch for Windows, and 600XL sonde software. In this Section, you will learn how to calibrate and run the Model 600XL and how to view your data on a computer display. If you choose to use your 600XL with a 610-series display/logger, refer to the operations manual for the 610 to obtain similar instructions to those provided below.

### **3.1 CALIBRATION TIPS**

---

**WARNING:** Reagents used to calibrate and check this instrument may be hazardous to your health. Refer to Appendix A for health and safety information.

Before you begin the calibration procedures outlined below, you may find it helpful to follow some or all of these calibration tips.

1. Remove the sonde stainless steel weight on the bottom of the sonde guard by turning it counterclockwise. This allows the calibration solutions access to the probes with minimal displacement of fluid within the calibration cup. Additionally, carry-over from one solution to the next is reduced.
2. Fill a large bucket with ambient temperature water for rinsing the sonde between calibration solutions.
3. Have several clean, absorbent paper towels or cotton cloths available to dry the sonde between rinses and calibration solutions. It is important to remove as much residual liquid as possible from the sonde after each rinse. Shake the sonde to remove excess rinse water from the inside of the guard. Then dry the outside of the sonde and guard. Drying the sonde and probes in this way reduces carry-over contamination of calibrator solutions and increases the accuracy of the calibration, particularly lower conductivity calibration standards.
4. It is not necessary to remove the probe guard to rinse and dry the probes between calibration solutions. The inaccuracy resulting from simply rinsing the probe compartment and drying the outside of the sonde is minimal.

### **3.2 CALIBRATION PROCEDURES**

---

**WARNING:** Calibration reagents may be hazardous to your health. Refer to Appendix A for health and safety information.

A calibration cup is supplied with the Model 600XL. Because the calibration cup fits over the outside of the sonde sensor guard, it is not recommended or necessary to remove the guard to calibrate the sensors. Follow the procedures below to calibrate the sensors. Only *basic* DO

---

**NOTE:** If an **ERROR** message appears, begin the calibration procedure again. Be certain that the value you enter for the calibration standard is correct. Also see Section 8, Troubleshooting for more information on error messages.

**CAUTION:** Be certain to immerse the entire sonde in solution standards for calibration of all parameters. Most calibrations require readings not only from the sensor being calibrated but also from the temperature sensor.

Specific start-up calibration procedures for all sensors which commonly require calibration are provided in the following paragraphs of this section. Remember that these are basic protocols designed to get the user up and running with regard to the 600XL. The more-detailed discussion of sensor calibration found in Section 4.2 should be examined prior to use of the instrument in the field.

**NOTE:** If the particular sensor listed is not installed in your sonde, proceed to the next sensor until the calibration protocol is complete.

## **CONDUCTIVITY**

---

**NOTE:** This procedure calibrates not only conductivity, but also specific conductance, salinity, and total dissolved solids.

Place approximately 300 mL of conductivity standard in a clean and dry calibration cup. The conductivity standard you choose should be within the same conductivity range as the water you are preparing to sample. However, we do not recommend using standard less than 1 mS/cm. For example:

- For fresh water choose a 1 mS/cm conductivity standard.
- For brackish water choose a 10 mS/cm conductivity standard.
- For sea water choose a 50 mS/cm conductivity standard.

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

Without removing the sonde guard, *carefully* immerse the probe end of the sonde into the solution. Gently rotate and/or move the sonde up and down to remove any bubbles from the conductivity cell. The probe must be completely immersed past its vent hole.

---

## DISSOLVED OXYGEN

---

Place approximately 1/8 inch of water or a wet sponge in the bottom of the calibration cup. Place the probe end of the sonde into the calibration cup. Make certain that the DO and the temperature probes are not immersed in the water. Wait approximately 10 minutes for the air in the calibration cup to become water saturated and for the temperatures of the thermistor and the oxygen probe to equilibrate. Make certain that the calibration cup is vented to the atmosphere.

From the Calibrate menu, select 2. Dissolved Oxy to access the DO % calibration procedure.

Enter the current barometric pressure in mm of Hg. *Remember that barometer readings which appear in meteorological reports are generally corrected to sea level and are not useful for you calibration procedure unless they are uncorrected.*

NOTE: Inches of Hg x 25.4 mm/inch = mm Hg

Press Enter and the current values of all enabled sensors will appear on the screen and will change with time as they stabilize. Observe the readings under DO % and when they show no significant change for approximately 30 seconds, press Enter. The screen will indicate that the calibration has been accepted and prompt you to press Enter again to return to the Calibrate menu.

Rinse the sonde in water and dry the sonde.

NOTE: Calibration of dissolved oxygen in the DO % procedure also results in calibration of the DO mg/L mode and vice versa.

NOTE: The above procedure is designed to calibrate your dissolved oxygen sensor for use in sampling applications where the sensor is being pulsed continuously in the Run mode because both "Auto sleep" and "Wait for DO" functions have been disabled as described in Section 2. If your 600XL is to be used in a monitoring application in which data is being captured to a computer or data collection platform, "Auto sleep" and "Wait for DO" will be activated and the calibration displays will be somewhat different. See Section 4 for details.

---

## DEPTH AND LEVEL

---

Following the DO calibration, leave the sonde in air. Make certain that the sonde is not submerged in water for this calibration.

From the Calibrate menu, select Pressure. Input 0.00 or some known sensor offset in feet. Press Enter and monitor the stabilization of the readings with time. When no significant change occurs for approximately 30 seconds, press Enter to confirm the calibration and zero the sensor.

## **2. GETTING STARTED**

---

This section is designed to quickly familiarize you with the hardware and software components of the 600XL sonde and its accessories. You will then proceed to sensor installations, cable connections, software installation and finally basic communication with the 600XL Sonde. Diagrams, menu flow charts and basic written instructions will guide you through basic hardware and software setup. For the first time user, we encourage the use a personal computer with PC6000 software during this initial setup procedure.

By the end of Section 2 you will have...

- Installed sensors in your sonde
- Installed PC6000 software in your PC
- Established communication between the sonde software and PC software
- Enabled appropriate sensors
- Assigned appropriate report parameters and units

Successful completion of the above list is essential for you to continue on to Section 3 which focuses on performing calibrations and making measurements.

### **2.1 UNPACKING**

---

Remove the instrument from the shipping container. Be careful not to discard any parts or supplies. Check off all items on the packing list and inspect all assemblies and components for damage. If any parts are damaged or missing, contact your representative immediately. If you do not know from which dealer your 600XL was purchased, refer to Appendix C for contact information.

**NOTE:** Reagents for the 600XL are not packaged in the same carton as the instrument. These materials must be ordered separately and will arrive in a separate package.

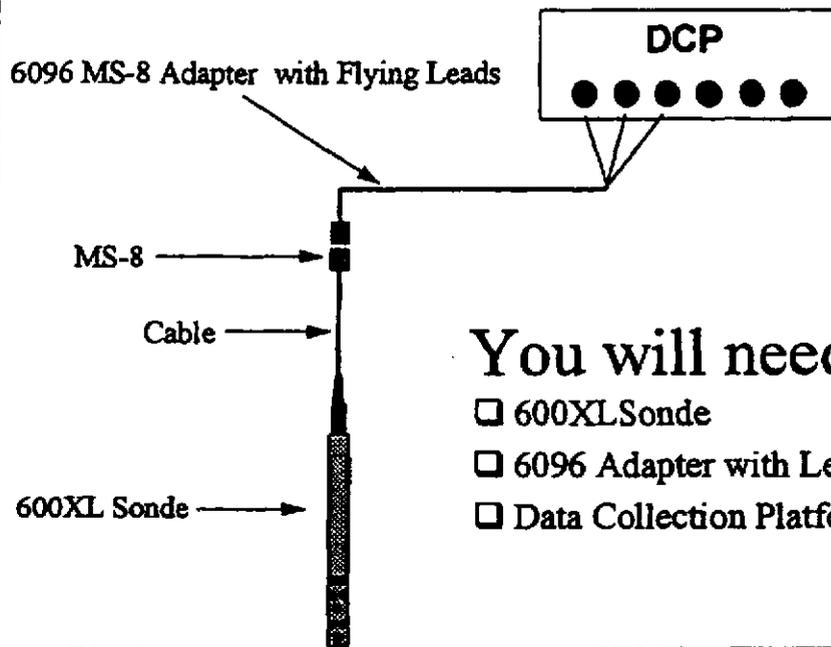
### **2.2 SYSTEM CONFIGURATION**

---

There are a number of ways in which you may configure the 600XL Sonde with various computers, terminals, and data collection devices. You should think about your particular application needs and then make certain that you have all of the components you need to make your system work. Below is a list of possible configurations that may be of interest to you. Each is depicted in diagrams on the next 3 pages.

- 600XL Sonde to Lab Computer
- 600XL Sonde to Data Collection Platform
- 600XL Sonde to Portable Computer
- 600XL Sonde to YSI 610 Display/Logger
- 600XL Sonde to YSI 610 with Portable Power
- Uploading Data from YSI 610 to Lab Computer

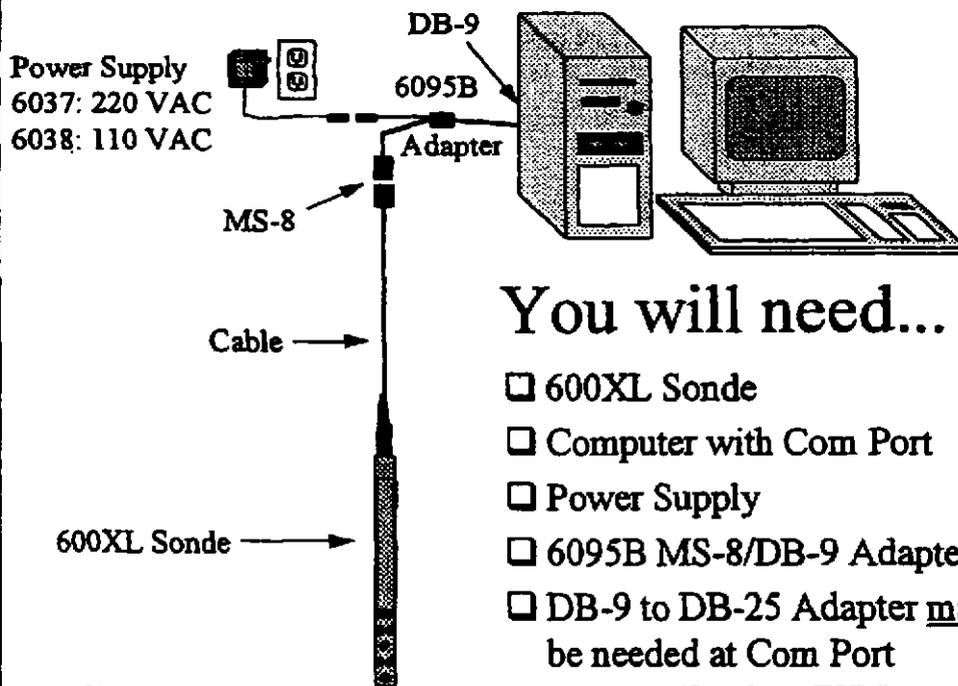
## 600XL Sonde to Data Collection Platform



### You will need...

- 600XL Sonde
- 6096 Adapter with Leads
- Data Collection Platform

## 600XL Sonde to Lab Computer



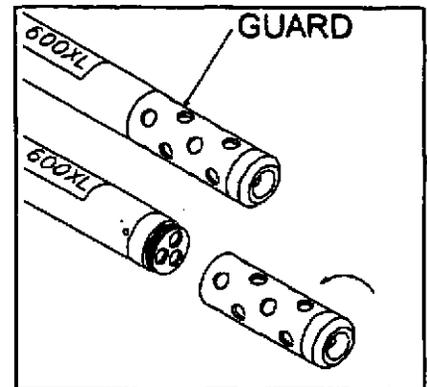
### You will need...

- 600XL Sonde
- Computer with Com Port
- Power Supply
- 6095B MS-8/DB-9 Adapter
- DB-9 to DB-25 Adapter may be needed at Com Port

## 2.3 SONDE SETUP

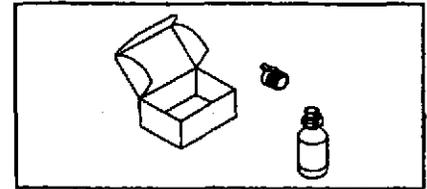
### SENSORS

1. Remove the Model 600XL probe guard by hand.

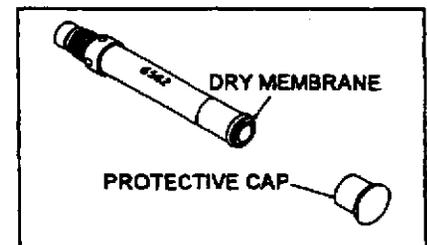


2. **NOTE:** Step 2 is for the preparation of the 6562 dissolved oxygen probe only. To install other probes, proceed to step 3.

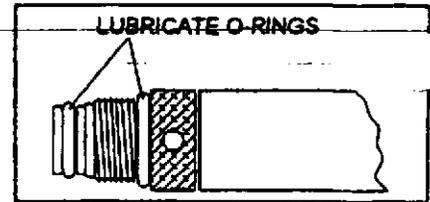
A. Open the membrane kit and prepare electrolyte. Dissolve the KCl in the dropper bottle by filling it to the neck with distilled water and shaking until the solid is fully dissolved. After dissolution is complete, wait 10-15 minutes until the solution is free of bubbles.



B. Remove protective cap and the dry membrane from the 600XL dissolved oxygen probe. **NOTE:** The dissolved oxygen probe is shipped with a protective dry membrane on the sensor tip. It is very important not to scratch or contaminate the sensor tip. Handle the new probe with care. Avoid touching or hitting of the sensor tip.

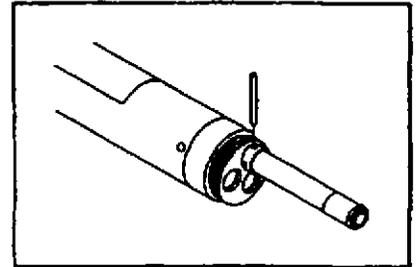


4. Apply a thin coat of O-ring lubricant (supplied in the YSI 6570 maintenance kit) to the O-rings on the connector side of the probe.

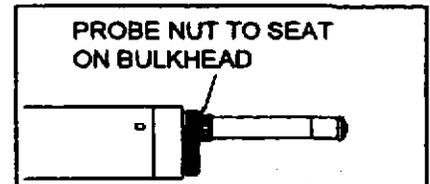


5. NOTE: Before installing probe into sonde, be sure probe port is free of moisture.

Insert the probe into the correct port and gently rotate the probe until the two connectors align.

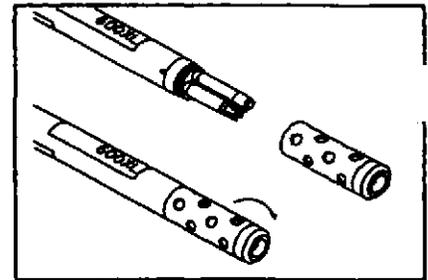


6. With connectors aligned, screw down the probe nut using the probe installation tool. CAUTION: Use care not to cross thread the probe nut. Seat nut on face of bulkhead. Do not over tighten.



7. Repeat steps 3-6 for all remaining probes.

8. Replace the 600XL probe guard.



## CABLES

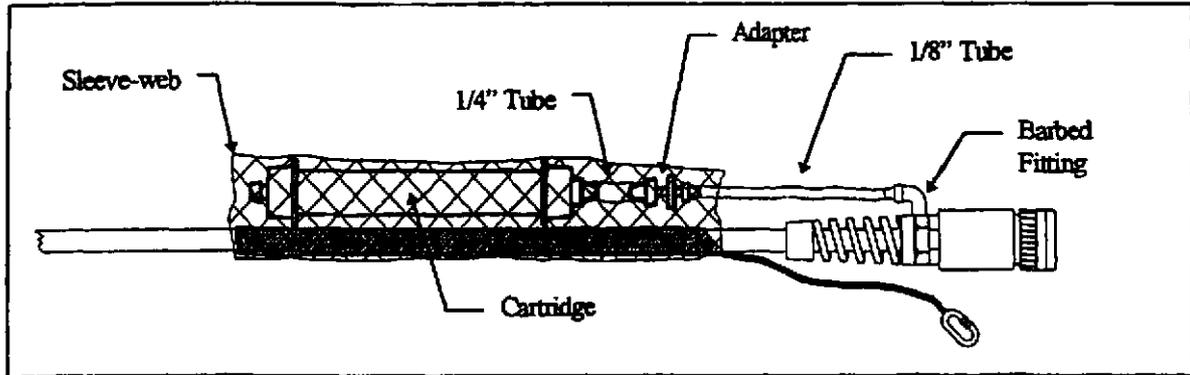
Sondes equipped with level sensors use vented cables. See the next section for details.

Some versions of the Model 600XL have permanently attached cables. If your 600XL has a cable which is non-detachable (no stainless steel connector), parts of this section will not be relevant.

To attach a cable to the 600XL, remove the waterproof cap from the sonde connector and set it aside carefully for later reassembly. Now connect your YSI PC interface cable to the sonde connector. A built-in "key" will ensure proper pin alignment; rotate the cable gently until the "key" engages and then tighten the connectors together by rotating clockwise.

The other end of the cable is a military-style 8-pin connector. This connector plugs directly into the 610 D and 610 DM display/loggers. Most other applications will require the use of an adapter. For example, to connect the 600XL to a computer, use a YSI 6095 MS8 to DB-9 adapter.

## INSTALLING THE CARTRIDGE KIT



1. Place the short length of 1/4" tubing onto the 1/4" side of the 1/8" to 1/4" adapter fitting. Seat firmly.
2. Place the length of 1/8" tubing onto the 1/8" side of the adapter fitting. Seat firmly.
3. Remove one of the plugs from the end of the desiccant cartridge and place the open end of the short length of 1/4" tubing onto the open end of the desiccant cartridge. Seat firmly.
4. Remove the plug from the barbed fitting on the end of the cable and place the open end of the 1/8" tubing onto the cable fitting. Seat firmly.
5. Slide the sleeve-web over the end of the cable and the bail. Work the sleeve-web down the cable and over the cartridge taking care not to unplug the hose that connects the cartridge to the cable.

**Optional:** Using one of the tie-wraps, secure the hose to the cable taking care not to close off the hose.

The vent end of the cartridge should remain plugged until the sonde is ready for use. When putting the sonde into service, remove the plug to ensure that the sensor in the sonde is vented to the atmosphere.

**Example: A: [Enter]**

---

To install PC6000 software execute the following command from the DOS prompt:

**INSTALL <destination>**

where destination is the drive and directory in which you want the PC6000 files to be installed.

For example, the command: **INSTALL C:\PC6000** will install the PC6000 software to the C: drive and \PC6000 directory.

If you are using a two floppy disk drive system, follow the instructions in Section 5.2. After installing the software, remove the disk from the floppy drive and keep the original disk in a safe place.

## **ECOWATCH FOR WINDOWS**

---

If you have purchased EcoWatch for Windows, install the program from the Program Manager menu of your Windows system. Use this software with an IBM-compatible PC with a 386 (or better) processor. The computer should also have at least 4MB of RAM and Windows Version 3.1 or later. First close any Windows applications which are currently running. After inserting the EcoWatch floppy disk in your disk drive, access the File command from the top menu bar of the Program Manager window. Click on Run and type "a:\setup.exe" at the prompt. Press Enter or click on "OK" and the display will indicate that EcoWatch is proceeding with a setup routine. After the setup is complete, you will be prompted to confirm that all applications have been closed and choose the hard drive location where EcoWatch will be installed. After answering these questions, the installation of EcoWatch will take place automatically. Use Help to learn about the program.

# Standard Operating Procedures

---

**B-8c**

**U.S. ENVIRONMENTAL PROTECTION AGENCY  
REGION I  
DRAFT CALIBRATION OF FIELD INSTRUMENTS**

U.S. ENVIRONMENTAL PROTECTION AGENCY  
REGION 1

DRAFT CALIBRATION OF FIELD INSTRUMENTS  
(temperature, pH, dissolved oxygen, conductivity/specific conductance,  
oxidation/reduction potential [ORP], and turbidity)

I. SCOPE & APPLICATION

The purpose of this standard operating procedure (SOP) is to provide a framework for calibrating field instruments used to measure water quality parameters for ground water and surface water. Water quality parameters include temperature, pH, dissolved oxygen, conductivity/specific conductance, oxidation/reduction potential [ORP], and turbidity. This SOP supplements, but does not replace, EPA analytical methods listed in 40 CFR 136 and 40 CFR 141 for temperature, dissolved oxygen, conductivity/specific conductance, pH and turbidity.

This SOP is written for instruments that utilize multiple probes (temperature, pH, dissolved oxygen, conductivity/specific conductance, and oxidation/reduction potential [ORP]) and the probe readings for pH, dissolved oxygen, and specific conductance are automatically corrected for temperature. Communications to the instrument (programming and displaying the measurement values) are performed using a display/logger or a computer. Information sent to the instrument is entered through the keypad on the display/logger or computer. It is desirable that the display/logger or computer have data storage capabilities. If the instrument does not have a keypad, follow the manufacturer's instructions for entering information into the instrument.

For ground water monitoring, the instrument must be equipped with a flow-through-cell, and the display/logger or computer display screen needs to be large enough to simultaneously contain the readouts of each probe in the instrument. Turbidity is measured using a separate instrument because turbidity cannot be measured in a flow-through-cell. This procedure is applicable for use with the EPA Region 1 Low Stress (low flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells.

II. GENERAL

All monitoring instruments must be calibrated before they are used to measure environmental samples. Part of the calibration is performed prior to the field event. For instrument probes that rely on the temperature sensor (pH, dissolved oxygen, conductivity/specific conductance, and

oxidation/reduction potential [ORP]), each temperature sensor needs to be checked for accuracy against a thermometer that is traceable to the National Institute of Standards and Technology (NIST). Before any instrument is calibrated or used to perform environmental measurements, the instrument must stabilize (warm-up) according to manufacturer's instructions.

Most instruments will require at least two standards to bracket the expected measurement range, that is, one standard less than the expected value and one above. Calibration must be performed at the beginning of each sampling day prior to sample collection. To determine if the instruments have remained in calibration during transport to each sampling location, use one of the previously used standards as a check standard at the sampling site. If the check measurement does not agree with the initial calibration or to within the specifications of the instrument, then the instrument must be re-calibrated. When an environmental sample measurement falls outside the calibration range, the instrument must be re-calibrated to bracket the new range before continuing measurements.

This SOP requires that the manufacturer's instruction manual (including the instrument specifications) accompany the instrument into the field.

### III. CALIBRATION PROCEDURES

Prior to calibration, all instrument probes must be cleaned according to the manufacturer's instructions. Failure to perform this step (proper maintenance) can lead to erratic measurements.

Program the multi-probe instrument so that the following parameters to be measured will be displayed: temperature, milligrams per liter dissolved oxygen, mg/l dissolved oxygen, conductivity, specific conductance, and ORP.

The volume of the calibration solutions must be sufficient to cover both the probe and temperature sensor (see manufacturer's instructions for additional information).

When calibrating or measuring, make sure there are no air bubbles lodged between the probe and the calibration guard.

### TEMPERATURE

Most instrument manuals state there is no calibration of the temperature sensor, but the temperature sensor must be checked to determine its accuracy. This accuracy check is performed

at least once per year and the accuracy check date/information is kept with the instrument. If the accuracy check date/information is not included with the instrument or the last check was over a year, the temperature sensor accuracy needs to be checked at the beginning of the sampling event. If the instrument contains multiple temperature sensors, each sensor must be checked.

### Verification Procedure

1. Allow a container filled with water to come to room temperature.
2. Place a thermometer that is traceable to the National Institute of Standards and Technology (NIST), and the instrument's temperature sensor into the water and wait for both temperature readings to stabilize.
3. Compare the two measurements. The instrument's temperature sensor must agree with the reference thermometer measurement within the accuracy of the sensor (usually  $\pm 0.15^{\circ}\text{C}$ ). If the measurements do not agree, the instrument may not be working properly and the manufacturer needs to be consulted.

### pH (electrometric)

The pH of a sample is determined potentiometrically using a glass electrode.

Choose the appropriate buffered standards that will bracket the expected values at the sampling locations. For ground water, the pH will usually be close to seven. Three standards are needed for the calibration: one at seven, one at least two pH units below seven and the other at least two pH units above seven. For those instruments that will not accept three standards, the instrument will need to be re-calibrated if the water sample's pH is outside the initial calibration range described by the two standards.

### Calibration Procedure

1. Allow the buffered standards to equilibrate to the ambient temperature.
2. Fill calibration containers with the buffered standards so each standard will cover the pH probe and temperature sensor.

3. Remove probe from its storage container, rinse with distilled water, blot dry with soft tissue.
4. Select monitoring/run mode. Immerse probe into the initial standard (e.g., pH 7).
5. Stir the standard until the readings stabilize. If the reading does not change within 30 seconds, select calibration mode and then select **Calibrate**. Enter the buffered standard value into instrument. Select monitoring/run mode. The readings should remain within manufacturer's specifications; if they change, re-calibrate. If readings continue to change after re-calibration, consult manufacturer.
6. Remove probe from the initial standard, rinse with distilled water, and blot dry.
7. Immerse probe into the second standard (e.g., pH 4). Repeat step 5.
8. Remove probe from the second standard, rinse with distilled water, and blot dry. If instrument only accepts two standards, the calibration is complete. Go to step 11. Otherwise continue.
9. Immerse probe into the buffered standard (e.g., pH 9) and repeat step 5.
10. Remove probe from the third standard, rinse with distilled water, and blot dry.
11. Select monitoring/run mode, if not already selected. To ensure that the initial calibration standard (e.g., pH 7) has not changed, immerse the probe into the initial standard. Wait for readings to stabilize. The reading should read the initial standard value within the manufacturer's specifications. If not, re-calibrate the instrument. If re-calibration does not help, the calibration range may be too great. Reduce calibration range by using standards that are closer together.
12. The calibration is complete. Place pH probe in its storage container.

## DISSOLVED OXYGEN

Dissolved oxygen (DO) content in water is measured using a membrane electrode. The DO probe's membrane and electrolyte solution should be replaced prior to the sampling period. Failure to perform this step may lead to erratic measurements.

### Calibration Procedure

1. Gently dry the temperature sensor according to manufacturer's instructions.
2. Place a wet sponge or a wet paper towel on the bottom of the DO calibration container.
3. Place the DO probe into the container without the probe coming in contact with the wet sponge or paper towel. The probe must fit tightly into the container to prevent the escape of moisture evaporating from the sponge or towel.
4. Allow the confined air to become saturated with water vapor (equilibration occurs in approximately 10 to 15 minutes). During this time, turn-on the instrument to allow the DO probe to warm-up. Select monitoring/run mode. Check temperature readings. Readings must stabilize before continuing to the next step.
5. Select calibration mode; then select "DO %".
6. Enter the local barometric pressure (usually in mm of mercury) for the sampling location into the instrument. This reading must be determined from an on-site barometer. Do not use barometric pressure obtained from the local weather services unless the pressure is corrected for the elevation of the sampling location. [Note: inches of mercury times 25.4 mm/inch equals mm of mercury or consult Oxygen Solubility at Indicated Pressure chart attached to the SOP for conversion at selected pressures].
7. The instrument should indicate that the calibration is in progress. The instrument will take approximately one minute to calibrate. After calibration, the instrument should display percent saturated DO.
8. Select monitoring/run mode. Compare the DO mg/l reading to the Oxygen Solubility at Indicated Pressure chart attached to the SOP. The numbers should agree. If they do not agree, check the accuracy of the instrument (usually  $\pm 0.2$  mg/L), repeat calibration. If this does not work, change the membrane and electrolyte solution.
9. Remove the probe from the container and place it into a 0.0 mg/L DO standard (see note). The standard must be filled to the top of its container and the DO probe must fit tightly into the standard's container (no head space). Check temperature readings. They must stabilize before continuing.

10. Wait until the "mg/l DO" readings have stabilized. The instrument should read 0.0 mg/L or to the accuracy of the instrument (usually  $\pm 0.2$  mg/L). If the instrument cannot reach these values, it will be necessary to clean the probe, and change the membrane and electrolyte solution. If this does not work, prepare a new 0.0 mg/L DO standard. If these measures do not work, contact manufacturer.

Note: To prepare a zero mg/L DO standard follow the procedure stated in Standard Methods (Method 4500-O G). The method basically requires to add excess sodium sulfite (until no more dissolves) and a trace amount of cobalt chloride to water. The standard container must be completely filled (no head space). This solution is prepared prior to the sampling event. If some of the solution is lost during instrument calibration, add more water to the container so that the standard is filled with no head space.

## SPECIFIC CONDUCTANCE

Conductivity is used to measure the ability of an aqueous solution to carry an electrical current. Specific conductance is the conductivity value corrected to 25°C.

Most instruments are calibrated against a standard which is near, but below the specific conductance of the environmental samples. A second standard which is above the environmental specific conductance is used to check the linearity of the instrument in the range of measurement.

### Calibration Procedure

1. Allow the calibration standard to equilibrate to the ambient temperature.
  2. Remove probe from its storage container, rinse the probe with a small amount of the conductivity/specific conductance standard (discard the rinsate), and place the probe into the conductivity/specific conductance standard.
- Select monitoring/run mode. Wait until the probe temperature has stabilized.

4. Look up the conductivity value at this temperature from the conductivity versus temperature correction table usually found on the standard bottle or the standard instruction sheet. You may need to interpolate the conductivity value between temperatures. Select calibration mode, then conductivity. Enter the temperature corrected conductivity value into the instrument.
5. Select monitoring/run mode. The reading should remain within manufacturer's specifications. If it does not, re-calibrate. If readings continue to change after re-calibration, consult manufacturer.
6. Read the specific conductance on the instrument and compare the value to the specific conductance value on the standard. The instrument value should agree with the standard within the manufacturer's specifications. If not, re-calibrate. If the re-calibration does not correct the problem, the probe may need to be cleaned or serviced by the instrument manufacturer.
7. Remove probe from the standard, rinse the probe with a small amount of the second conductivity/specific conductance standard (discard the rinsate), and place the probe into the second conductivity/specific conductance standard. The second standard will serve to verify the linearity of the instrument. Read the specific conductance value from the instrument and compare the value to the specific conductance on the standard. The two values should agree within the specifications of the instrument. If they do not agree, re-calibrate. If readings do not compare, then the second standard may be outside the linear range of the instrument. Use a standard that is closer, but above the first standard and repeat the verification. If values still do not compare, try cleaning the probe or consult the manufacturer.
8. When monitoring ground water or surface water, use the specific conductance readings.

#### **OXIDATION/REDUCTION POTENTIAL (ORP)**

The oxidation/reduction potential is the electrometric difference measured in a solution between an inert indicator electrode and a suitable reference electrode. The electrometric difference is measured in millivolts and is temperature dependent.

### Calibration or Verification Procedure

1. Allow the calibration standard (a Zobell solution) to equilibrate to ambient temperature.
2. Remove the probe from its storage container, and place it into the standard.
3. Select monitoring/run mode.
4. While stirring the standard, wait for the probe temperature to stabilize, then read the temperature.
5. Look up the millivolt (mv) value at this temperature from the millivolt versus temperature correction table usually found on the standard bottle or on the standard instruction sheet. You may need to interpolate millivolt value between temperatures. Select "calibration mode", then "ORP". Enter the temperature-corrected ORP value into the instrument.
6. Select monitoring/run mode. The readings should remain unchanged within manufacturer's specifications. If they change, re-calibrate. If readings continue to change after re-calibration, contact manufacturer.
7. If the instrument instrument manual states that the instrument is factory calibrated, then verify the factory calibration against the standard. If they do not agree within the specifications of the instrument, the instrument will need to be re-calibrated by the manufacturer.

### **TURBIDITY**

Turbidity method is based upon a comparison of intensity of light scattered by a sample under defined conditions with the intensity of light scattered by a standard reference suspension. A turbidimeter is a nephelometer with a visible light source for illuminating the sample and one or more photo-electric detectors placed ninety degrees to the path of the light source.

Some instruments will only accept one standard. For these instruments, the standards will serve as check points.

### Calibration Procedures

1. Allow the calibration standards to equilibrate at the ambient temperature. The use of commercially available polymer primary standards (AMCO-AEP) is preferred, however, the standards can be prepared using Formazin according to the EPA analytical Method 180.1.
2. If the standard cuvette is not sealed, rinse a cuvette with deionized water. Shake the cuvette to remove as much water as possible. Do not wipe dry the inside of the cuvette because lint from the wipe may remain in the cuvette. Add the standard to the cuvette.
3. Before performing the calibration procedure, make sure the cuvettes are not scratched and the outside surfaces are dry, free from fingerprints, and dust. If the cuvette is scratched or dirty, discard or clean the cuvette respectively.
4. Zero the instrument by using either a zero or 0.0 NTU standard. A zero standard (approximately 0 NTU) can be prepared by passing distilled water through a 0.45 micron pore size membrane filter.
5. Using a standard in the range of 10 to 100 NTUs, calibrate according to manufacturer's instructions or verify calibration if instrument will not accept a second standard. If verifying, the instrument should read standard value to within the specifications of the instrument. If the instrument has range of scales, check each range that will be used during the sampling event with a standard that falls within that range.
6. Using a standard between 20 and 100 NTUs, calibrate according to manufacturer's instructions or verify calibration if instrument does not accept a third standard. If verifying, the instrument should read standard value to within the specifications of the instrument. If the instrument has range of scales, check each range that will be used with the proper standard for that scale.

### IV. DATA MANAGEMENT AND RECORDS MANAGEMENT

All calibration records must be documented in the project's log book. At a minimum, include the instrument manufacturer, model number, instrument identification number, standards used to calibrate the instruments (including source), calibration date, and the instrument readings.

References

Standard Methods for the Examination of Water and Wastewater, 19<sup>th</sup> edition, 1985.

Methods for Chemical Analysis of Water and Wastes, EPA-600/4-91-020, Revised March 1983.

Turbidity - Methods for the Determination of Inorganic Suspensions in Environmental Samples, EPA/600/R-93/100, August 1993.

**DRAFT**

Oxygen Solubility at Indicated Pressure

Temp.	Pressure (Hg)							mm in
	760	755	750	745	740	735	730	
°C	29.92	29.72	29.53	29.33	29.13	28.94	28.74	in
0	14.57	14.47	14.38	14.28	14.18	14.09	13.99	mg/l
1	14.17	14.08	13.98	13.89	13.79	13.70	13.61	
2	13.79	13.70	13.61	13.52	13.42	13.33	13.24	
3	13.43	13.34	13.25	13.16	13.07	12.98	12.90	
4	13.08	12.99	12.91	12.82	12.73	12.65	12.56	
5	12.74	12.66	12.57	12.49	12.40	12.32	12.23	
6	12.42	12.34	12.26	12.17	12.09	12.01	11.93	
7	12.11	12.03	11.95	11.87	11.79	11.71	11.63	
8	11.81	11.73	11.65	11.57	11.50	11.42	11.34	
9	11.53	11.45	11.38	11.30	11.22	11.14	11.07	
10	11.28	11.19	11.11	11.04	10.96	10.89	10.81	
11	10.99	10.92	10.84	10.77	10.70	10.62	10.55	
12	10.74	10.67	10.60	10.53	10.45	10.38	10.30	
13	10.50	10.43	10.36	10.29	10.22	10.15	10.07	
14	10.27	10.20	10.13	10.06	10.00	9.92	9.85	
15	10.05	9.98	9.92	9.85	9.78	9.71	9.65	
16	9.83	9.76	9.70	9.63	9.57	9.50	9.43	
17	9.63	9.57	9.50	9.44	9.37	9.30	9.24	
18	9.43	9.37	9.30	9.24	9.17	9.10	9.05	
19	9.24	9.18	9.12	9.05	8.99	8.92	8.85	
20	9.06	9.00	8.94	8.88	8.82	8.75	8.68	
21	8.88	8.82	8.76	8.70	8.64	8.58	8.51	
22	8.71	8.65	8.59	8.53	8.47	8.42	8.36	
23	8.55	8.49	8.43	8.38	8.32	8.26	8.20	
24	8.39	8.33	8.27	8.22	8.16	8.11	8.05	
25	8.24	8.18	8.12	8.07	8.01	7.96	7.90	
26	8.09	8.03	7.97	7.92	7.86	7.81	7.76	
27	7.95	7.89	7.83	7.77	7.72	7.68	7.62	
28	7.81	7.76	7.70	7.65	7.60	7.54	7.49	
29	7.67	7.63	7.57	7.52	7.47	7.42	7.36	
30	7.53	7.50	7.44	7.39	7.34	7.29	7.24	
31	7.39	7.35	7.32	7.27	7.22	7.16	7.11	
32	7.25	7.20	7.20	7.15	7.10	7.05	7.00	
33	7.08	7.03	7.03	7.03	6.98	6.93	6.88	
34	7.07	7.01	7.01	6.92	6.87	6.82	6.78	
35	6.95	6.89	6.85	6.80	6.76	6.71	6.66	
36	6.84	6.78	6.76	6.70	6.65	6.60	6.55	
37	6.73	6.68	6.64	6.59	6.54	6.49	6.45	
38	6.63	6.58	6.54	6.49	6.44	6.40	6.35	
39	6.52	6.47	6.43	6.38	6.35	6.29	6.24	
40	6.41	6.37	6.33	6.28	6.24	6.19	6.15	
41	6.32	6.27	6.23	6.18	6.14	6.09	6.05	
42	6.22	6.18	6.13	6.09	6.04	6.00	5.95	
43	6.13	6.09	6.04	6.00	5.95	5.91	5.87	
44	6.03	5.99	5.94	5.90	5.86	5.81	5.77	
45	5.94	5.90	5.85	5.81	5.77	5.72	5.68	

(Continued)

Source: Draft EPA Handbook of Methods for Acid Deposition Studies, Field Operations for Surface Water Chemistry, EPA/600/4-89/020, August 1989.

Temp.	Pressure (Hg)								mm in
	725	720	715	710	705	700	695	690	
°C	28.54	28.35	28.15	27.95	27.76	27.56	27.36	27.17	mg/l
0	13.89	13.80	13.70	13.61	13.51	13.41	13.32	13.22	
1	13.51	13.42	13.33	13.23	13.14	13.04	12.95	12.86	
2	13.15	13.06	12.97	12.88	12.79	12.69	12.60	12.51	
3	12.81	12.72	12.63	12.54	12.45	12.36	12.27	12.18	
4	12.47	12.39	12.30	12.21	12.13	12.04	11.95	11.87	
5	12.15	12.06	11.98	11.89	11.81	11.73	11.64	11.56	
6	11.84	11.73	11.68	11.60	11.51	11.43	11.35	11.27	
7	11.55	11.47	11.39	11.31	11.22	11.14	11.06	10.98	
8	11.26	11.18	11.10	11.02	10.95	10.87	10.79	10.71	
9	10.99	10.92	10.84	10.76	10.69	10.61	10.53	10.45	
10	10.74	10.66	10.59	10.51	10.44	10.37	10.29	10.21	
11	10.48	10.40	10.33	10.28	10.18	10.11	10.04	9.96	
12	10.24	10.17	10.10	10.02	9.95	9.88	9.81	9.74	
13	10.01	9.94	9.87	9.80	9.73	9.66	9.59	9.52	
14	9.79	9.72	9.65	9.68	9.51	9.45	9.38	9.31	
15	9.58	9.51	9.44	9.58	9.31	9.24	9.17	9.10	
16	9.37	9.30	9.24	9.17	9.11	9.04	8.97	8.90	
17	9.18	9.11	9.05	8.98	8.92	8.85	8.79	8.72	
18	8.99	8.92	8.86	8.80	8.73	8.67	8.61	8.54	
19	8.81	8.74	8.68	8.62	8.55	8.49	8.43	8.36	
20	8.63	8.57	8.51	8.45	8.39	8.33	8.27	8.21	
21	8.46	8.40	8.34	8.28	8.22	8.16	8.10	8.04	
22	8.30	8.24	8.18	8.12	8.06	8.00	7.94	7.89	
23	8.15	8.09	8.03	7.97	7.91	7.86	7.80	7.74	
24	7.99	7.94	7.88	7.82	7.76	7.71	7.65	7.59	
25	7.85	7.79	7.73	7.68	7.62	7.57	7.51	7.46	
26	7.70	7.65	7.59	7.54	7.48	7.43	7.37	7.32	
27	7.57	7.52	7.46	7.41	7.35	7.30	7.25	7.19	
28	7.44	7.39	7.33	7.28	7.22	7.17	7.12	7.06	
29	7.31	7.26	7.20	7.15	7.10	7.05	7.00	6.94	
30	7.18	7.14	7.08	7.03	6.98	6.93	6.88	6.82	
31	7.05	7.01	6.95	6.90	6.86	6.81	6.76	6.70	
32	6.92	6.88	6.83	6.78	6.70	6.70	6.64	6.59	
33	6.83	6.79	6.73	6.68	6.63	6.58	6.53	6.48	
34	6.73	6.69	6.63	6.58	6.53	6.48	6.43	6.38	
35	6.61	6.57	6.51	6.47	6.42	6.37	6.36	6.27	
36	6.51	6.47	6.41	6.36	6.31	6.27	6.22	6.17	
37	6.40	6.36	6.31	6.26	6.21	6.16	6.12	6.07	
38	6.30	6.26	6.21	6.16	6.12	6.07	6.02	5.98	
39	6.26	6.21	6.11	6.06	6.01	5.97	5.92	5.87	
40	6.18	6.06	6.01	5.96	5.92	5.86	5.83	5.78	
41	6.09	5.96	5.91	5.87	5.82	5.78	5.73	5.69	
42	6.01	5.86	5.82	5.77	5.73	5.69	5.64	5.60	
43	5.82	5.78	5.73	5.69	5.65	5.60	5.56	5.51	
44	5.72	5.68	5.64	5.59	5.55	5.51	5.46	5.42	
45	5.64	5.59	5.55	5.51	5.47	5.42	5.38	5.34	

Source: Draft EPA Handbook of Methods for Acid Deposition Studies, Field Operations for Surface Water Chemistry, EPA/600/4-89/020, August 1989.

# Standard Operating Procedures

---

**B-8d**

**HORIBA INSTRUCTIONS**

# Hanna CE-10

## Specifications

### pH

Principle	Glass electrode
Range	pH0-14
Resolution	Standard : 0.1pH Expanded : 0.01pH
Repeatability	±0.05pH
Temperature compensation	0°-50°C
Readout	LCD
Calibration	1-point auto (Zero) Manual 2-point

### Temperature

Principle	Thermistor
Range	0°-50°C
Resolution	Standard : 1°C Expanded : 0.1°C
Repeatability	±0.3°C
Temperature compensation	—
Readout	LCD
Calibration	—

### DO

Principle	Membrane galvanic cell
Range	0-19.9mg/l
Resolution	Standard : 0.1mg/l Expanded : 0.01mg/l
Repeatability	±0.1mg/l
Temperature compensation	0°-40°C
Readout	LCD
Calibration	1-point auto (Span) Manual 2-point

### Conductivity

Principle 4-electrode  
 Range 0-100mS/cm  
 Resolution Standard: 0-1mS/cm : 0.01mS/cm  
 0-10mS/cm : 0.1mS/cm  
 10-100mS/cm : 1mS/cm  
 Expanded: 0-1mS/cm : 0.01mS/cm  
 0-10mS/cm : 0.1mS/cm  
 10-100mS/cm : 1mS/cm  
 Repeatability  $\pm 1\%$ /F.S. within each measurement range  
 Temperature compensation 0°-50°C  
 Readout LCD  
 Calibration 1-point auto (Span)  
 Manual 2-point

### Turbidity

Principle Scattered/Transmitted light  
 Range 0-800 NTU  
 Resolution Standard : 10 NTU  
 Expanded : 1 NTU  
 Repeatability  $\pm 3\%$ /F.S.  
 Temperature compensation —  
 Readout LCD  
 Calibration 1-point auto (Zero)  
 Manual 2-point

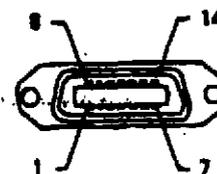
### Salinity

Principle Conversion based on conductivity  
 Range 0-4%  
 Resolution Standard : 0.1%  
 Expanded : 0.01%  
 Repeatability  $\pm 0.1\%$   
 Temperature compensation 0°-30°C  
 Readout LCD  
 Calibration —

### Common specification

Data storage Max. 20 samples  
 Printer output Canonics specs.  
 Power Battery 9V,  
 with auto power-off function  
 Operating temperature 0° - 45°C  
 Weight Main unit: Approx. 400g  
 Probe, with 2-m cable: Approx. 800g

• Output connector pin layout



Pin No.	Name	Pin No.	Name
1	STB	8	DB <sub>8</sub>
2	DB <sub>2</sub>	9	DB <sub>9</sub>
3	DB <sub>3</sub>	10	Not used
4	DB <sub>4</sub>	11	BUSY
5	DB <sub>5</sub>	12	Not used
6	DB <sub>6</sub>	13	Not used
7	DB <sub>7</sub>	14	GND

This equipment is in conformity with the following directive (s) and standard (s):

Directive (s) the EMC Directive 89/336/EEC as amended by 91/263/EEC, 92/31/EEC and 93/68/EEC, in accordance with the Article 10 (1) of the Directive

Standard (s) EN55011:1991 Class B Group 1 and EN50062-1:1992