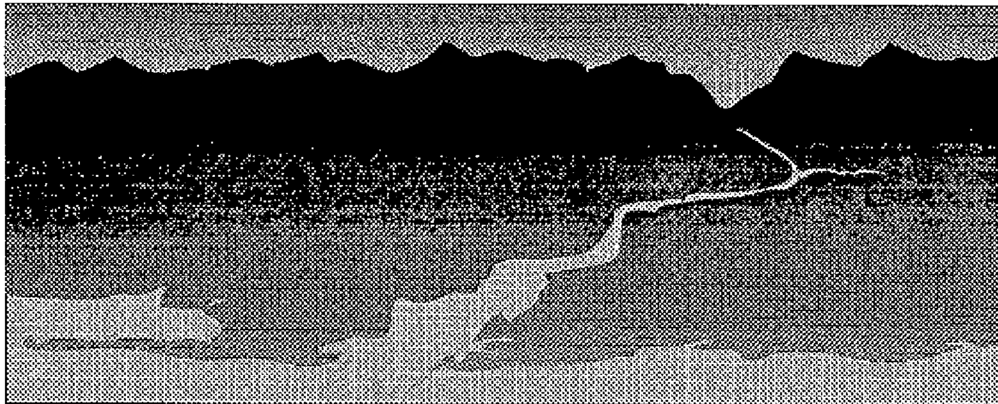
LOWER COLUMBIA RIVER



BI-STATE PROGRAM

RECONNAISSANCE SURVEY OF THE LOWER COLUMBIA RIVER

QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) PLAN

OCTOBER 29, 1991

Prepared By:

TETRA TECH

In Association With:

DAVID EVANS AND ASSOCIATES
EVS CONSULTANTS

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Final Plan

QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) PLAN FOR RECONNAISSANCE SURVEY OF THE LOWER COLUMBIA RIVER

by

Tetra Tech, Inc.

in association with

E.V.S. Consultants
David Evans and Associates

for

The Lower Columbia River Bi-State Program

October 1991

Tetra Tech, Inc.
11820 Northup Way, Suite 100E
Bellevue, WA 98005

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1.0 INTRODUCTION

1.1 PROGRAM AND SURVEY OBJECTIVES

The Bi-State Lower Columbia River Water Quality Program (Bi-State Program) was formed at the direction of the Washington and Oregon State Legislatures. The states entered into an Interstate Agreement that directs a four-year water quality program to characterize water quality in the lower Columbia River, identify water quality problems, determine whether beneficial uses are impaired, and develop solutions to problems found in the river below Bonneville Dam.

These goals will be met by carrying out the following tasks:

- Involve the public through education and public participation.
- Develop work plans that identify the studies needed to characterize the river's water quality.
- Evaluate existing data and conduct reconnaissance surveys.
- Carry out baseline studies.
- Conduct advance studies and recommend long-term monitoring.
- Make recommendations to regulatory agencies.

The Bi-State Program recognizes that the lower Columbia River (the 146 miles below Bonneville Dam) is a small part of a drainage basin which includes parts of seven states and Canada. Therefore, the effects occurring in this portion of the river will be the result of sources both in the study area and upstream, which may be the subject of future study. The Bi-State Program, however, will focus its efforts on identifying problems within the study area.

It is important to define a realistic expectation of what the Bi-State Program can accomplish within its resource and geographic constraints. Priority-setting will be a critical process for the Bi-State Program, and priorities will be defined and reviewed at each major step in the technical studies. The timeline will not permit an analysis of every issue, but those studied will be based on good science. An underlying principle for the Program is to ensure careful and objective study.

This document presents a quality assurance plan for the reconnaissance survey mentioned in the third bulleted item above. The reconnaissance survey has several objectives:

1. Provide a reconnaissance of levels of contaminants in water, sediment, and tissue.

2. Fill data gaps.

3. Tentatively identify problem areas.

4. Make recommendations for baseline studies.

This plan has been modified based on comments on a draft quality assurance plan submitted on August 20, 1991.

1.2 DOCUMENT PURPOSE AND SCOPE

This Quality Assurance/Quality Control (QA/QC) Plan has been developed for the sampling program of the Reconnaissance Survey of the lower Columbia River. This document addresses QA/QC protocols and procedures for both field sampling and laboratory analytical work. The document also includes a Health and Safety Plan for the project, a glossary of terms (Appendix A), standard operating procedures, tissue preparation, and tributyl tin procedures (Appendix B), and Field Equipment Checklist (Appendix C).

This document discusses field protocols for navigation and station positioning, sample collection and handling, equipment decontamination, field documentation, and chain of custody. The laboratory section discusses protocols for sample receipt, handling, tracking and storage, as well as analytical methods and QA procedures for conventional variables, organic and inorganic contaminants.

The field measurement and laboratory protocols prescribed for this project are based primarily on U.S. EPA approved methods. Sediment sampling procedures are based on the Washington Department of Ecology's Marine Sediment Quality Implementation Plan, the Department of Environmental Quality's 1990 Work Plan for the Investigation of Toxins in the Columbia River Basin, and protocols established in the Puget Sound Estuary Program (PSEP 1989). Water sampling procedures will follow those outlined by Thomas (1977). These protocols have been modified as appropriate for the lower Columbia River. Analytical testing of water samples will follow procedures outlined in Methods for Chemical Analysis of Water and Wastes (EPA 1983) Standard Methods for the Examination of Water and Wastewater (APHA 1989), and U.S. EPA Methods 624/625. Analytical testing of sediment and tissue will be done in accordance with EPA SW-846, 3rd edition (1986b) except where noted in Table 5. Any differences between these protocols are identified in this document to provide clear instruction to the laboratories conducting the analyses.

Laboratory analyses will be conducted by five separate laboratories. Each laboratory has been assigned specific parameter sets and is responsible for QA/QC for those parameter sets. Alden Laboratories is responsible for organic analyses. Precision Analytics is responsible for inorganics, radionuclides, and conventional analyses. Keystone/NEA will conduct dioxin and furan analyses. Coffey Laboratories will conduct bacteriological analyses and E.V.S. is responsible for the benthic analyses.

The Health and Safety Plan, which pertains primarily to field work, addresses chemical hazards, physical hazards, safe work practices, functions of the safety officer, emergency planning, and distribution of information and instructions.

2.0 GENERAL QA/QC PROCEDURES

Quality Assurance/Quality Control (QA/QC) procedures are necessary to ensure that the data collected as part of this study achieve an acceptable level of quality and that the level of quality attained is adequately documented. Detailed QA/QC procedures for the variables considered in this study are described in the specific protocols. This section describes the more general QA procedures that will be incorporated into the collection and analysis of all environmental samples.

Project organization and responsibilities are an important part of the QA protocols. Table 1 shows the personnel responsible for QA.

TABLE 1. PERSONNEL RESPONSIBILITIES FOR QUALITY ASSURANCE

Personnel	Responsibilities
Tetra Tech Project Manager Dr. Ted Turk (206) 822-9596	Provide oversight of all program activities. Review work plan, health and safety plan, and QA project plan to ensure objectives for the program are met.
Bi-State Contract Officers Cordelia Shea (503) 229-5664 Neal Aaland (503) 459-6868	Review final project QA objectives, needs, problems, and requests. Approve appropriate QA corrective actions as needed. Provide oversight and expertise for sampling activities.
Tetra Tech **Field Team Leaders** Dr. Steve Ellis Gary Braun (206) 822-9596	Implement necessary action and adjustments to accomplish field survey objectives. Oversee field survey performance and provide technical expertise to accomplish project objectives. Ensure that tasks are successfully completed within the projected time periods. Oversee chain-of-custody procedures.
Tetra Tech **Project QA Coordinator** Mark Matyjas (206) 822-9596	Provide technical QA assistance to accomplish project objectives including suggestions for corrective action implementation. Oversee laboratory performance and adherence to QA/QC plan. Ensure that data quality objectives have been met. Conduct field sampling operations in accordance with approved site work plan. Ensure that all QA protocols (including chain-of-custody documentation, sample collection and labeling, sample storage and shipping, and instrument calibration) are followed as required. Recognize and implement necessary corrective actions. Document field operations.
Tetra Tech **Health and Safety Officer** David Hose (206) 822-9596	Ensure that health and safety guidelines are followed by field team members and any contractors to avoid any compromise of sample integrity or worker health and safety. Document any health and safety issues affecting project implementation or sample collection. Provide technical assistance as required to resolve health and safety issues requiring corrective action.

TABLE 1. (Continued)

Personnel	Responsibilities
Laboratory QA Coordinator (each lab) **Alden Labs** (Organics,AVS, TBT) Bryan Graham (206) 623-3660 **Precision Analytics** (Inorganics, Radionuclides, Conventionals) Mike Pearson (509) 332-0928 **Keystone/NEA** (Dioxins and Furans, Lipids, Fish Prep.) Hank Chambers (503) 624-2773 **Coffey Labs** (Bacteria) Dick Reid (503) 254-1794 **E.V.S.** (Benthos) Mark Munn (206) 328-4188	Establish analytical program QC procedures; oversee preparation of laboratory QA/QC plan. Monitor compliance with laboratory's QA/QC plan and serve as QA/QC point of contact. Perform all required QC sample analyses including analytical duplicates, blanks, matrix spikes, performance evaluation samples, and standard reference materials. Initiate and document required corrective action. Perform preliminary review of data for completeness and transcription or analytical error. Follow good laboratory practices and U.S. EPA guidelines.

3.0 OBJECTIVES FOR MEASUREMENT

3.1 SAMPLING OBJECTIVES

The overall sampling objectives for the reconnaissance survey of the Columbia River are 1) to collect 50 water samples, 60 sediment samples, 76 tissue samples, and 54 benthic samples from 99 sites, and analyze the water, sediment, and tissue for 177 different parameters, including inorganic and organic contaminants, conventionals, and bacteria; then 2) compare the results of the analyses to federal and state criteria for these parameters for freshwater (acute and chronic), saltwater (acute and chronic), drinking water, fish consumption, and sediment. The sampling objectives are achieved through the design and implementation of the sampling program, and by collection of a sufficient number of samples from appropriate locations. The rationale for selection of sampling locations, the number of samples to be collected, and the methods for collecting samples are presented in a separate document, the *Reconnaissance Survey of the Lower Columbia River Sampling Plan.*

3.2 DATA OBJECTIVES

The overall QA objective for measurement data is to ensure that data of known and acceptable quality are provided. To achieve this goal, data must be reviewed for 1) representativeness, 2) comparability, 3) precision, 4) accuracy (or bias), and 5) completeness.

1. **Representativeness:** All measurements will be made to yield consistent results which are representative of the media and conditions measured. Representativeness means the degree to which data accurately and precisely represent a characteristic of a population, natural variation at a sampling point, or an environmental condition. Representativeness is achieved through sampling program design. Goals for representativeness are met by ensuring that sampling locations are selected properly and that a sufficient number of samples are collected. The proposed number and distribution of samples, and the associated representativeness of these samples, are addressed in the *Reconnaissance Survey of the Lower Columbia River Sampling Plan.*

2. **Comparability:** Data will be calculated and reported in units consistent with those of other agencies and organizations (Table 2) to allow comparability of databases. Comparability is a qualitative characteristic expressing the confidence with which one data set can be compared with another. The comparability goal is achieved by using standard techniques to collect and analyze representative samples and reporting analytical results in appropriate units. Only when precision and accuracy are known can data sets be compared with confidence.

3. **Precision:** Precision measures the reproducibility of measurements under a given set of conditions. It is a quantitative measure of the variability of a group of measurements compared to their average value. The precision of laboratory duplicate analyses and matrix spike/matrix spike duplicate (MS/MSD) analyses will be calculated to provide an estimate of laboratory precision. Laboratory precision as determined by duplicate laboratory sample analyses will be summarized in the QA/QC section of the draft report.

4. **Accuracy:** Accuracy is a measure of bias in the measurement system. For this survey, the analytical data will be determined through an assessment of the recovery of surrogate compounds, spike compounds, and check standards. Surrogate compounds will be added to each sample for organic compound analysis and the percent recovery will be reported with sample results. Reanalysis will be required for samples in which surrogate recoveries are outside established control limits. All corrective actions taken for samples requiring reanalysis will be reported with sample results. MS/MSD spike compound recoveries will also be calculated and used for determining accuracy. The results of MS/MSD analyses will be reported with sample results. If spike compound recoveries are outside control limits, then sample reanalysis will be required. Results of check standards will also be used to indicate whether recalibration is necessary during analysis. Any actions taken to bring compound recoveries within control limits will be reported by the laboratory in case narratives supplied with sample results.

5. **Completeness:** Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct normal conditions. Completeness of the data will be calculated by dividing the number of valid measurements obtained by the number of measurements planned. Completeness of the data set obtained for this survey will be reported with sample results in the draft report.

Quality assurance objectives setting requirements for precision, accuracy, and completeness have been established for each measurement variable where possible, and are presented in Table 2.

TABLE 2. OBJECTIVES FOR MEASUREMENT DATA

Variables	Matrix	Units	Maximum Permissible Bias	Required Analytical Precision	Required Completeness	Method[a]
Volatiles	Water	ug/L	± 25%	± 25%	95%	624
AOX	Water	ug/L	[f]	[f]	95%	SM 506/5320[i]
Dioxins/Furans	Sediment	ng/kg[b]	± 50%	± 30%	95%	1613
	Tissue	ng/kg	[f]	[f]	95%	8290/1613[d]
PCBs/Pesticides	Water	ug/L	± 25%	± 25%	95%	608
	Sediment	ug/kg[b]	± 30%	± 30%	95%	8080
	Tissue	ug/kg[b]	± 30%	± 30%	95%	8080[d]
Base/Neutral/Acid	Water	ug/L	± 25%	± 25%	95%	625
Extractables (includes	Sediment	ug/kg[b]	± 35%	± 35%	95%	8270
semivolatiles)	Tissue	ug/kg[b]	± 35%	± 35%	95%	8270[d]
Metals	Water	ug/L	± 20%	± 20%	95%	200 series, 200.7
	Sediment	mg/kg[b]	± 25%	± 25%	95%	6020, 7000 series[c]
	Tissue	mg/kg[b]	± 35%	± 35%	95%	6020, 7000 series[d]
Grain Size	Sediment	%	± 10%	± 10%	95%	43-2
Acid Volatile Sulfides	Sediment	mg/kg[b]	± 20%	± 25%	95%	Ditoro et al. (1989)
Bacteria	Water	#/100ml	[f]	[f]	95%	SM9222D/9230C
TOC	Water	mg/L	± 20%	± 25%	95%	415.1
	Sediment	mg/kg[b]	± 30%	± 30%	95%	9060

TABLE 2. CONTINUED

Variables	Matrix	Units	Maximum Permissible Bias[g]	Required Analytical Precision[g]	Required Completeness	Method[a]
Nitrogen TKN	Water	mg/L	± 25%	± 0.5 mg/L	95%	350.2
NO_3-NO_2	Water	mg/L	± 20%	± 0.5 mg/L	95%	353.2
NH_3	Water	mg/L	± 10%	± 0.005 mg/L	95%	350.1
Phosphorous	Water	mg/L	± 20%	± 0.1 mg/L	95%	365.4
TSS	Water	mg/L	(f)	(f)	95%	160.1
Hardness	Water	mg/L	± 5%	± 10 mg/L (g)	95%	130.2
Total Solids (% moisture)	Sediment	%	(f)	(f)	95%	Gravimetric (subset of metals analyses)
Lipids	Tissue	%	(f)	(f)	95%	Gravimetric (subset of dioxin/furan; pesticides/PCBS, and BNA analyses)
Flouride	Water	mg/L	± 10%	± 0.1 mg/L	95%	340.1
Radionuclides	Sediment	pCi/g	± 10%	(f)	95%	901.1
Field Analyses Dissolved oxygen	Water	mg/L	± 1%	± 0.1 mg/L	95%	360.1
pH	Water	pH units	± 1%	± 0.2 units	95%	150.1
Conductivity	Water	umhos at 25° C	± 5%	± 8 umhos(e)	95%	120.1(h)
Temperature	Water	° C	(f)	(f)	95%	170.1(h)
Turbidity	Water	NTU	(f)	± 5 units	95%	180.1

(a) Methods specified are from the following references: Water (U.S. EPA 1982, 1983; APHA 1989), Sediment and Tissue (U.S. EPA 1980, 1984, 1986b, 1989; Ditoro et al. 1989; American Society of Agronomy 1985).

TABLE 2. CONTINUED

(b) Dry-weight basis.

(c) Extraction/preparation procedures for Tributyl Tin will be modified, as outlined in Appendix B.

(d) Extraction/preparation procedures will be modified slightly for tissue (see Appendix B).

(e) Given for a range of up to 100 umhos/cm. For more specific criteria, refer to method 120.1.

(f) Bias or precision for this method has not been determined.

(g) Given for a range of up to 444 mg/L. For more specific criteria, refer to method 130.2.

(h) Modified for field measurements, shoreline stations only (see Appendix B). In situ measurements taken from vessel will use a CTD.

(i) Modified slightly from methods listed.

4.0 SAMPLING PREPARATION

The chief scientist or a designee will thoroughly review the sample plan (including QA/QC criteria) before each sampling effort. Prior to sampling, the sampling crew should be familiar with:

- Identification of scientific party and the responsibilities of each member
- Statement and prioritization of study objectives
- Description of survey area, including background information and station locations
- Identification of variables to be measured and corresponding required containers and preservatives
- Identification of all sample splits or performance samples to be submitted with the survey samples
- Brief description of sampling methods, including station positioning technique, sampling devices, replication, and any special considerations
- Detailed cruise schedule, including time, date, and location of embarkation and debarkation
- Storage and shipping procedures
- Identification of onshore laboratories to which samples should be shipped periodically during the cruise and at cruise completion
- Survey vessel requirements (e.g., size, laboratory needs, sample storage needs)

- L[illegible]ion and availability of an alternate survey vessel

- All special equipment needed for the survey (e.g., sampling equipment, navigation equipment, communication devices).

Study objectives and their prioritization will be understood by all members of the scientific party. This will ensure that if modifications of the plan become necessary in the field, their impact on the overall goals of the cruise can be evaluated adequately. After the sampling plan has been reviewed, contingency plans will be outlined. These plans should include potential problems and their solutions.

5.0 SAMPLING PROCEDURES

The quality of data collected in an environmental study depends largely on the quality of sampling activities. Field operations must be well conceived and carefully implemented. Detailed procedures and protocols for sample collection, handling, preservation, shipping, and storage must be specified and documented.

5.1 NAVIGATION AND STATION LOCATION

The navigational system that will be used for this study is the Global Positioning System (GPS). GPS is a radio navigation system that calculates and displays position information obtained from orbiting satellites. The GPS system that will be used for this survey is the Magnavox MX 200 GPS Navigator System. Position information is displayed as latitude and longitude, in either degrees and decimal minutes, or degrees, minutes, and seconds format. This system has a horizontal root mean square accuracy of 15 m. The accuracy of the GPS signal is sometimes lessened to about 100 m by Selective Availability, a Department of Defense program that denies full GPS accuracy to non-military users by introducing algorithms that alter satellite radio signals. At the present time, however, Selective Availability is not in place and it is not expected to be applied during this survey. Therefore, the navigation system used for this survey is expected to have an accuracy of approximately 15 m.

The precision of the system is governed by the number of satellite signals received during a given time period. The MX 200 has six channels to receive satellite signals and so can update position information every 1/4 to 1/2 second, while more basic systems update every 2 to 3 seconds. Therefore, the proposed navigation system will have excellent precision.

Although other navigation systems involving shore operations (e.g., laser range-azimuth positioning systems) may offer a higher degree of both accuracy and precision, it is impractical to employ them given the location and number of sampling stations to be included in this study. In addition, highly accurate navigation is not required for this reconnaissance survey. The single samples taken at each station are not intended to provide a thorough documentation of contaminant levels at an accurately located spot, but rather, when combined with other stations, to indicate the overall water quality of the lower river, or reaches of the lower river.

For these purposes, accurate reoccupation of a sampled station is not needed. Therefore, the proposed GPS will provide more than adequate navigational accuracy.

The latitude and longitude of each station will be recorded to the nearest 0.1 second using the GPS system. Navigational information will be augmented by plotting all station locations on USGS 7.5 - minute quadrangle maps, and by photographing and estimating distances to landmarks from sampling locations. Depth of all sampling stations will be measured with a digital readout fathometer.

5.2 SAMPLE COLLECTION AND ANALYSIS

The number of samples and the variables for which the samples will be analyzed are listed in Table 3. This number includes the ten percent duplicate samples required of this project. Lists of materials and equipment that will be used for each phase of the field efforts are included as Appendix C. Table 4 provides a summary of sample containers, preservation procedures, and holding times to be used during field sampling operations. Sample containers will be kept closed and in a cooler until use. Samples will be completely labeled as they are collected. To prevent misidentification, sample collection data, including label information, will be recorded in the field logbook as the samples are collected, and samples will be labeled before the field crew leaves the sampling location. A description of the QC samples to be collected, frequency of QC sample collection, and collection techniques is provided below.

Field duplicate samples will be collected and analyzed to obtain an estimate of the precision for the field sampling handling procedures. Where possible, duplicates will be selected from stations where concentrations of contaminants are expected to be at measurable levels. All field duplicate samples will be submitted blind to the laboratory. Field precision and accuracy by the analysis of duplicates will be calculated and compared to laboratory precision and accuracy for the same samples to provide a determination of overall (field plus laboratory) precision and accuracy.

Sample containers will be put on ice in a cooler (4°C) after sampling, sealing, and labeling. Fish samples will be placed on dry ice at -80° C. Sample information will be recorded in a field logbook and on a sample summary log as samples are collected. Field duplicate samples will be clearly identified on the sample summary log and in the field logbook.

TABLE 3. COLUMBIA RIVER SAMPLING PLAN
CHEMICALS OF CONCERN

Compound	Number of Samples Water	Sediments	Tissues
METALS			
Aluminum	50	60	
Antimony[a]	50	60	76
Arsenic[a,b]	50	60	76
Barium	50	60	76
Beryllium[a]	50	60	
Cadmium[a,b]	50	60	76
Chromium[a]	50	60	
Copper[a,b]	50	60	76
Iron	50	60	
Lead[a,b]	50	60	76
Mercury[a,b,d]	50	60	76
Nickel[a]	50	60	76
Selenium[a,d]	50	60	76
Silver[a]	50	60	76
Thallium[a]	50	60	
Zinc[a,d]	50	60	76
Cyanide[a]	50	60	
Tributyl Tin		10	
VOLATILES			
Chloromethane	5		
Vinyl chloride[a]	5		
Methylene chloride[a]	5		
1,1-Dichloroethane[a]	5		
Chloroform[a]	5		
1,1,1-Trichloroethane[a]	5		
Bromodichloromethane	5		
trans-1,3-Dichloropropene	5		
Dibromochloromethane[a]	5		
Benzene[a]	5		
Bromoform[a]	5		
Tetrachloroethylene[a]	5		
Chlorobenzene[a]	5		
Total xylenes	5		
Bromomethane	5		
Chloroethane[a]	5		
1,1-Dichloroethylene	5		
trans-1,2-Dichloroethylene[a]	5		
1,2-Dichloroethane[a]	5		
Carbon tetrachloride[a]	5		
1,2-Dichloropropane[a]	5		
Trichloroethylene[a]	5		
1,1,2-Trichloroethane[a]	5		
cis-1,3-Dichloropropene	5		
1,1,2,2-Tetrachloroethane[a]	5		
Toluene[a]	5		
Ethylbenzene[a]	5		
Methyl chloride[a]	5		
Methyl bromide[a]	5		
2-Chloroethylvinyl ether[a]	5		

TABLE 3. (Continued)

Compound	Water	Number of Samples Sediments	Tissues
1,2-Dichloropropylene[a]	5		
Acrolein[a]	5		
Acrylonitrile[a]	5		
ADSORBABLE ORGANIC HALIDES (AOX)	20		
ACID EXTRACTABLE ORGANICS			
Phenolic Compounds			
Phenol[a]	5	60	76
2-Methylphenol	5	60	
4-Methylphenol	5	60	
2,4-Dimethylphenol[a]	5	60	
Pentachlorophenol[a]	5	60	76
2-Methoxyphenol	5	60	
2-Chlorophenol[a]	5	60	76
2,4-Dichlorophenol[a]	5	60	76
2,4-Dinitrophenol[a]	5	60	76
2-Nitrophenol[a]	5	60	76
4-Nitrophenol[a]	5	60	
2,4,6-Trichlorophenol[a]	5	60	76
BASE/NEUTRALS (SEMIVOLATILES)			
Halogenated Ethers (Other than those listed elsewhere)			
bis(2-chloroethyl)ether[a]	5	60	76
bis(2-chloroethyoxy)methane[a]	5	60	76
bis(2-chloroisopropyl)ether[a]	5	60	76
4-Bromophenylphenylether[a]	5	60	76
4-Chlorophenylphenylether[a]	5	60	76
Nitroaromatics			
2,4-Dinitrotoluene[a]	5	60	76
2,6-Dinitrotoluene[a]	5	60	76
Nitrobenzene[a]	5	60	76
Nitrosamines			
N-nitroso-di-n-propylamine[a,e]	5	60	76
N-nitrosodimethylamine[a]	5	60	76
N-nitrosodiphenylamine[a]	5	60	76
Chlorinated Naphthalene			
2-Chloronaphthalene[a]	5	60	76

TABLE 3. (Continued)

Compound	Number of Samples Water	Sediments	Tissues
Polynuclear Aromatics			
Acenaphthene[a]	5	60	76
Acenaphthylene[a]	5	60	76
Anthracene[a]	5	60	76
Benzo(a)anthracene[a]	5	60	76
Benzofluoranthenes[a]	5	60	76
Benzo(a)pyrene[a]	5	60	76
Benzo(g,h,i)perylene[a]	5	60	76
Chrysene[a]	5	60	76
Dibenzo(a,h)anthracene[a]	5	60	76
Fluoranthene[a]	5	60	76
Fluorene[a]	5	60	76
Indeno(1,2,3-cd)pyrene[a]	5	60	76
Naphthalene[a]	5	60	76
Phenanthrene[a]	5	60	76
Pyrene[a]	5	60	76
Chlorinated Benzenes			
1,3-Dichlorobenzene[a]	5	60	76
1,2-Dichlorobenzene[a]	5	60	76
1,4-Dichlorobenzene[a]	5	60	76
1,2,4-Trichlorobenzene[a]	5	60	76
Hexachlorobenzene[a]	5	60	76
Hexachlorobutadiene[a]	5	60	76
Hexachloroethane[a]	5	60	76
Hexachlorocyclopentadiene[a]	5	60	76
Benzidines			
3,3'-Dichlorobenzidine[a,e]	5	60	76
Benzidine[a]	5	60	76
Phthalate Esters			
Dimethylphthalte[a]	5	60	76
Diethylphthalate[a]	5	60	76
Di-n-butylphthalate[a]	5	60	76
Butylbenzylphthalate[a]	5	60	76
bis-2-(ethylhexyl)phthalate[a,e]	5	60	76
Di-n-octylphthalate[a]	5	60	76
PESTICIDES/PCBs			
Pesticides			
o,p'-DDE	5	60	76
o,p'-DDD	5	60	76
o,p'-DDT	5	60	76
4,4'-DDT[a,b,c,e]	5	60	76
4,4'-DDE[a,b,c,d,e]	5	60	76
4,4'-DDD[a,b,c,e]	5	60	76
Heptachlor[a,b,c,d,e]	5	60	76

TABLE 3. (Continued)

Compound	Number of Samples Water	Sediments	Tissues
Pesticides (Cont.)			
Heptachlor epoxide[a,b,c,d,e]	5	60	76
alpha-chlordane[a,b,c,d,e]	5	60	76
Aldrin[a,b,e]	5	60	76
Dieldrin[a,b,c,d,e]	5	60	76
Nonachlor	5	60	76
Mirex (dechlorane)	5	60	76
Dacthal	5	60	76
Dicofal	5	60	76
Methyl parathion	5	60	76
Parathion	5	60	76
Malathion	5	60	76
Toxaphene[a,b,e]	5	60	76
Isophorone[a]	5	60	76
Endosulfan I[a]	5	60	76
Endosulfan II[a]	5	60	76
Endosulfan sulfate[a]	5	60	76
Endrin[a,b,c,d]	5	60	76
Endrin aldehyde[a]	5	60	76
Methoxychlor	5	60	76
alpha-BHC[a,b,c,d,e]	5	60	76
beta-BHC[a,e]	5	60	76
delta-BHC[a]	5	60	76
gamma-BHC (Lindane)[a,b,c,d,e]	5	60	76
PCBs			
Arochlor 1016[a,c,e]	5	60	76
Arochlor 1221[a,c,e]	5	60	76
Arochlor 1232[a,c,e]	5	60	76
Arochlor 1242[a,c,e]	5	60	76
Arochlor 1248[a,c,e]	5	60	76
Arochlor 1254[a,c,e]	5	60	76
Arochlor 1260[a,c,e]	5	60	76
DIOXINS AND FURANS[f]			
2,3,7,8-TCDD[a,c,d,e]		20	44
1,2,3,7,8-PeCDD[c,d]		20	44
1,2,3,4,7,8-HxCDD[d]		20	44
1,2,3,6,7,8-HxCDD[c,d]		20	44
1,2,3,7,8,9-HxCDD[d]		20	44
1,2,3,4,6,7,8-HpCDD[c,d]		20	44
Octachlorodibenzo-p-dioxin[c,d]		20	44
2,3,7,8-TCDF[c,d]		20	44
1,2,3,7,8-PeCDF[c,d]		20	44
2,3,4,7,8-PeCDF[d]		20	44
1,2,3,4,7,8-HxCDF[d]		20	44
1,2,3,7,8,9-HxCDF[d]		20	44
1,2,3,6,7,8-HxCDF[d]		20	44

TABLE 3. (Continued)

Compound	Water	Number of Samples Sediments	Tissues
2,3,4,6,7,8-HpCDF[d]		20	44
1,2,3,4,7,8,9-HpCDF[d]		20	44
Octachlorodibenzofuran[d]		20	44
RADIONUCLIDES			
Americium-241		6	
Cesium 137		6	
Cobalt-60		6	
Europium-152		6	
Europium-154		6	
Plutonium-238, 239, 240		6	
CONVENTIONALS[g]			
Nitrogen (TKN, NO_3, NO_2, NH_4)	50	—	—
Phosphorus	50	—	—
Total suspended solids	50	—	—
Hardness	50	—	—
TOC	5	60	—
Grain size	—	60	—
Acid volatile sulfides	—	60	—
Total solids	—	60	—
Lipids	—	—	76
BACTERIA			
Fecal coliform	30	—	—
Enterococcus	30	—	—

[a] Priority pollutant.

[b] Target compounds of bioconcentration study by Schmitt and Brumbaugh (1990), and Schmitt et al. (1990).

[c] Currently monitored by Oregon Department of Environmental Quality.

[d] Bioconcentrating compounds monitored in the National Bioaccumulation Study (U.S. EPA 1991b).

[e] Chemicals of highest concern listed by U.S. EPA (1991a).

[f] All dioxin and furan isomers identified by Method 1613 will be reported.

[g] The following measurements will be taken at each station in the field: pH, DO, conductivity, temperature, and turbidity.

TABLE 4. CONTAINERS, COLLECTION VOLUMES, PRESERVATION, AND HOLDING TIMES

Parameter	Matrix	Container	Size	Number Required	Preservation	Holding Time
Metals	Water	Polypropylene	500 ml	55[a]	HNO_3 to pH < 2	6 months (Hg-28 days)
	Sediment	Glass, teflon lined lids	8 oz.	66[a]	Cool, 4° C	6 months (Hg-28 days)
	Tissue[b]	Polypropylene	8 oz.	76	Frozen, -20° C	6 months
Cyanide	Water	Polypropylene	1L	55[a]	NaOH to pH > 12	14 days
	Sediment	Glass, Teflon lined lid	[e]	[e]	Cool, 4° C	14 days to extraction
	Tissue[b]	Polypropylene	[e]	[e]	Frozen, -20° C	60 days
TBT	Sediment	Glass, teflon lined lid	8 oz.	12[a]	Cool, 4° C	10 days
Volatiles	Water	Glass, teflon lined septum	40 ml	7 sets[a] of 2	Cool, 4° C [c]	14 days
AOX	Water	Amber glass, teflon lined lid	250 ml	22[a]	Cool, 4° C[c]	28 days
BNAs (Includes Semivolatiles)	Water	Glass, teflon lined lid	1L	7 sets[a] of 2	Cool, 4° C	7 days to extraction, 40 days to analysis
	Sediment	Glass, teflon lined lid	8 oz.	66[a]	Cool, 4° C	14 days to extraction, 40 days to analysis
	Tissue[b]	Glass, teflon lined lid	8 oz.	76	Frozen, -20° C [b]	60 days
Pesticides / PCBs	Water	Glass, teflon lined lid	1L	7 sets[a] of 2	Cool, 4° C	7 days to extraction, 40 days to analysis
	Sediment	Glass, teflon lined lid	[d]	[d]	Cool, 4° C	14 days to extraction, 40 days to analysis
	Tissue[b]	Glass, teflon lined lid	[d]	[d]	Frozen, -20° C [b]	60 days

TABLE 4. CONTINUED

Parameter	Matrix	Container	Size	Number Required	Preservation	Holding Time
Dioxins and Furans	Sediment	Glass, teflon lined lid	16 oz.	22[a]	Cool, 4° C	14 days to extraction, 40 days to analysis
	Tissue	Aluminum foil wrap, Plastic zip-lock bags	Variable	48[a]	Frozen, -80° C	60 days
Radionuclides	Sediment	Poly wide-mouth	8 oz.	6	Cool, 4° C	6 months
N,P, Hardness	Water	Polypropylene	1L	55[a]	Cool, 4° C H_2SO_4 to pH < 2	N, P - 28 days Hardness - 6 months
Flouride, TSS	Water	Polypropylene	1L	55[a]	Cool, 4° C	28 days
TOC	Water	Amber glass	250 ml	7[a]	Cool, 4 C°, store in dark, HCL or H_2SO_4 to pH < 2	28 days
	Sediment	Glass	4 oz.	66[a]	Cool, 4° C	28 days
Grain Size	Sediment	Glass	8 oz.	66[a]	Cool, 4° C	28 days
Acid Volatile Sulfides	Sediment	Polypropylene	4 oz.	66[a]	Cool, 4° C	14 days
Bacteria	Water	Glass, sterilized and sealed	125 ml	33[a]	Cool, 4° C	24 hours

[a] Includes required sample numbers per Table 3 plus additional containers (10-15% extra).

[b] Will be shipped as previously ground tissue.

[c] Container should be completely filled to eliminate headspace.

[d] The same containers can be used for both the BNA and Pesticide/PCB analyses - see BNA category.

[e] The same containers will be used for the metals and cyanide analyses - see metals category.

NOTE: Lipids analyses will be performed during the dioxin/furan procedure. Total solids analyses will be performed during the metals analyses.

5.3 CHANGES IN PROCEDURE

Any changes in the sampling procedures will be documented in the field logbook. Modifications of the sampling design or procedures must be approved by the Tetra Tech Project Manager prior to implementation of the change.

5.4 SEDIMENT SAMPLE COLLECTION

Sediment sampling will follow the protocols developed for EPA for the Puget Sound Estuary Program (PSEP 1989) and the Oregon Department of Environmental Quality's *1990 Work Plan for the Investigation of Toxins in the Columbia River Basin* (DEQ 1990). Samples will be collected in a consistent, repeatable manner with a stainless steel modified 0.1 m^2 van Veen grab sampler. This sampler will operate well in soft sediments and, in sand, is heavy enough to operate in channels with strong flows, and will collect sufficient sample volume. The sampling device will be attached to the hydraulic winch cable with a ball bearing swivel to prevent twisting movements on the sampler during deployment. The device will be raised and lowered through the water column by the vessel's hydraulic winch at a rate no greater than 20 meters per minute. This will ensure that the sampler does not flip over on descent and will prevent disturbance of the sediment surface on retrieval. Once the sampler is brought on board, it will be placed on the sieving stand. Access doors on the top of the sampler will allow visual characterization of the sediment surface in order to assess sample acceptability. For a sample to be acceptable, certain criteria must be met:

- Sediment is not to extrude from the upper surface of the sampler.
- Overlying water is present and not excessively turbid (indicates minimal leakage and sample disturbance).
- The sediment surface must be relatively flat.
- For biological and chemical replicates the difference in penetration depth between replicates within a station should be no more than 10 percent. If the criteria are not met, sampling will continue until they are met. The following are minimum penetration depths:

Medium-coarse sand	4-5 cm
Fine sand	6-7 cm
Silt/clay	10 cm

A detailed discussion of acceptability criteria is presented in PSEP (1989).

Prior to further characterization, the overlying water in the sampler will be slowly siphoned off. Notes will be made as to the sample depth, sediment color, texture, odor, and other distinguishing characteristics such as oil sheen, wood debris, etc., of the sample.

After the sample is described and the redox potential discontinuity depth is measured, surface sediments will be removed from the grab to a depth of 2 centimeters using a stainless steel cookie cutter. The cookie cutter, an inverted stainless steel pan, will be placed on the sediment surface, gently pushed into the sediment, and a stainless steel spatula will be slid underneath the device. Only portions of the sample away from the edges of the grab will be collected.

Sediment from three grab samples will be composited and homogenized prior to being placed in containers for analysis. The sediment will be placed in a pre-cleaned (methanol rinse, distilled water rinse) stainless-steel bowl and carefully homogenized until uniform color and consistency are achieved. The interstitial water salinity will be measured on the homogenized composite using a refractometer. The homogenized sample will then be divided into quarters, and material from alternating quarters will be placed in the sample collection containers. Sample containers for organics and metals analysis will be prepared by the laboratories using standard U.S. EPA procedures (U.S. EPA 1980, 1982, 1983, 1984, 1986). All sediment handling devices will be rinsed with methanol, distilled water, and river water prior to use at each station.

Since an undisturbed sediment surface is necessary for chemical sampling, more detailed physical characterization of the sediment in the grab sample will be delayed until after the chemical samples have been taken. After the sediment sample has been removed, the sediment remaining in the sampler will be examined again to refine the description of the sediment characteristics, particularly through the remaining depth of the sample. Prior to, and following the collection of a set of field samples at a sampling station, sampling equipment will be decontaminated. Decontamination for the sediment samplers will consist of a methanol rinse, distilled water rinse, and river water rinse (DEQ 1990). Following the rinse, one sample will be collected, then discarded, before collecting the sample to be retained for analysis. The decontamination (DCON) column on the sample summary log will be checked to document equipment decontamination. Cross-contamination of samples will be prevented by decontaminating sampling equipment before collecting samples at each location and by keeping all sample containers closed except the one being filled.

Samples will be collected in 8-oz or 4-oz glass containers as per Table 4 to ensure that enough sediment is provided for analysis and reanalysis. All sample containers will be labeled on the outside with indelible ink with the laboratory ID number, date collected, and analysis to be performed. Sediment samples for grain size, organics, metals, and conventional analyses will be stored on ice until returned to the laboratory for analysis. The sample collection checklist will be completed immediately following sample collection. The chain-of-custody log will be completed just prior to offloading the samples from the boat for shipping to the laboratories.

5.5 TISSUE SAMPLE COLLECTION

5.5.1 Carp and Peamouth Chub

Carp and peamouth chub will be collected from 18 depositional areas (see Sampling Plan, Tetra Tech 1991) by gill netting. At each site, five individuals of each species will be collected. The sex of the fish will be recorded, scales will be removed for determination of age, and length (standard length) and weight measurements will be recorded.

The five fish collected for each species at each site will be wrapped in aluminum foil (dull side against fish), placed in a single large plastic bag, placed on dry ice, frozen, and transported to the laboratory. Each collection of five whole fish will be composited into a single large sample in the laboratory for chemical analysis. Two field duplicates will also be submitted for each fish species. (Total will be 20 composite samples for each species.)

5.5.2 Crayfish

Eighteen crayfish samples will be collected from depositional areas using baited traps. A single composite sample will be collected from each site. A composite sample will consist of 10 to 20 individuals. The individual weights, total weight of the sample, and number of individuals in the sample will be documented. Crayfish will be wrapped in aluminum foil, placed on dry ice, frozen, and shipped to the analytical laboratory. Whole-body analyses of contaminants of concern and dioxins and furans will be measured on 12 of the 18 samples. A minimum 25 g (wet weight) of tissue are needed for dioxin and furan analysis. For the remaining six samples, dioxins and furans will not be measured and only tissue levels of contaminants of concern will be measured. Approximately 60 g (wet weight) will be needed for the metals analyses, and 60 g (wet weight) for the organic analysis. As part of the QA/QC procedures for crayfish sampling, duplicate measurements of contaminants will be made for two of the 18 samples (i.e., 10 percent duplication).

5.5.3 White Sturgeon

Sturgeon will also be collected from commercial gillnet fishermen during the survey (see Sampling Plan, Tetra Tech 1991) and will be processed and analyzed for contaminants of concern. Eight of the sixteen fish obtained (four each from four river segments), will be analyzed for dioxins and furans, as well as other contaminants of concern. The remaining eight fish will not be analyzed for dioxins and furans, but will be analyzed for semivolatiles, PCBs/pesticides, and metals.

Each fish will be measured (standard length) and weighed, and an age determination will be made using the pectoral spines. Steaks from each of these fish will be wrapped in acid washed aluminum foil, and placed in plastic bags. The bags will then be placed on dry ice, and shipped immediately to the laboratory.

5.5.4 Tissue Preparation and Storage Procedures

The preparation of the fish for chemical analysis will be dependent on the species. Carp and peamouth chub will be ground whole, and sturgeon will be cut into steakes of edible tissue. Tissue for analysis will be taken only from the inner portion of the steaks. Fish tissue will be ground frozen at the lab in a stainless steel industrial blender. Each sample will be processed three times to homogenize it thoroughly. For whole crayfish samples, the entire organism will be ground including the organs and carapace. The ground tissue will be stored at -20° C in glass jars with teflon lined plastic lids.

5.6 BENTHOS SAMPLE COLLECTION

Subsamples from each of three benthic grab samples will be collected at each of the stations (see Sampling Plan, Tetra Tech 1991). Benthic samples will be collected using a modified van Veen (0.06 m^2) grab sampler. The grab will be attached to a hydraulic winch cable with a swivel to prevent twisting movements during sample deployment and to ensure proper contact with the bottom. The sample will be evaluated for acceptance based upon the degree of disturbance, penetration depth, and amount of leakage from the grab. Samples with minimal disturbance of surface sediments and adequate penetration depth will be accepted. Minimum penetration depths required for sample acceptance vary by sediment type as follows:

- 4 cm for medium to coarse sand
- 6 cm for fine sand
- 10 cm for silt and clay.

Samples will also be rejected if the grab is overfilled or there is leakage (water or sediments) from the grab.

Upon acceptance, the overlying water in the grab will be removed using a siphon and the sediments will be characterized with respect to color, odor, type, and the presence of non-sediment material (e.g., shell, wood debris). After these observations are recorded, two core samples will be taken from each grab to form a single replicate sample. The sample will be washed into a 0.5-mm mesh sieve and gently rinsed with water to remove fine materials. Once the sieving is complete, the remaining material will be rinsed into thick plastic bags for preservation. This process will be repeated for three grab samples at each station.

The samples will be preserved with a 10 percent formaldehyde solution buffered with sodium borate. Samples containing large volumes of fine grained sand or wood fragments will require a higher concentration of formaldehyde. Caution will be exercised when handling formaldehyde mixtures because it is toxic and carcinogenic. The sample bags or jars will be labeled using indelible ink on water resistant paper. Both internal and external labels will be used. The sample containers will be inventoried, sealed, and placed in labeled buckets or boxes, for return to the laboratory. The sample will be entered on a chain-of-custody form.

Standard techniques will be used for sorting organisms from the sediments. Each sample will be sorted in its entirety by a single individual to facilitate quality assurance and control checks. Small fractions of a sample will be placed in a petri dish under a 6-10 power magnification dissecting microscope. The petri dish will be scanned systematically and all animals and fragments will be removed using forceps. Each petri dish will be sorted twice to ensure removal of all animals.

All organisms will be counted and identified to the lowest practical taxonomic level, generally genus or species; some groups, like the Oligochaeta will only be identified as Oligochaeta due to the complexity of the group. If animal fragments are present, only anterior portions will be counted. Identifications will be performed by regional taxonomic experts. Taxonomists will maintain a notebook with all data and information about a sample or a specimen. Taxa will be compared against specimens in the E.V.S. permanent reference collections for confirmation and

consistency of identifications. A voucher collection representing all taxa collected during the baseline survey will be prepared and archived by major taxonomic groups.

QA/QC procedures for both sorting and taxonomy will be rigorously followed. A minimum of twenty percent of each processed sample will be resorted to check sorting efficiency and accuracy. Sorting QA/QC will be done using 25 power magnification by someone other than the original sorter. A sample will pass if the number of organisms found during the QA/QC check does not represent more than a 5 percent difference of the total number of organisms found in the entire sample. If the number of organisms found is greater than 5 percent of the total number, the entire sample will be resorted. In addition, all other sorting work performed by the sorter responsible for the error will be checked.

5.7 WATER SAMPLE COLLECTION

Water samples will be collected as grab samples using 2.5 L Niskin bottles. Grab samples will be collected at five depths: 1 meter below the surface, 1 meter above the bottom, at mid-depth, and midway between mid-depth and the surface and bottom. For samples at major and minor river segment boundaries (11 samples), samples will be collected at three locations along a transect across the river. These three locations will be at the center of the channel and at points halfway between the center and each bank. Water collected for each water column station will be composited and thoroughly mixed prior to filling the sample containers.

Between samples, the sampling bottles and carbuoy will be rinsed thoroughly with distilled water. In addition, lowering the open bottles at each sampling location will result in additional removal of any possible residue from previous samples. The Niskin bottles are made of PVC with silicone rubber seals. The hinges are not lubricated. These materials have a very low potential for leaching any chemicals targeted by this survey into the collected water.

Samples analyzed for volatile organics should fill the volatile vials so no air bubbles are present. No preservation is necessary for organics (with the exception of total organic carbon (TOC), which should be acidified to pH <2), besides cool temperature (4° C). Bottles containing preserved samples should be refrigerated at 4° C to minimize decomposition of the solids prior to filtration. Samples to be analyzed for base/neutral/acid extractables (BNA) and pesticides/PCBs will be hand carried or sent overnight via Federal Express to the analytical

laboratories handling these procedures to ensure that all samples will arrive no later than 96 hours after sampling. The analyses for these chemicals have a 7-days-to-extraction requirement (Table 4).

Conventionals will not require special preservatives, with the exception of samples to be analyzed for nitrogen, phosphorous, and hardness, which must be acidified to pH <2 with H_2SO_4.

Bacteriological samples, which have a 24-hour holding time, will be hand-delivered immediately following sampling. Samples will be taken below the surface in less than 2 m of water.

On the ship, a CTD will be deployed with the sampler to measure conductivity, temperature, and depth. Dissolved oxygen will be measured with portable field equipment down to 15 in depth. [NOTE: For bacteriological sampling stations, dissolved oxygen (DO), temperature, and conductivity will be measured with portable field equipment (see Appendix B)].

A portable turbidimeter will be used to measure turbidity at each site, using a modified version of the EPA approved procedure specified in Table 5. The pH at each site will also be measured in the field using a YSI pH meter (see Table 5). Procedures for these measurements are outlined in Appendix B.

6.0 SAMPLE CUSTODY

Sample custody is a vital aspect of field investigation programs to document the proper handling and integrity of the sample. All samples must be traceable from the time of sample collection until such time as the data are used for comparative purposes or for policy decision.

The labeling scheme for the survey will be composed of two parts, the station numbers and the sample numbers. Station numbers will consist of the following designations:

- The first set of characters will designate the type of station:
  - D for Depositional area
  - E for Non-Depositional area
  - W for Water column
- The final set of characters will be numerals designating the number of the stations as described in the sampling plan (Tetra Tech 1991).

Sample numbers will consist of the following designations:

- The first set of characters will designate the media sampled:
  - S for Sediment
  - W for Water
  - C for Carp
  - P for Peamouth Chub
  - St for Sturgeon
  - CF for Crayfish
  - B for Benthos
- The final set of characters will be numerals designating the order of sample collection (e.g., 01).

Duplicate samples will be collected as a check on sampling and analysis procedures. Therefore, they will be submitted "blind" to the laboratory. Duplicate sample labels will be filled out using dummy field sample numbers and locations. The dummy locations and sample numbers for the duplicate sample will be cross-referenced and duly noted in the field logbook and sample summary form. The dummy sample numbers will not give any hint that the samples are duplicates, and the sample label will appear as it would on a normal environmental sample.

6.1 CHAIN-OF-CUSTODY PROCEDURES

Samples obtained during the course of this effort will be strictly controlled by chain-of-custody procedures from point of origin to the analytical laboratory. Regardless of sampling method, the samples must conform to the chain-of-custody procedures established in this section. The history of each sample and its handling will be documented from its collection through all transfers of custody until it is transferred to the analytical laboratory. Internal laboratory records will document custody of the sample from the time it is received through its final disposition.

A sample is considered to be in someone's custody if any of the following rules are met:

- It is in actual physical possession of the custodian.
- It is in the custodian's view, after being in the custodian's physical possession.
- It is in the physical possession of the custodian's, and then locked or otherwise sealed so that tampering will be evident.
- It is kept in a secure area, restricted to authorized personnel only.

6.2 FIELD CUSTODY PROCEDURES

The key aspect of documenting sample custody is thorough record keeping. A field logbook will be maintained to document the collection of every sample. A Summary Sampling Log (Figure 1) will be completed as samples are collected.

SUMMARY SAMPLING LOG

CLIENT ____________________
SITE ____________________
LOCATION ____________________
REFERENCE ____________________

SURVEY: ____________________

SAMPLING DATE	STATION	SAMPLER	MATRIX	SAMPLE NUMBER	SAMPLES COLLECTED							
					VOA	BNA	PCB PEST.	METALS	DIOXIN/ FURANS	RADIO-NUCLIDES	CONVENT	DCON

RECORDER: ____________________ **ORG. CODE:** __________ **DATE:** __________

MATRIX:
S = SEDIMENT
W = WATER
F = FISH
C = CRAYFISH

CONVENTIONAL PARAMETERS:
(LIST SPECIFICS)

SEDIMENT: ____________________
____

WATER: ____________________
____

Figure 1. Typical Summary Sampling Log

Sample containers will be labeled with waterproof ink prior to the time of sampling with the following information:

> Project Name/Number
> Station Number
> Sampling Date
> Sample Number
> Preservative Used
> Initials of Person Sampling

At the time of sampling, the appropriate containers will be selected, and the sample number for each sample will be recorded on the sample summary log and field log book. Sample labels (Figure 2) will be filled in with the information listed above (using waterproof ink), attached to the sample container, and wrapped with clear tamper-proof tape before the sample container is filled.

The following field custody procedures will be followed:

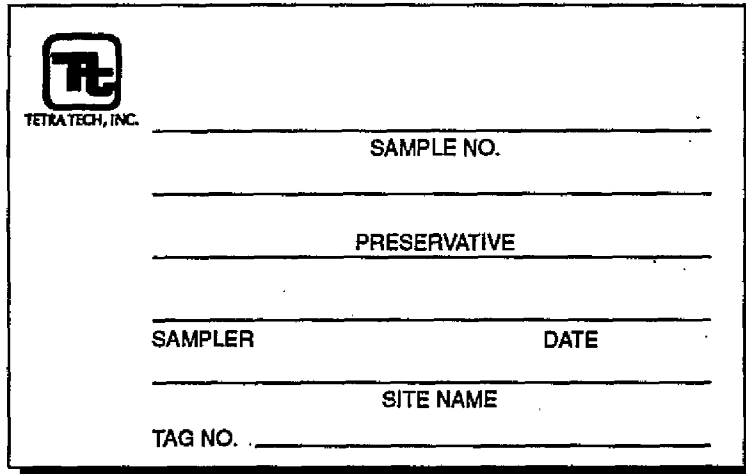
a) Samples will be collected as described in the sampling portion of this plan.

b) Sample labels will be completed for each sample using waterproof ink, unless prohibited by weather conditions (e.g., a logbook notation would explain that a pencil was used to fill out the sample label because a ballpoint pen would not function in freezing weather).

c) Information on the labels will be checked against Summary Sampling Log entries, and samples recounted before leaving the vessel to verify no samples are misplaced.

d) The Field Team Leader will be personally responsible for the care and custody of the samples until they are properly transferred or dispatched to the laboratory.

e) The Field Team Leader will determine whether custody procedures are followed properly during the field work and will decide if additional samples are required.



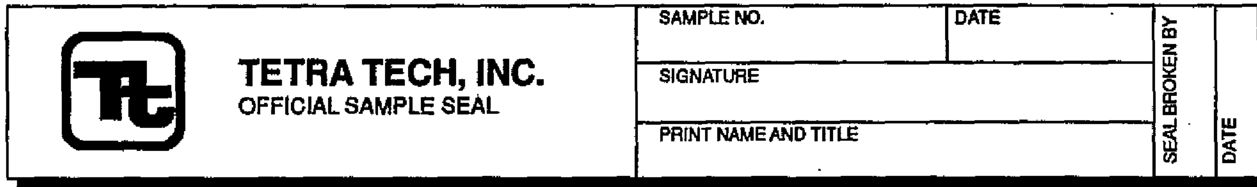


Figure 2. Typical Sample and Custody Seal

f) If a sample tag is lost during shipment or a tag is never created, the Field Team Leader will write a statement detailing how the sample was collected, stored, and transferred to the laboratory. The statement will include all pertinent information, such as entries in field logbooks regarding the sample, whether the sample was in the sample collector's physical possession or in a locked compartment until hand transported to the laboratory, etc.

6.3 TRANSFER OF CUSTODY AND SHIPMENT PROCEDURES

All samples will be accompanied by a Chain-of-Custody Record (Figure 3) and by a Sample Analysis Request/Packing List (Figure 4) indicating sample numbers and the requested analysis. Copies of all forms will be retained by Tetra Tech.

a) Prior to shipping, sample containers will be securely packed inside the cooler. The original chain-of-custody and sample analysis request forms will be enclosed in plastic and taped to the inside lid of the cooler. The cooler will be closed, fiber tape will be wrapped completely around it, and a custody seal (Figure 2) will be attached so that it must be broken when the cooler is opened. All samples collected will be packaged and shipped to the designated laboratory via Federal Express, except for those samples where hand carrying is preferred, due to holding times of 7 days or less (see Table 4).

b) When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the Chain-of-Custody Form. This form documents sample custody transfer from the sampler, often through courier to the analyst at the laboratory. Copies of the original Chain-of-Custody Forms and Sample Analysis Request Forms will be retained by the Field Team Leader for inclusion in the project files.

c) If sent by mail, the package will be registered with return receipt requested. If sent by common carrier or air freight, proper documentation will be maintained (e.g., bill of lading).

6.4 SPLIT SAMPLES PROCEDURE

For tissue analyses, separate Chain-of-Custody and Sampling Analysis Forms (see Figures 3 and 4) must be prepared for those samples and marked to indicate with whom the samples are

Section No. ____
Revision No. ____
Date ____
Page ____ of ____

CHAIN OF CUSTODY RECORD				DOCUMENT NO.							
PROJECT				SAMPLERS: *(Signature)*							
SAMPLE NO.	SITE	DATE	TIME	SAMPLE MATRIX						NUMBER OF CONTAINERS	REMARKS
				WATER	SEDIMENT	TISSUE	AIR	OIL	OTHER		TAG NO.

RELINQUISHED BY: *(Signature)*	RECEIVED BY: *(Signature)*	DATE/TIME
RELINQUISHED BY: *(Signature)*	RECEIVED BY: *(Signature)*	DATE/TIME
RELINQUISHED BY: *(Signature)*	REC'V'D BY MOBILE LAB FOR FIELD ANALYSIS: *(Signature)*	DATE/TIME

DISPATCHED BY: *(Signature)*	DATE/TIME	RECEIVED FOR LAB BY: *(Signature)*	DATE/TIME
METHOD OF SHIPMENT:			

Distribution: Original - Accompany Shipment
One Copy - Field Team Leader Files

Figure 3. Typical Chain of Custody Record

SAMPLE ANALYSIS REQUEST

PACKING LIST

PROJECT: ____	SAMPLING DATE(S): ____	SHIPPED TO:	FOR LAB USE ONLY
SAMPLING CONTACT: ____ (NAME) ____ (PHONE)	DATE SHIPPED: ____ TASK NAME/CODE: ____	ATTN.:	DATE SAMPLES REC'D: ____ RECEIVED BY: ____

SAMPLE NUMBERS	SAMPLE DESCRIPTION (ANALYSIS / MATRIX / CONCENTRATION/ PRESERVATIVE)
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	
13.	
14.	
15.	
16.	
17.	
18.	
19.	
20.	

Figure 4. Typical Sample Analysis Request

being split. The person relinquishing the split samples to the other laboratories will require the signature of a representative of the appropriate party acknowledging receipt of the samples. If a representative is unavailable or refuses to sign, this is noted in the "Received By" space. When appropriate, as in the case where the representative is unavailable, the Chain-of-Custody Form will contain a statement that the samples were delivered to the designated location at the designated time. This disposition will not jeopardize the chain-of-custody for the split sample portion retained for analysis. A copy must be given to the owner, operator, or agent-in-charge even if the offer for split samples is declined. The original will be retained by the contractor laboratory responsible for preparing the fish tissue (Keystone/NEA).

6.5 LABORATORY CUSTODY PROCEDURES

a) A designated sample custodian will accept custody of the shipped samples and verify that the information on the sample labels matches that on the Chain-of-Custody Form. Pertinent information as to shipment, pickup, courier, damage, etc., will be entered in the "Remarks" section. The custodian will then enter the sample label data into the sample tracking system of the laboratory. This system will use the sample label number or assign a unique laboratory number to each sample label and will assure that all samples are transferred to the proper analyst or stored in the appropriate secure area.

b) Samples will be distributed to the appropriate analysts as described in laboratory procedures. Laboratory personnel will be responsible for the care and custody of samples from the time they are received until the samples are depleted, or disposed of. The laboratory sample custodian will also maintain a Lab Tracking Report to follow each sample through all stages of laboratory processing (Figure 5). The sample tracking records must include the dates of sample extraction or preparation, and the date of sample analysis.

c) When sample analyses and necessary quality assurance checks have been completed in the laboratory, the unused portion of the sample and the sample container will be disposed of properly. All identifying tags, data sheets, chain-of-custody, and laboratory records will be retained as part of the permanent documentation. Samples received by the laboratory will be retained until analyses and quality assurance checks are completed.

W/O NO. ____________ PAGE ____________

LAB TRACKING REPORT ____________ (LOC-SN-FSC)

FRACTION CODE	X	PREP/ANALYSIS REQUIRED	RESPONSIBLE INDIVIDUAL	DATE DELIVERED	DATE COMPLETED

Figure 5. Typical Lab Tracking Report

7.0 CALIBRATION AND PREVENTIVE MAINTENANCE

Calibration procedures, calibration frequency, and standards for laboratory measurement variables and equipment will be in accordance with the requirements set forth in the U.S. EPA Contract Laboratory Program (CLP) or the specified analytical protocols. Field equipment calibration results and the methods used for preparing standards (e.g., pH buffer solutions) will be recorded in the field logbook and equipment logbooks accompanying each instrument.

Preventive maintenance of equipment is also essential if project resources are to be used cost-effectively. Preventive maintenance will take two forms: 1) implementing a schedule of preventive maintenance activities to minimize downtime and ensure accuracy of measurement systems, and 2) ensuring stock of critical spare parts and backup systems and equipment. The preventive maintenance approach for specific pieces of equipment used in sampling, monitoring, and documentation will follow manufacturers specifications. Performance of these maintenance procedures will be documented in field logbooks.

8.0 ANALYTICAL PROCEDURES

Analytical methods and method detection limits (MDLs) for analyses are summarized in Table 5, along with the federal and state criteria for the chemicals to be analyzed. Due to stringent federal and state criteria for surface water and fish consumption, some MDLs listed are higher than the corresponding criteria. The following chemicals are included in this category: hexachlorobenzene hexachloropentadiene, DDT isomers, heptachlor, chlordane, aldrin, dieldrin, parathion, toxaphene, endrin, and PCB arochlors.

Analysis of sediment and water samples will be performed using procedures based on the U.S. EPA approved methods, with the following exceptions:

- Acid Volatile Sulfides (AVS) - The procedure for measuring AVS in sediments will be based on Ditoro et al. (1989).

- Tributyl Tin (TBT) - Modified EPA 1986 SW-846 Methods (see Appendix B).

- Particle Size Distribution - The procedure for measuring particle size distribution is outlined in Methods of Soils Analysis (Am. Society of Agronomy 1985).

- Adsorbable Organic Halides (AOX) - This procedure will be a modified version of Standard Methods 506 (16th ed.) and 5230 (17th ed.).

Of the 30 pesticides to be analyzed as part of the Bi-State program, 12 are not typically analyzed by Method 608/8080. However, additional pesticides indicated as possibly being incorporated in the 608/8080 procedures are referenced in analytical methods which employ organic solvent extraction techniques and gas chromatography - electron capture detection, which is consistent with EPA methods 608 and 8080. Malathion, Parathion, Methyl Parathion, and Mirex are referenced in Standard Methods 509A titled,"Organochlorine Pesticides." Nonachlor and Dacthal (DCPA) are referenced in EPA's test methods 505 and 508, respectively. Dicofol (Kelthane), o,p'-DDE, o,p'-DDD, amd o,p'-DDT exhibit structures similar to the other pesticides in methods 608 and 8080 and therefore the likelihood of incorporating

them into these methods is very good. It should be noted that these additional pesticides will only be included in the 608 and 8080 scan if research (i.e., recovery on check standards and matrix spikes falls within data objective range outlined in Table 2) substantiates their incorporation.

Analysis of tissues will be performed using those U.S. EPA methods specified for solid wastes (U.S. EPA 1986b, 1989) and Official Methods of Analysis (AOAC 1984), with some modifications in sample preparation procedures. These modifications are described in Appendix B. All tissue samples will initially be processed by Keystone/NEA. The homogeneous, ground samples will be distributed by Keystone/NEA to Alden Labs (organic analyses - 60 g per sample) and Precision Analytics (metals analyses - 60 to 100 g per sample). Lipid content analysis will be performed by a gravimetric determination of the residual weight from an aliquot of sample extract after solvent evaporation.

Conductivity, temperature, pH, dissolved oxygen, and turbidity will be measured in the field according to modified U.S. EPA methods (U.S. EPA 1983) and instrument manufacturer instructions (see Appendix B).

To determine precision and accuracy, a combination of surrogate spikes, method blanks, matrix spikes, check standards, analytical replicates, and field duplicates will be run with each batch of parameters analyzed by a specified method. Table 6 lists the recommended frequency of these quality control analyses.

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[xx]
(Page 1 of 59)

		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
				METALS				
Aluminum	Fed	—	—	—	—	—	(L)	—
	WA	—	—	—	—	—	—	—
	MDL	0.035 mg	0.035 mg	0.035 mg	0.035 mg	0.035 mg	0.035 mg	0.70 ppm[yy]
	Method	ICP 200.7	ICP 200.7	ICP 200.7	ICP 200.7	ICP 200.7	ICP 200.7	ICP-MS 6020
Antimony	Fed	9,000 µg[a]	1,600 µg[a]	—	—	45,000 µg	0.01/0.05 mg (P)	—
	WA	—	—	—	—	—	—	—
	MDL	0.019 mg	0.019 mg	0.019 mg	0.019 mg	0.019 mg	0.019 mg	0.37 ppm[yy]
	Method	ICP 200.7	ICP 200.7	ICP 200.7	ICP 200.7	ICP 200.7	ICP 200.7	ICP-MS 6020
Arsenic	Fed	—	—	—	—	17.5 ng[b]	0.05 mg[c]	—
	Fed AS^{+5}	850 µg[a]	48 µg[a]	2,319 µg[a]	13 µg[a]	—	—	—
	Fed AS^{+3}	360 µg	190 µg	69 µg	36 µg	—	—	—
	WA	—	—	—	—	—	0.05 mg	57 ppm[yy]
	MDL	0.005 mg	0.005 mg	0.005 mg	0.005 mg	0.005 mg	0.005 mg	0.10 ppm[yy]
	Method	GFAA 206.2	GFAA 206.2	GFAA 206.2	GFAA 206.2	GFAA 206.2	GFAA 206.2	GFAA 7060

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]
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Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
		(Units per Liter)						Units as noted
METALS								
Barium	Fed	—	—	—	—	—	2 mg (P)	—
	WA	—	—	—	—	—	1.0 mg	—
	MDL	0.025 mg	0.025 mg	0.025 mg	0.025 mg	0.025 mg	0.025 mg	0.50 ppm[yy]
	Method	ICP 200.7	ICP 200.7	ICP 200.7	ICP 200.7	ICP 200.7	ICP 200.7	ICP-MS 6020
Beryllium	Fed	130 μg[a]	5.3 μg[a]	—	—	117 ng[b]	0.001 mg (P)	—
	WA	—	—	—	—	—	—	—
	MDL	0.005 mg	0.005 mg	0.005 mg	0.005 mg	0.005 mg	0.005 mg	5.00 ppm[yy]
	Method	GFAA 210.2	GFAA 210.2	GFAA 210.2	GFAA 210.2	GFAA 210.2	GFAA 210.2	GFAA 7091
Cadmium	Fed	3.9 μg[kk]	1.1 μg[kk]	43 μg	9.3 μg	—	0.005 mg (F)	—
	WA	[x,v]	[y,w]	43 μg[v]	9.3 μg[w]	—	0.01 mg	5.1 ppm dry[yy]
	MDL	0.5 μg	0.5 μg	0.5 μg	0.5 μg	0.5 μg	0.5 μg	0.53 ppm[yy]
	Method	GFAA 213.2	GFAA 213.2	GFAA 213.2	GFAA 213.2	GFAA 213.2	GFAA 213.2	ICP-MS 6020
Chromium[(HEX)]	Fed	16 μg	11 μg	1,100 μg	50 μg	—	Total 0.1 mg (F)	—
	WA	16.0 μg[v]	11.0 μg[w]	1,100 μg[v]	50 μg[w]	—	Type not specified 0.05 mg	Type not specified 260 ppm d[yy]
	MDL	0.010 mg (Total)	0.010 mg (Total)	0.010 mg (Total)	0.010 mg (Total)	0.010 mg (Total)	0.010 mg (Total)	5.00 ppm[yy] (Total)
	Method	ICP 200.7	ICP 200.7	ICP 200.7	ICP 200.7	ICP 200.7	ICP 200.7	ICP-MS 6020

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[α]
(Page 3 of 59)

		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
METALS								
Chromium[(TRI)]	Fed	1,700 μg[kk]	210 μg[kk]	10,300 μg[a]	—	3,433 mg	0.1 mg (F) Total	—
	WA	[ll,v]	[mm,w]	—	—	—	Type not specified 0.05 mg	See Chromium (HEX)
Copper	Fed	18 μg[kk]	12 μg[kk]	2.9 μg	2.9 μg	—	1.3 mg (P)	—
	WA	[z,v]	[aa,w]	2.9 μg[v]	—	—	—	390 ppm[yy]
	MDL	10 μg	10 μg	10 μg	10 μg	10 μg	10 μg	2.17 ppm[yy]
	Method	ICP 200.7	ICP 200.7	ICP 200.7	ICP 200.7	ICP 200.7	ICP 200.7	ICP-MS 6020[e]
Iron	Fed	—	1,000 μg	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	0.100 mg	0.100 mg	0.100 mg	0.100 mg	0.100 mg	0.100 mg	14.74 ppm[yy]
	Method	ICP 200.7	ICP 200.7	ICP 200.7	ICP 200.7	ICP 200.7	ICP 200.7	ICP-MS 6020
Lead	Fed	82 μg[kk]	3.2 μg[kk]	140 μg	5.6 μg	—	0.005 mg[c] (P) (at source)	—
	WA	[bb,v]	[cc,w]	140 μg[v]	5.6 μg[w]	—	0.05 mg	450 ppm[yy]
	MDL	0.001 mg	0.001 mg	0.001 mg	0.001 mg	0.001 mg	0.001 mg	0.11 ppm[yy]
	Method	GFAA 7421	GFAA 7421	GFAA 7421	GFAA 7421	GFAA 7421	GFAA 7421	ICP-MS 6020

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[a]
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		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
METALS								
Mercury	Fed	2.4 μg	0.012 μg	2.1 μg	0.025 μg	146 ng	0.002 mg (F)	—
	WA	2.4 μg[v]	0.012 μg[w]	2.1 μg[v]	0.025 μg[w]	—	0.002 mg	0.41 ppm[yy]
	MDL	0.5 μg	0.5 μg	0.5 μg	0.5 μg	0.5 μg	0.5 μg	0.10 ppm[yy]
	Method	CVAA 245.2	CVAA 245.2	CVAA 245.2	CVAA 245.2	CVAA 245.2	CVAA 245.2	CVAA 7471
Nickel	Fed	1,400 μg[kk]	160 μg[kk]	75 μg	8.3 μg	100 μg	0.1 mg (P)	—
	WA	[dd,v]	[ee,w]	75 μg[v]	8.3 μg[w]	—	—	—
	MDL	0.040 mg	0.040 mg	0.040 mg	0.040 mg	0.040 mg	0.040 mg	2.33 ppm[yy]
	Method	ICP 200.7	ICP 200.7	ICP 200.7	ICP 200.7	ICP 200.7	ICP 200.7	ICP-MS 6020
Selenium	Fed	260 μg	35 μg	410 μg	54 μg	—	0.05 mg (F)	—
	WA	260 μg[v]	35 μg[w]	410 μg[v]	54 μg[w,oo]	—	0.01 mg	—
	MDL	0.005 mg	0.005 mg	0.005 mg	0.005 mg	0.005 mg	0.005 mg	0.10 ppm[yy]
	Method	GFAA 270.2	GFAA 270.2	GFAA 270.2	GFAA 270.2	GFAA 270.2	GFAA 270.2	GFAA 7740
Silver	Fed	4.1 μg[kk]	0.12 μg[kk]	2.3 μg	—	—	— (L)	—
	WA	[ff,t]	—	2.3 μg[t]	—	—	0.05 mg	6.1 ppm dry
	MDL	0.001 mg	0.001 mg	0.001 mg	0.001 mg	0.001 mg	0.001 mg	0.62 ppm[yy]
	Method	ICP 200.7	ICP 200.7	ICP 200.7	ICP 200.7	ICP 200.7	ICP 200.7	ICP-MS 6020

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]
(Page 5 of 59)

		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
METALS								
Thallium	Fed	1,400 µg[a]	40 µg[a]	2,130 µg[a]	—	48 µg	0.002/0.001 mg (P)	—
	WA	—	—	—	—	—	—	—
	MDL	0.004 mg	0.004 mg	0.004 mg	0.004 mg	0.004 mg	0.004 mg	0.08 ppm[yy]
	Method	ICP 200.7	ICP 200.7	ICP 200.7	ICP 200.7	ICP 200.7	ICP 200.7	ICP-MS 6020
Zinc	Fed	120 mg[kk]	110 mg[kk]	95 µg	86 µg	—	— (L)	—
	WA	[gg,v]	[hh,w]	95 µg[v]	86 µg[w]	—	—	410 ppm dry
	MDL	0.020 mg	0.020 mg	0.020 mg	0.020 mg	0.020 mg	0.020 mg	5.56 ppm[yy]
	Method	ICP 200.7	ICP 200.7	ICP 200.7	ICP 200.7	ICP 200.7	ICP 200.7	ICP-MS 6020[e]
Cyanide	Fed	22 µg	5.2 µg	1 µg	1 µg	200 µg	0.2 mg (P)	—
	WA	22 µg[v]	5.2 µg[w]	1.0 µg[v]	—	—	—	—
	MDL	2 µg	2 µg	2 µg	2 µg	2 µg	2 µg	1.0 ppm[yy]
	Method	Titrimetric 335.3	Titrimetric 335.3	Titrimetric 335.3	Titrimetric 335.3	Titrimetric 335.3	Titrimetric 335.3	Colorimetric 9010
Tributylin	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	—	—	—	—	—	—	50 ppb[yy]
	Method	NA	NA	NA	NA	NA	NA	(Durell et al 1989)

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[a]
(Page 6 of 59)

		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
VOLATILES								
Chloromethane	Fed	—	—	—	—	—	— (L)	—
	WA	—	—	—	—	—	—	—
	MDL	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA
Vinyl chloride	Fed	—	—	—	—	525 µg[b]	0.002 mg (F)	—
	WA	—	—	—	—	—	0.002 mg	—
	MDL	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA
Methylene chloride	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	10 µg	10 µg	10 µg	10 µg	10 µg	10 µg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA
1,1-Dichloroethane	Fed	—	—	—	—	—	— (L)	—
	WA	—	—	—	—	—	—	—
	MDL	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]
(Page 7 of 59)

		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
VOLATILES								
Chloroform	Fed	28,900 µg[a]	1,240 µg[a]	—	—	15.7 µg[b]	0.1 mg (L) (THM)	—
	WA	—	—	—	—	—	—	—
	MDL	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA
1,1,1-Trichloro-ethane	Fed	18,000 µg[a] (Trichlorinated ethanes)	—	31,200 µg[a]	—	1.03 g	0.2 mg (F)	—
	WA	—	—	—	—	—	0.200 mg	—
	MDL	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA
Bromodichloro-methane	Fed	—	—	—	—	—	0.1 mg (L) (THM)	—
	WA	—	—	—	—	—	—	—
	MDL	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]
(Page 8 of 59)

		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
				VOLATILES				
trans-1,3-Dichloropropene	Fed	6,060 µg[a] (Dichloropropene)	244 µg[a] (Dichloropropene)	790 µg[a] (Dichloropropene)		14.1 mg (Dichloropropene)	__ (L) (Dichloropropene 1,3-)	—
	WA	—	—	—	—	—	—	—
	MDL	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA
Chlorodibromomethane	Fed	—	—	–	—	—	0.1 mg (L) (THM)	—
	WA	—	—	—	—	—	—	—
	MDL	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA
Benzene	Fed	5,300 µg[a]	—	5,100 µg[a]	700 µg[a]	40.0 µg[b]	0.005 mg (F)	—
	WA	—	—	—	—	—	0.005 mg	—
	MDL	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA
Bromoform	Fed	—	—	–	—	—	0.1 mg (L) (THM)	—
	WA	—	—	—	—	—	—	—
	MDL	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]
(Page 9 of 59)

		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
VOLATILES								
Tetrachloro-ethylene	Fed	5,280 μg[a]	840 μg[a]	10,200 μg[a]	450 μg[a]	8.85 μg[b]	0.005 mg (P)[c]	—
	WA	—	—	—	—	—	—	—
	MDL	1.0 μg	1.0 μg	1.0 μg	1.0 μg	1.0 μg	1.0 μg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA
Chlorobenzene	Fed	250 μg[a] (Chlorinated benzenes)	50 μg[a] (Chlorinated benzenes)	160 μg[a] (Chlorinated benzenes)	129 μg[a] (Chlorinated benzenes)	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	1.0 μg	1.0 μg	1.0 μg	1.0 μg	1.0 μg	1.0 μg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA
Total xylenes	Fed	—	—	—	—	—	10 mg (F)	—
	WA	—	—	—	—	—	—	—
	MDL	1.0 μg	1.0 μg	1.0 μg	1.0 μg	1.0 μg	1.0 μg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA
Bromomethane	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	1.0 μg	1.0 μg	1.0 μg	1.0 μg	1.0 μg	1.0 μg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]
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		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
VOLATILES								
Chloroethane	Fed	—	—	—	—	—	—(L)	—
	WA	—	—	—	—	—	—	—
	MDL	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA
1,1-Dichloro-ethylene	Fed	11,600 µg[a] (Dichloro-ethylene)	—	224,000 µg[a] (Dichloro-ethylene)	—	1.85 µg[b] (Dichloro-ethylene)	0.007 mg (F) (1,1-Dichloro-ethylene)	—
	WA	—	—	—	—	—	0.007 mg	—
	MDL	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA
trans-1,2-Dichloro-ethylene	Fed	11,600 µg[a] (Dichloro-ethylene)	—	224,000 µg[a] (Dichloro-ethylene)	—	1.85 µg[b] (Dichloro-ethylene)	0.1 mg (F) (1,1-Dichloro-ethylene)	—
	WA	—	—	—	—	—	0.007 mg (1,1-Dichloro-ethylene)	—
	MDL	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]
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		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
VOLATILES								
1,2-Dichloroethane	Fed	118,000 µg[a]	20,000 µg[a]	113,000 µg[a]	—	243 µg[b]	0.005 mg (F)	—
	WA	—	—	—	—	—	0.005 mg	—
	MDL	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA
Carbon tetrachloride	Fed	35,200 µg[a]	—	50,000 µg[a]	—	6.94 µg[b]	5 (F)	—
	WA	—	—	—	—	—	0.005 mg	—
	MDL	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA
1,2-Dichloro-propane	Fed	23,000 µg[a] (Dichloro-propane)	5,700 µg[a] (Dichloro-propane)	10,300 µg[a] (Dichloro-propane)	3,040 µg[a] (Dichloro-propane)	—	0.005 mg (F)	—
	WA	—	—	—	—	—	—	—
	MDL	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA
Trichlorethylene	Fed	45,000 µg[a]	21,900 µg[a]	2,000 µg[a]	—	80.7 µg[b]	5 µg (F)	—
	WA	—	—	—	—	—	0.005 mg	—
	MDL	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[aa]
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		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
VOLATILES								
1,1,2-Trichloro-ethane	Fed	18,000 μg[a] (Trichlorinated ethanes)	9,400 μg[a]	—	—	41.8 μg[b]	0.005 mg (P)	—
	WA	—	—	—	—	—	0.200 mg (1,1,1-Tri-chloroethane)	—
	MDL	1.0 μg	1.0 μg	1.0 μg	1.0 μg	1.0 μg	1.0 μg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA
cis-1,3-Dichloro-propene	Fed	6,060 μg[a] (Dichloro-propene)	244 μg[a] (Dichloro-propene)	790 μg[a]	—	14.1 mg (Dichloro-propene)	__(L)	—
	WA	—	—	—	—	—	—	—
	MDL	1.0 μg	1.0 μg	1.0 μg	1.0 μg	1.0 μg	1.0 μg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA
1,1,2,2-Tetra-chloroethane	Fed	9,320 μg[a] (Tetrachlori-nated ethanes)	2,400 μg[a]	9,020 μg[a]	—	10.7 μg[b]	__ (L)	—
	WA	—	—	—	—	—	—	—
	MDL	1.0 μg	1.0 μg	1.0 μg	1.0 μg	—	1.0 μg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	—	GC/MS 624	NA

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]
(Page 13 of 59)

		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
VOLATILES								
Toluene	Fed	17,500 µg[a]	—	6,300 µg[a]	5,000 µg[a]	424 mg	1 mg (F)	—
	WA	—	—	—	—	—	—	—
	MDL	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA
Ethylbenzene	Fed	32,000 µg[a]	—	430 µg[a]	—	3.28 mg	0.7 mg (F)	—
	WA	—	—	—	—	—	—	—
	MDL	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA
Methyl chloride	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA
Methyl bromide	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]
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		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
VOLATILES								
2-Chloroethyl-vinylether	Fed	—	—	—	—	1.36 µg[b]	—	—
	WA	—	—	—	—	—	—	—
	MDL	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA
1,2-Dichloro-propylene	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA
Acrolein	Fed	68 µg[a]	21 µg[a]	55 µg[a]	—	780 µg	—	—
	WA	—	—	—	—	—	—	—
	MDL	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA
Acrylonitrile	Fed	7,550 µg[a]	2,600 µg[a]	—	—	0.65 µg[b]	—(L)	—
	WA	—	—	—	—	—	—	—
	MDL	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	1.0 µg	—
	Method	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	GC/MS 624	NA

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc] (Page 15 of 59)								
		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
ADSORBABLE ORGANIC HALIDES (AOX)								
AOX	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	10 μg	10 μg	10 μg	10 μg	10 μg	10 μg	—
	Method	GC 506	GC 506	GC 506	GC 506	GC 506	GC 506	NA

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[xx]

		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
ACID EXTRACTABLE ORGANICS PHENOLIC COMPOUNDS								
Phenol	Fed	10,200 μg[a]	2,560 μg[a]	5,800 μg[a]	—	—	—	—
	WA	—	—	—	—	—	—	420 ppb[yy]
	MDL	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
2-Methylphenol	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	63 ppb[yy]
	MDL	4.0 μg	4.0 μg	4.0 μg	4.0 μg	4.0 μg	4.0 μg	4.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
4-Methylphenol	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	670 ppb[yy]
	MDL	4.0 μg	4.0 μg	4.0 μg	4.0 μg	4.0 μg	4.0 μg	4.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
2,4-Dimethylphenol	Fed	2,120 μg[a]	—	—	—	—	—	—
	WA	—	—	—	—	—	—	29 ppb[yy]
	MDL	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc] (Page 17 of 59)								
		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
ACID EXTRACTABLE ORGANICS PHENOLIC COMPOUNDS								
Pentachlorophenol	Fed	20 µg[pp]	13 µg[pp]	13 µg	7.9 µg[a]	—	0.001 mg (P)	—
	WA	[ii,v]	[ii,w]	13.0 µg[v]	7.9 µg[w]	—	—	360 ppb[yy]
	MDL	20 µg	20 µg	20 µg	20 µg	20 µg	20 µg	20 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
2-Methyoxyphenol	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
2-Chlorophenol	Fed	4,380 µg[a]	2,000 µg[a]	—	—	—	— (L)	—
	WA	—	—	—	—	—	—	—
	MDL	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
2,4-Dichlorophenol	Fed	2,020 µg[a]	365 µg[a]	—	—	—	— (L)	—
	WA	—	—	—	—	—	—	—
	MDL	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]
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		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
ACID EXTRACTABLE ORGANICS PHENOLIC COMPOUNDS								
2,4-Dinitrophenol	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	20 µg	20 µg	20 µg	20 µg	20 µg	20 µg	20 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
2-Nitrophenol	Fed	230 µg[a] (Nitrophenols)	150 µg[a] (Nitrophenols)	4,850 µg[a] (Nitrophenols)	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
4-Nitrophenol	Fed	230 µg[a] (Nitrophenols)	150 µg[a] (Nitrophenols)	4,850 µg[a] (Nitrophenols)	—	—	—	—
	WA							
	MDL	20 µg	20 µg	20 µg	20 µg	20 µg	20 µg	20 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270	GC/MS 625	GC/MS 8270
2,4,6-Trichlorophenol	Fed	–	970 µg[a]			3.6 µg[b]	— (L)	
	WA	—	—	—	—	—	—	—
	MDL	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]

		Units per Liter						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
BASE/NEUTRALS (SEMIVOLATILES) HALOGENATED ETHERS								
bis 2-Chloroethyl Ether	Fed	—	—	—	—	1.36 µg[b]	—	—
	WA	—	—	—	—	—	—	—
	MDL	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
bis 2-Chloroethyoxy Methane	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
bis 2-Chloro-isopropyl Ether	Fed	—	—	—	—	4.36 mg	—	—
	WA	—	—	—	—	—	—	—
	MDL	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
4-Bromo-phenylphenylether	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270

		Units per Liter						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
BASE/NEUTRALS (SEMIVOLATILES) HALOGENATED ETHERS								
4-Chloro-phenylphenylether	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]

		Units per Liter						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
NITROAROMATICS								
2,4-Dinitrotoluene	Fed	330 μg[a] (Dinitro-toluene)	230 μg[a] (Dinitro-toluene)	590 μg[a] (Dinitro-toluene)	370 μg[a] (Dinitro-toluene)	9.1 μg[b]	— (L)	—
	WA	—	—	—	—	—	—	—
	MDL	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
2,6-Dinitrotoluene	Fed	330 μg[a] (Dinitro-toluene)	230 μg[a] (Dinitro-toluene)	590 μg[a] (Dinitro-toluene)	330 μg[a] (Dinitro-toluene)	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
Nitrobenzene	Fed	27,000 μg[a]	—	6.680 μg[a]	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[xx]

		Units per Liter						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
NITROSAMINES								
N-nitroso-di-n-propylamine	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
N-nitrosodimethylamine	Fed	—	—	—	—	16,000 ng[b]	—	—
	WA	—	—	—	—	—	—	—
	MDL	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
N-nitrosodiphenylamine	Fed	—	—	—	—	16,100 ng[b]	—	—
	WA	—	—	—	—	—	—	11 ppm carbon
	MDL	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]
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		Units per Liter						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
CHLORINATED NAPHTHALENE								
2-Chloronaphthalene	Fed	1,600 µg[a] Chlorinated naphthalenes	—	7.5 µg[a] Chlorinated naphthalenes	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[aa]
(Page 24 of 59)

		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
POLYNUCLEAR AROMATICS								
Acenaphthene	Fed	1,700 μg[a]	520 μg[a]	970 μg[a]	710 μg[a]	31.1 ng[b,d]	—	—
	WA	—	—	—	—	—	—	16 ppm carbon
	MDL	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg (ppb)	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
Acenaphthylene	Fed	—	—	300 μg[b,d]	—	31.1 ng[b,d]	—	—
	WA	—	—	—	—	—	—	66 ppm carbon
	MDL	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg (ppb)	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
Anthracene	Fed	—	—	300 μg[b,d]	—	31.1 ng[b,d]	—	—
	WA	—	—	—	—	—	—	220 ppm carbon
	MDL	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg (ppb)	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[xx]
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		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
POLYNUCLEAR AROMATICS								
Benzo(a)anthracene	Fed	—	—	300 µg[b,d]	—	31.1 ng[b,d]	0.0001 mg (P) (PAH)	—
	WA	—	—	—	—	—	—	110 ppm carbon
	MDL	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg (ppb)	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
Benzofluoranthene	Fed	—	—	300 µg[b,d]	—	31.1 ng[b,d]	0.0002 mg (P) (PAH)	—
	WA	—	—	—	—	—	—	230 ppm carbon
	MDL	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 µg (ppb)	4.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
Benzo(a)pyrene	Fed	—	—	300 µg[b,d]	—	31.1 ng[b,d]	0.0002 mg (P) (PAH)	—
	WA	—	—	—	—	—	—	99 ppm carbon
	MDL	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 µg (ppb)	4.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[xx]
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		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
POLYNUCLEAR AROMATICS								
Benzo(g,h,i)perylene	Fed	—	—	300 μg[b,d]	—	31.1 ng[b,d]	0.0002 mg (P) (PAH)	—
	WA	—	—	—	—	—	—	31 ppm carbon
	MDL	4.0 μg	4.0 μg	4.0 μg	4.0 μg	4.0 μg	4.0 μg (ppb)	4.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
Chrysene	Fed	—	—	300 μg[b,d]	—	31.1 ng[b,d]	0.0002 mg (P) (PAH)	—
	WA	—	—	—	—	—	—	110 ppm carbon
	MDL	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
Dibenzo(a,h)-anthracene	Fed	—	—	300 μg[b,d]	—	31.1 ng[b,d]	0.0003 mg (P) (PAH)	—
	WA	—	—	—	—	—	—	12 ppm carbon
	MDL	4.0 μg	4.0 μg	4.0 μg	4.0 μg	4.0 μg	4.0 μg	4.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]
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Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
		(Units per Liter)						Units as noted
POLYNUCLEAR AROMATICS								
Fluoranthene	Fed	3,980 µg[a]	—	40 µg[a]	16 µg[a]	54 µg	—	—
	WA	—	—	—	—	—	—	160 ppm carbon
	MDL	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
Fluorene	Fed	—	—	300 µg[b,d]	—	31.1 ng[b,d]	0.0002 mg (P) (PAH	—
	WA	—	—	—	—	—	—	23 ppm carbon
	MDL	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
Indeno(1,2,3-cd)-pyrene	Fed	—	—	300 µg[b,d]	—	31.1 ng[b,d]	0.0002 mg (P) (PAH)	—
	WA	—	—	—	—	—	—	34 ppm carbon
	MDL	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[xx]
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		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
POLYNUCLEAR AROMATICS								
Naphthalene	Fed	2,300 µg[a]	620 µg[a]	2,350 µg[a]	—	31.1 ng[b,d]	—	—
	WA		—	—	—	—	—	99 ppm carbon
	MDL	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
Phenanthrene	Fed	—	—	300 µg[b,d]	—	31.1 ng[b,d]	—	—
	WA	—	—	—	—	—	—	100 ppm carbon
	MDL	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
Pyrene	Fed	—	—	300 µg[b,d]	—	31.1 ng[b,d]	—	—
	WA	—	—	—	—	—	—	1,000 ppm carbon
	MDL	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED
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		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
CHLORINATED BENZENES								
1,3-Dichlorobenzene	Fed	1,120 μg[a,e]	763 μg[a,e]	1,970 μg[a,e]	—	2.6 mg[e]	0.6 mg (F)	—
	WA	—	—	—	—	—	.075 mg[f]	—
	MDL	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
1,2-Dichlorobenzene	Fed	1,120 μg[a,e]	763 μg[a,e]	1,970 μg[a,e]	—	2.6 mg[e]	0.6 mg (F)	—
	WA	—	—	—	—	—	0.075 mg[f]	2.3 ppm carbon
	MDL	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
1,4-Dichlorobenzene	Fed	1,120 μg[a,e]	763 μg[a,e]	1,970 μg[a,e]	—	2.6 mg[e]	0.075 mg (F)	—
	WA	—	—	—	—	—	0.075 mg[f]	3.1 ppm carbon
	MDL	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
1,2,4-Trichloro-benzene	Fed	—	—	—	—	—	0.009 mg (P)	—
	WA	—	—	—	—	—	—	0.81 ppm carbon
	MDL	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 μg	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED
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		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
CHLORINATED BENZENES								
Hexachlorobenzene	Fed	—	—	—	—	0.74 ng[b]	0.001 mg (P)	—
	WA	—	—	—	—	—	—	0.38 ppm carbon
	MDL	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
Hexachloro-butadiene	Fed	90 µg[a]	9.3 µg[a]	32 µg[a]	—	50 µg[b]	—	—
	WA	—	—	—	—	—	—	3.9 ppm carbon
	MDL	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
Hexachloroethane	Fed	980 µg[a]	540 µg[a]	940 µg[a]	—	8.74 µg	—	—
	WA	—	—	—	—	—	—	—
	MDL	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
Hexachloroyclo-pentadiene	Fed	7 µg[a]	5.2 µg[a]	7 µg[a]	—	—	0.05 mg (P)	—
	WA	—	—	—	—	—	—	—
	MDL	10 µg	10 µg	10 µg	10 µg	10 µg	10 µg	10 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED
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		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
BENZIDINES								
3,3-Dichloro-benzidine	Fed	—	—	—	—	0.020 μg[b] (Dichloro-benzidine)	—	—
	WA	—	—	—	—	—	—	—
	MDL	20 μg	20 μg	20 μg	20 μg	20 μg	20 μg	20 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
Benzidine	Fed	2,500 μg[a]	—	—	—	0.53 ng[b]	—	—
	WA	—	—	—	—	—	—	—
	MDL	20 μg	20 μg	20 μg	20 μg	20 μg	20 μg	20 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED
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		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
PHTHALATE ESTHERS								
Dimethylphthalate	Fed	940 µg[a,zz]	3 µg[a,zz]	2,944 µg[a,zz]	3.4 µg[a,zz]	2.9 g	—	
	WA	—	—	—	—	—	—	53 ppm carbon
	MDL	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
Diethylphthalate	Fed	940 µg[a,zz]	3 µg[a,zz]	2,944 µg[a,zz]	3.4 µg[a,zz]	1.8 g	—	—
	WA	—	—	—	—	—	—	61 ppm carbon
	MDL	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
Di-n-butylphthalate	Fed	940 µg[a,zz]	3 µg[a,zz]	2,944 µg[a,zz]	3.4 µg[a,zz]	154 mg	0.004 mg (P) (PAE)	—
	WA	—	—	—	—	—	—	220 ppm carbon
	MDL	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED

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		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA Marine)
PHTHALATE ESTHERS								
Butylbenzylphthalate	Fed	940 µg[a,zz]	3 µg[a,zz]	2,944 µg[a,zz]	3.4 µg[a,zz]	—	0.004 mg (P) (PAE)	—
	WA	—	—	—	—	—	—	4.9 ppm carbon
	MDL	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
bis-2-(ethylhexyl)-phthalate	Fed	940 µg[a,zz]	3 µg[a,zz]	2,944 µg[a,zz]	3.4 µg[a,zz]	—	—	—
	WA	—	—	—	—	—	—	47 ppm carbon
	MDL	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 µg	2.0 ppb[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270
Di-n-octylphthalate	Fed	940 µg[a,zz]	3 µg[a,zz]	2,944 µg[a,zz]	3.4 µg[a,zz]	—	—	—
	WA	—	—	—	—	—	—	58 ppm carbon
	MDL	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 µg	4.0 ppm[yy]
	Method	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 625	GC/MS 8270

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]
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Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA marine)
		(Units per Liter)						Units as noted
PESTICIDES								
O,P'-DDE	Fed	1,050 µg[a,h]	—	14 µg[a,h]	—	—	—	—
	WA	1.1 µg[t,g]	0.001 µg[g,u]	0.13 µg[t,g]	0.001 µg[u,g]	—	—	—
	MDL	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	5.0 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080
O,P'-DDD	Fed	1,050 µg[a,h]	—	14 µg[a,h]	—	—	—	—
	WA	1.1 µg[t,g]	0.001 µg[g,u]	0.13 µg[t,g]	0.001 µg[u,g]	—	—	—
	MDL	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	5.0 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080
O,P'-DDT	Fed	1.1 µg[g]	0.001 µg[g]	0.13 µg[g]	0.001 µg[g]	0.024 ng[g,b]	—	—
	WA	1.1 µg[g,t]	0.001 µg[g,u]	0.13 µg[t,g]	0.001 µg[g,u]	—	—	—
	MDL	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	5.0 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080
4,4'-DDT	Fed	1.1 µg[g]	0.001 µg[g]	0.13 µg[g]	0.001 µg[g]	0.024 ng[b,g]	—	—
	WA	1.1 µg[g,t]	0.001 µg[g,u]	0.13 µg[t,g]	0.001 µg[u,g]	—	—	—
	MDL	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	5.0 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]
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Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA ma[illegible])
		(Units per Liter)						Units as noted
PESTICIDES								
4,4'-DDE	Fed	1,050 µg[a,h]	—	14 µg[a,h]	—	—	—	—
	WA	1.1 µg[g,i]	0.001 µg[g,u]	0.13 µg[i,g]	0.001 µg[u,g]	—	—	—
	MDL	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	5.0 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080
4,4'-DDD	Fed	1,050 µg[a,h]	—	14 µg[a,h]	—	—	—	—
	WA	1.1 µg[g,i]	0.001 µg[g,u]	0.13 µg[i,g]	0.001 µg[u,g]	—	—	—
	MDL	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	5.0 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080
Heptachlor	Fed	0.52 µg	0.0038 µg	0.053 µg	0.0036 µg	0.29 ng[b]	0.0004 mg (F)	—
	WA	0.52 µg[i]	0.0038 µg[u]	0.053 µg[i]	0.0036 µg[b]	—	—	—
	MDL	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	5.0 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080
Heptachlor Epoxide	Fed	—	—	—	—	—	0.0002 mg (F)	—
	WA	—	—	—	—	—	—	—
	MDL	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	5.0 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[a]
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		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA marine)
PESTICIDES								
Chlordane	Fed	2.4 μg	0.0043 μg	0.09 μg	0.004 μg	0.48 ng[b]	0.002 mg (F)	—
	WA	2.4 μg[t]	0.0043 μg[u]	0.09 μg[t]	0.004 μg[u]	—	—	—
	MDL	0.05 μg	0.05 μg	0.05 μg	0.05 μg	0.05 μg	0.05 μg	5.0 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080
Aldrin	Fed	3.0 μg	—	1.3 μg	—	0.079 ng[b]	—	—
	WA	2.5 μg[t,aaa]	0.0019 μg[u,aaa]	0.71 μg[t,aaa]	0.0019 μg[u,aaa]	—	—	—
	MDL	0.05 μg	0.05 μg	0.05 μg	0.05 μg	0.05 μg	0.05 μg	5.0 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080
Dieldrin	Fed	2.5 μg	0.0019 μg	0.71 μg	0.0019 μg	0.076 ng[b]	(L)	—
	WA	2.5 μg[t,aaa]	0.0019 μg[u,aaa]	0.71 μg[t,aaa]	0.0019 μg[u,aaa]	—	—	—
	MDL	0.05 μg	0.05 μg	0.05 μg	0.05 μg	0.05 μg	0.05 μg	5.0 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080
Nonachlor	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	0.05 μg	0.05 μg	0.05 μg	0.05 μg	0.05 μg	0.05 μg	5.0 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]
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		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA marine)
PESTICIDES								
Mirex (dechlorane)	Fed	—	0.001 µg	—	0.001 µg	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	5.0 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080
Dacthal	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	5.0 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080
Dicofol	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	5.0 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080
Methyl Parathion	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	5.0 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[xx]
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		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA marine)
PESTICIDES								
Parathion	Fed	0.065 μg	0.013 μg	—	—	—	—	—
	WA	0.065 μg[v]	0.013 μg[w]	—	—	—	—	—
	MDL	0.05 μg	0.05 μg	0.05 μg	0.05 μg	0.05 μg	0.05 μg	5.0 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080
Malathion	Fed	—	0.1 μg	—	0.1 μg	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	0.05 μg	0.05 μg	0.05 μg	0.05 μg	0.05 μg	0.05 μg	5.0 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080
Toxaphene	Fed	0.73 μg	0.0002 μg	0.21 μg	0.0002 μg	0.73 ng[b]	0.005 mg[c] (P)	—
	WA	0.73 μg[v]	0.0002 μg[w]	0.21 μg[v]	0.002 ug[w]	—	0.005 mg	—
	MDL	5.0 μg	5.0 μg	5.0 μg	5.0 μg	5.0 μg	5.0 μg	200 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080
Isophorone	Fed	117,000 μg[a]	—	12,900 μg[a]	—	520 mg	— (L)	—
	WA	—	—	—	—	—	—	—
	MDL	0.05 μg	0.05 μg	0.05 μg	0.05 μg	0.05 μg	0.05 μg	5.0 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]
(Page 39 of 59)

		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA marine)
PESTICIDES								
Endosulfan I	Fed	0.22 μg	0.056 μg	0.034 μg	0.0087 μg	159 μg	—	—
	WA	0.22 μg[t]	0.056 μg[u]	0.034 μg[t]	0.0087 μg[u]	—	—	—
	MDL	0.05 μg	0.05 μg	0.05 μg	0.05 μg	0.05 μg	0.05 μg	5.0 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080
Endosulfan II	Fed	0.22 μg	0.056 μg	0.034 μg	0.0087 μg	159 μg	—	—
	WA	0.22 μg[t]	0.056 μg[u]	0.034 μg[t]	0.0087 μg[u]	—	—	—
	MDL	0.05 μg	0.05 μg	0.05 μg	0.05 μg	0.05 μg	0.05 μg	5.0 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080
Endosulfan Sulfate	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	0.05 μg	0.05 μg	0.05 μg	0.05 μg	0.05 μg	0.05 μg	5.0 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080
Endrin	Fed	0.18 μg	0.0023 μg	0.037 μg	0.0023 μg	—	0.002 mg (P)	—
	WA	0.18 μg[t]	0.0023 μg[u]	0.037 μg[t]	0.0023 μg[u]	—	0.0002 mg	—
	MDL	0.05 μg	0.05 μg	0.05 μg	0.05 μg	0.05 μg	0.05 μg	5.0 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]
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		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA marine)
				PESTICIDES				
Endrin Aldehyde	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	5.0 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080
Methoxychlor	Fed	—	0.03 µg	—	0.03 µg	—	0.04 mg (F)	—
	WA	—	—	—	—	—	0.1 mg	—
	MDL	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	5.0 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080
Alpha-BHC	Fed	100 µg[a,j]	—	0.34 µg[a,j]	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	5.0 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080
Beta-BHC	Fed	100 µg[a,j]	—	0.34 µg[a,j]	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	5.0 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]
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Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA marine)
		(Units per Liter)						Units as noted
PESTICIDES								
Delta-BHC	Fed	100 µg[a,j]	—	0.34 µg[a,j]	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	5.0 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080
Gamma-BHC (Lindane)	Fed	100 µg[a,j]	—	0.34 µg[a,j]	—	—	0.0002 mg (F)	—
	WA	2.0 µg[t]	0.08 µg[u]	0.16 µg[t]	—	—	0.004 mg	—
	MDL	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	0.05 µg	5.0 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]
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		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA marine)
PCBs								
Arochlor 1016	Fed	2.0 μg[k]	0.014 μg[k]	10 μg[k]	0.03 μg[k]	0.079 ng[b,k]	0.0005 mg[k] (F)	—
	WA	2.0 μg[k,u]	0.014 μg[k,u]	10 μg[k,u]	0.03 μg[k,u]	—	—	12 ppm carbon (total PCBs)
	MDL	0.50 μg	0.50 μg	0.50 μg	0.50 μg	0.50 μg	0.50 μg	50 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080
Arochlor 1221	Fed	2.0 μg[k]	0.014 μg[k]	10 μg[k]	0.03 μg[k]	0.079 ng[b,k]	0.0005 mg[k] (F)	—
	WA	2.0 μg[k,u]	0.014 μg[k,u]	10 μg[k,u]	0.03 μg[k,u]	—	—	12 ppm carbon (total PCBs)
	MDL	0.50 μg	0.50 μg	0.50 μg	0.50 μg	0.50 μg	0.50 μg	50 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080
Arochlor 1232	Fed	2.0 μg[k]	0.014 μg[k]	10 μg[k]	0.03 μg[k]	0.079 ng[b,k]	0.0005 mg[k] (F)	—
	WA	2.0 μg[k,u]	0.014 μg[k,u]	10 μg[k,u]	0.03 μg[k,u]	—	—	12 ppm carbon (total PCBs)
	MDL	0.50 μg	0.50 μg	0.50 μg	0.50 μg	0.50 μg	0.50 μg	50 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080
Arochlor 1242	Fed	2.0 μg[k]	0.014 μg[k]	10 μg[k]	0.03 μg[k]	0.079 ng[b,k]	0.0005 mg[k] (F)	—
	WA	2.0 μg[k,u]	0.014 μg[k,u]	10 μg[k,u]	0.03 μg[k,u]	—	—	12 ppm carbon (total PCBs)
	MDL	0.50 μg	0.50 μg	0.50 μg	0.50 μg	0.50 μg	0.50 μg	50 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]
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		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA marine)
				PCBs				
Arochlor 1248	Fed	2.0 µg[k]	0.014 µg[k]	10 µg[k]	0.03 µg[k]	0.079 ng[b,k]	0.0005 mg[k] (F)	—
	WA	2.0 µg[k,u]	0.014 µg[k,u]	10 µg[k,u]	0.03 µg[k,u]	—	—	12 ppm carbon (total PCBs)
	MDL	0.50 µg	0.50 µg	0.50 µg	0.50 µg	0.50 µg	0.50 µg	50 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080
Arochlor 1254	Fed	2.0 µg[k]	0.014 µg[k]	10 µg[k]	0.03 µg[k]	0.079 ng[b,k]	0.0005 mg[k] (F)	—
	WA	2.0 µg[k,u]	0.014 µg[k,u]	10 µg[k,u]	0.03 µg[k,u]	—	—	12 ppm carbon (total PCBs)
	MDL	0.50 µg	0.50 µg	0.50 µg	0.50 µg	0.50 µg	0.50 µg	50 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080
Arochlor 1260	Fed	2.0 µg[k]	0.014 µg[k]	10 µg[k]	0.03 µg[k]	0.079 ng[b,k]	0.0005 mg[k] (F)	—
	WA	2.0 µg[k,u]	0.014 µg[k,u]	10 µg[k,u]	0.03 µg[k,u]	—	—	12 ppm carbon (total PCBs)
	MDL	0.50 µg	0.50 µg	0.50 µg	0.50 µg	0.50 µg	0.50 µg	50 ppb[yy]
	Method	GC 608	GC 608	GC 608	GC 608	GC 608	GC 608	GC 8080

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[xx]
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		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA marine)
DIOXINS AND FURANS								
2,3,7,8-TCDD	Fed	0.01 µg[a]	0.00001 µg[a]	—	—	0.000014 ng[b]	$5x10^{-8}$ mg (P)	—
	WA	—	—	—	—	—	—	—
	MDL	—	—	—	—	—	—	1 ppt[yy]
	Method	NA	NA	NA	NA	NA	NA	GC/MS 1613
1,2,3,7,8-PeCDD	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	—	—	—	—	—	—	5 ppt[yy]
	Method	NA	NA	NA	NA	NA	NA	GC/MS 1613
1,2,3,4,7,8-HxCDD	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	—	—	—	—	—	—	5 ppt[yy]
	Method	NA	NA	NA	NA	NA	NA	GC/MS 1613
1,2,3,6,7,8-HxCDD	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	—	—	—	—	—	—	5 ppt[yy]
	Method	NA	NA	NA	NA	NA	NA	GC/MS 1613

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]
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		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA marine)
DIOXINS AND FURANS								
1,2,3,7,8,9-HxCDD	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	—	—	—	—	—	—	5 ppt[yy]
	Method	NA	NA	NA	NA	NA	NA	GC/MS 1613
1,2,3,4,6,7,8-HpCDD	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	—	—	—	—	—	—	5 ppt[yy]
	Method	NA	NA	NA	NA	NA	NA	GC/MS 1613
Octachlorodibenzo-p-dioxin	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	—	—	—	—	—	—	10 ppt[yy]
	Method	NA	NA	NA	NA	NA	NA	GC/MS 1613
2,3,7,8-TCDF	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	—	—	—	—	—	—	1 ppt[yy]
	Method	NA	NA	NA	NA	NA	NA	GC/MS 1613

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]
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		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA marine)
DIOXINS AND FURANS								
1,2,3,7,8-PeCDF	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	—	—	—	—	—	—	5 ppt[yy]
	Method	NA	NA	NA	NA	NA	NA	GC/MS 1613
2,3,4,7,8-PeCDF	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	—	—	—	—	—	—	5 ppt[yy]
	Method	NA	NA	NA	NA	NA	NA	GC/MS 1613
1,2,3,4,7,8-HxCDF	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	—	—	—	—	—	—	5 ppt[yy]
	Method	NA	NA	NA	NA	NA	NA	GC/MS 1613
1,2,3,7,8,9-HxCDF	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	—	—	—	—	—	—	5 ppt[yy]
	Method	NA	NA	NA	NA	NA	NA	GC/MS 1613

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]
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		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA marine)
DIOXINS AND FURANS								
1,2,3,6,7,8-HxCDF	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	—	—	—	—	—	—	5 ppt[yy]
	Method	NA	NA	NA	NA	NA	NA	GC/MS 1613
2,3,4,6,7,8-H[illegible]	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	—	—	—	—	—	—	5 ppt[yy]
	Method	NA	NA	NA	NA	NA	NA	GC/MS 1613
1,2,3,4,7,8,9-HpCDF	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	—	—	—	—	—	—	5 ppt[yy]
	Method	NA	NA	NA	NA	NA	NA	GC/MS 1613
Octachlorodibenzo-furan	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	—	—	—	—	—	—	10 ppt[yy]
	Method	NA	NA	NA	NA	NA	NA	GC/MS 1613

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]
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		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA marine)
RADIONUCLIDES								
Americium-241	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	—	—	—	—	—	—	0.5pCi/g
	Method	NA	NA	NA	NA	NA	NA	Alpha Spec-troscopy
Cesium 137	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	—	—	—	—	—	—	0.5pCi/g
	Method	NA	NA	NA	NA	NA	NA	LN_2 Ge Det EPA 901.1
Cobalt-60	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	—	—	—	—	—	—	0.5pCi/g
	Method	NA	NA	NA	NA	NA	NA	LN_2 Ge Det EPA 901.1
Europium-152	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	—	—	—	—	—	—	0.5pCi/g
	Method	NA	NA	NA	NA	NA	NA	LN_2 Ge Det EPA 901.1

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]
(Page 49 of 59)

		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA marine)
RADIONUCLIDES								
Europium-154	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	—	—	—	—	—	—	2.0pCi/g
	Method	NA	NA	NA	NA	NA	NA	LN_2 Ge Det EPA 901.1
Plutonium-238, 239,240	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	—	—	—	—	—	—	0.5pCi/g
	Method	NA	NA	NA	NA	NA	NA	Alpha Spec-troscopy

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]
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		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA marine)
CONVENTIONALS								
Nitrogen TKN	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	0.03 mg	0.03 mg	0.03 mg	0.03 mg	0.03 mg	0.03 mg	NA
	Method	Colorimetric 351.2	Colorimetric 351.2	Colorimetric 351.2	Colorimetric 351.2	Colorimetric 351.2	Colorimetric 351.2	NA
NO_3-NO_2	Fed	—	—	—	—	—	10 mg (F) (nitrate + nitrite)	—
	WA	—	—	—	—	—	10 mg (nitrate as N)	—
	MDL	0.05 mg	0.05 mg	0.05 mg	0.05 mg	0.05 mg	0.05 mg	NA
	Method	Colorimetric 353.2	Colorimetric 353.2	Colorimetric 353.2	Colorimetric 353.2	Colorimetric 353.2	Colorimetric 353.2	NA
NH_3	Fed	[qq,v]	[rr,w]	—	—	—	— (L)	—
	WA	[qq,v]	[rr,w]	—	—	—	—	—
	MDL	0.03 mg	0.03 mg	0.03 mg	0.03 mg	0.03 mg	0.03 mg	NA
	Method	Colorimetric 350.1	Colorimetric 350.1	Colorimetric 350.1	Colorimetric 350.1	Colorimetric 350.1	Colorimetric 350.1	NA

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]
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		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA marine)
CONVENTIONALS								
Phosphorus	Fed	—	—	—	0.1 µg (elemental)	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	0.1 mg	0.1 mg	0.1 mg	0.1 mg	0.1 mg	0.1 mg	NA
	Method	Colorimetric 365.4	Colorimetric 365.4	Colorimetric 365.4	Colorimetric 365.4	Colorimetric 365.4	Colorimetric 365.4	NA
Total Suspended Solids	Fed	p	p	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	1 mg	1 mg	1 mg	1 mg	1 mg	1 mg	NA
	Method	Gravimetric 160.1	Gravimetric 160.1	Gravimetric 160.1	Gravimetric 160.1	Gravimetric 160.1	Gravimetric 160.1	NA
Turbidity	Fed	p	p	—	—	—	Performance Standard 0.5NTU-1.0-NTU (F)	—
	WA	m	m	—	—	—	o	—
	OR	r	r	—	—	—	—	—
	MDL	0.1 NTU	0.1 NTU	0.1 NTU	0.1 NTU	0.1 NTU	0.1 NTU	NA
	Method	Nephelometric 180.1	Nephelometric 180.1	Nephelometric 180.1	Nephelometric 180.1	Nephelometric 180.1	Nephelometric 180.1	NA

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]
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		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA marine)
CONVENTIONALS								
Hardness	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	1 mg	1 mg	1 mg	1 mg	1 mg	1 mg	NA
	Method	Titration 130.2	Titration 130.2	Titration 130.2	Titration 130.2	Titration 130.2	Titration 130.2	NA
TOC	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	1 mg	1 mg	1 mg	1 mg	1 mg	1 mg	200 ppm
	Method	Combustion 415.1	Combustion 415.1	Combustion 415.1	Combustion 415.1	Combustion 415.1	Combustion 415.1	Gravimetric 9060
Grain Size	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	—	—	—	—	—	—	0.01 mg
	Method	NA	NA	NA	NA	NA	NA	Gravimetric 43-2

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]
(Page 53 of 59)

		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA marine)
CONVENTIONALS								
Acid Volatile Sulfides	Fed	—	2 µg (undissociated H_2S)	—	2 µg (undissociated H_2S)	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	—	—	—	—	—	—	1 ppm
	Method	NA	NA	NA	NA	NA	NA	Ditoro et al (1989)
Total Solids	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	—	—	—	—	—	—	0.01 mg
	Method	NA	NA	NA	NA	NA	NA	Gravimetric Subset of 6010/7000 Series
Lipids	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	—	—	—	—	0.01 mg	—	—
	Method	NA	NA	NA	NA	Gravimetric Subset of 8290/8270	NA	NA

TABLE 5. ANALYTICAL METHODS, METHOD DETECTION LIMITS, AND WATER QUALITY CRITERIA FOR PARAMETERS ANALYZED[cc]

(Page 54 of 59)

		(Units per Liter)						Units as noted
Parameter	Category	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Fish Consumption	Drinking Water[bbb]	Sediment (WA marine)
CONVENTIONALS								
Fluoride	Fed	—	—	—	—	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	0.1 mg	0.1 mg	0.1 mg	0.1 mg	0.1 mg	0.1 mg	—
	Method	Distillation 340.1	Distillation 340.1	Distillation 340.1	Distillation 340.1	Distillation 340.1	Distillation 340.1	NA
BACTERIA								
Fecal Coliform	Fed	[q,uu]	[q,uu]	[uu]	[uu]	—	[ccc] (F)	—
	WA	[l]	[l]	[ww]	[ww]	—	[n]	—
	OR	[s]	[s]	[tt]	[tt]	—	—	—
	MDL	1 count/100ml	1 count/100ml	1 count/100ml	1 count/100ml	1 count/100ml	1 count/100ml	—
	Method	Membrane Filter 9222D	Membrane Filter 9222D	Membrane Filter 9222D	Membrane Filter 9222D	Membrane Filter 9222D	Membrane Filter 9222D	NA
Enterococcus	Fed	33/100ml[q]	33/100ml[q]	[vv]	[vv]	—	—	—
	WA	—	—	—	—	—	—	—
	MDL	1 count/100ml	1 count/100ml	1 count/100ml	1 count/100ml	1 count/100ml	1 count/100ml	—
	Method	Membrane Filter 9230C	Membrane Filter 9230C	Membrane Filter 9230C	Membrane Filter 9230C	Membrane Filter 9230C	Membrane Filter 9230C	NA

[a] Insufficient data to develop criteria. Value presented is the L.O.E.L.

[b] Human health criteria for carcinogens reported for three risk levels. Value presented is the 10^{-6} risk level.

[c] Under review by U.S. EPA.

[d] Value reported is for general category of polynuclear aromatic hydrocarbons.

[e] Value reported is for dichlorobenzene.

[f] Value reported is for para-Dichlorobenzene.

[g] Value reported is for DDT (and metabolites for Washington).

[h] Value reported is for DDE.

[i] Value reported is for endosulfan.

[j] Value reported is for BHC.

[k] Value reported is for PCBs.

[l] Fecal coliform organisms shall not exceed a geometric mean value of 100 organisms/100 mL, with not more than 10 percent of samples exceeding 200 organisms/100 mL.

[m] Turbidity shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTU.

[n] The MCL for coliform bacteria is as follows:

(I) When the membrane filter test is used, the number of coliform bacteria shall not be greater than:

- A. 1/100 mL as the average of all samples tested each month; or
- B. 4/100 mL in two or more samples when less than 20 samples are tested each month; or
- C. 4/100 mL in more than 5 percent of the samples when 20 or more samples are tested each month.

(II) When the five-tube MPN method is used, coliform bacteria shall not be present in:

- A. More than 10 percent of the tubes tested each month; or
- B. Three or more tubes in two or more samples when less than 20 samples are tested each month; or
- C. Three or more tubes in more than 5 percent of the samples when 20 or more samples are tested each month.

[o] The MCLs for turbidity are:

(I) One NTU, based on a monthly average of the maximum daily turbidity, where the maximum daily turbidity is defined as the average of the:

A. Highest 2 hourly readings over a 24-hour peiod when continuous monitoring is used; or
B. Daily grab samples taken within 1 hour when daily monitoring is used.

The department may increase the MCL to five NTUs if the purveyor can show the source is within a controlled watershed and the source meets the requirements under WAC 246-290-210 and 246-290-450.

(II) Five NTUs based on an average of the maximum daily turbidity for 2 consecutive days.

[p] For freshwater fish and other aquatic life: settleable and suspended solids should not reduce the depth of the compensation point for photosynthetic activity by more than 10 percent from the seasonally established norm for aquatic life.

[q] For freshwater bathing based on a statistically sufficient number of samples, the geometric mean of the bacterial densities should not exceed one or the other of:

E. coli	126 per 100 mL; or
Enterococci	33 per 100 mL

[r] No more than 10 percent cumulative increase in natural stream turbidities, as measured relative to a control point immediately upstream of the turbidity causing activity.

[s] Columbia River from Highway 5 bridge between Vancouver and Portland to the mouth: a log mean of 200 fecal coliform per 100 mL based on a minimum of 5 samples in a 30-day period with no more than 10 percent of the samples in the 30-day period exceeding 400/100 mL.

[t] An instantaneous concentration not to be exceeded at any time.

[u] A 24-hour average not be exceeded.

[v] A 1-hour average concentration not to be exceeded more than once every 3 years.

[w] A 4-day average concentration not to be exceeded more than once every 3 years.

[x] $\leq e^{(1.128[\ln(\text{hardness})] -3.828)}$

[y] $\leq e^{(0.7852[\ln(\text{hardness})] -3.490)}$

[z] $\leq e^{(0.9422[\ln(\text{hardness})] -1.464)}$

[aa] $\leq e^{(0.8545[\ln(\text{hardness})] -1.465)}$

[bb] $\leq e^{(1.273[\ln(\text{hardness})] -1.460)}$

[cc] $\leq e^{(1.273[\ln(\text{hardness})] -4.705)}$

[dd] $\leq e^{(0.8460[\ln(\text{hardness})] +3.3612)}$

[ee] $\leq e^{(0.8460[\ln(\text{hardness})] +1.1645)}$

[ff] $\leq e^{(1.72[\ln(\text{hardness})] -6.52)}$

[gg] $\leq e^{(0.8473[\ln(\text{hardness})] +0.8604)}$

[hh] $\leq e^{(0.8473[\ln(\text{hardness})] +0.7614)}$

[ii] $\leq e^{(1.005(\text{pH}) -4.830)}$

[jj] $\leq e^{(1.005(\text{pH}) -5.290)}$

[kk] Hardness dependent criteria (100 mg/L used).

[ll] $\leq e^{(0.8190[\ln(\text{hardness})] +3.688)}$

[mm] $\leq e^{(0.8190[\ln(\text{hardness})] +1.561)}$

[nn] Salinity dependent effects. At low salinity the 1-hour average may not be sufficiently protective.

[oo] The status of the fish community should be monitored whenever the concentration of selenium exceeds 5.0 ug/L in salt water.

[pp] pH dependent criteria (7.8 pH used).

[qq] Shall not exceed the numerical value given by:

$$\frac{0.52}{FT/(FPH/2)}$$

where: FT $= 10^{[0.03(0-TCAP)]}; TCAP \leq T \leq 30$

FT $= 10^{[0.03(20-T)]}; 0 \leq T \leq TCAP$

FPH $= 1 ; 8 \leq pH \leq 9$

FPH $= \dfrac{1+10^{(7.4-pH)}}{1.25}; 6.5 \leq pH \leq 8.0$ (WA) or 7.7 (EPA National Criteria)

TCAP = 20°C;Salmonids or other cold water species present.

TCAP = 25°C;Salmonids and other cold water species absent.

[rr] Shall not exceed the numerical value given by:

$$\frac{0.80}{FT/(FPH/RATIO)}$$

where: RATIO $= 16; 77 \leq 7.7 \leq pH \leq 9$

RATIO $= 24 \times \dfrac{10^{(7.7-pH)}}{1+10^{(7.4-pH)}}; 6.5 \leq pH \leq 7.7$

where: FT and FPH are as shown in (f) above except:

TCAP = 15°C;Salmonids or other cold water species present.

TCAP = 20°C;Salmonids or other cold water species absent.

[ss] Measured in milligrams per liter rather than micrograms per liter.

[tt] For marine and estuarine shellfish growing waters: A fecal coliform median concentration of 14 organisms/100 mL, with not more than 10 percent of the samples exceeding 400/100 mL.

[uu] For shellfish harvesting waters: the median fecal coliform bacterial concentration should not exceed 14 MPN per 100 mL with not more than 10 percent of samples exceeding 43 MPN per 100 mL for the taking of shellfish.

[vv] For marine water bathing: based on a statistically sufficient number of samples, the geometric mean of the enterococci densities should not exceed 35 per 100 mL.

[ww] Fecal coliform organisms shall not exceed a geometric mean value of 14 organisms/100 mL, with not more than 10 percent of samples exceeding 43 organisms/100 mL.

[xx] Methods specified are from the following references: Water (U.S. EPA 1982, 1983; APHA 1989), Sediment and Tissue (U.S. EPA 1980, 1984, 1986b, 1989; Ditoro et al. 1989; American Society of Agronomy 1985). MDLs listed are those achievable by the laboratories contracted for this project. Tissue MDLs and methods are the same as for sediments. Criteria sources: Federal Water Quality and Fish Consumption Criteria (EPA 1986a); Federal Drinking Water Criteria (EPA 1991c); Washington Water Quality Criteria (WAC 173-201, 1988); Washington Drinking Water Criteria (WSR 91-07-031, 1991); and Washington Marine Sediment Criteria (WAC 173-204, 1991). Current Oregon criteria for the categories listed are the same as federal criteria; therefore, these criteria are not listed here.

[yy] Dry-weight basis.

[zz] Value reported is for phthalate esters.

[aaa] Aldrin is metabolically converted to Dieldrin. Therefore, the sum of the Aldrin and Dieldrin concentrations are compared with the Dieldrin criteria.

[bbb] Regulatory status:

F = final
D = draft
L = listed for regulation
P = proposed

[ccc] No more than 5% of the samples per month may be positive. For systems collecting fewer than 40 samples/month, no more than 1 sample per month may be positive.

TABLE 6. SUMMARY OF QUALITY CONTROL SAMPLES[a]

Analysis Type	Recommended Frequency of Analysis
Surrogate spikes	Required in batch – minimum three neutral, two acid spikes, plus one spike for pesticide/PCB analyses, and three spikes for volatiles. Isotope dilution technique (i.e., with all available labeled surrogates) is recommended for full scan analyses and to enable recovery corrections to be applied to data.
Method blank	Two per set of samples.
Matrix spikes[b]	Not required if complete isotope dilution technique used <20 samples: one per set of samples submitted to lab for conventional analyses, 2 per set of samples for organic and metals analyses. ≥20 samples: 5 percent of total number of samples.
Check standards	One check standard at 0.9 times the concentration of the highest calibration standard per batch of samples, and one at 0.2 times the highest calibration standard per batch of samples.
Analytical replicates	<20 samples: one per set of samples submitted to lab ≥20 samples: one triplicate and additional duplicates for a minimum of 5 percent total replication.
Field duplicates	10% of samples.

[a] Does not apply to bacteria (with the exception of field duplicates) or radionuclide analyses.

[b] Does not apply to the following criteria: conductivity, hardness, pH, TOC, TSS, total solids, turbidity, lipids.

9.0 LABORATORY QA/QC

A rigorous laboratory QA/QC program traces the historical record of laboratory data and allows one to track reproducibility, accuracy, and precision of the analytical results. The objective of the laboratory quality assurance program for analytical measurements is to reduce measurement errors to agreed-upon limits and to assure that the results have a high probability of being of acceptable quality. Quality control is the mechanism established to control errors.

A quality control program in a laboratory includes the following:

1. Development of and strict adherence to principles of good laboratory practice

2. Consistent use of standard operating procedures

3. Establishment of and adherence to carefully designed protocols for specific measurements programs

4. Reliable and well maintained equipment

5. Appropriate calibrations and standards

6. Close supervision of all operations by management and senior personnel, including review of data calculations for errors or omissions.

When properly conceived and executed, a quality control program will result in a measurement system operating in a state of statistical control, which means errors have been reduced to acceptable levels and characterized statistically.

Tetra Tech has reviewed the QA/QC manuals submitted by the three major laboratories on this study, Precision Analytics, Keystone/NEA, and Alden Laboratories, to ensure that an ongoing rigorous QA/QC program is part of standard laboratory practice. These QA/QC plans are on file at the Tetra Tech office in Bellevue, WA. Each plan describes the QA and QC programs, equipment, training, analytical procedures, sample tracking, sample storage and disposal, and health and safety programs in each lab.

9.1 INTERNAL QUALITY CONTROL CHECKS

Each analytical laboratory will demonstrate its ability to produce acceptable results using the recommended methods. This is consistent with EPA QA/QC guidelines and contract laboratory guidelines. Data will be evaluated based on the following criteria (as appropriate for inorganic or organic chemical analyses):

- Performance on method tests (U.S. EPA 1980, 1982, 1983, 1984, 1986, 1989)
- Percent recovery of surrogate standards
- Adequacy of detection limits obtained
- Precision of replicate analyses
- Comparison of the percentage of missing or undetected substances among replicate samples
- Percent recovery of spike compounds
- Results of check standards.

Table 6 summarizes the quality control samples and their recommended frequency of analysis.

The analytical laboratory will be required to submit data supported by sufficient backup and QA information to permit independent determination of data quality. Deliverables submitted by the laboratory will include the information described below.

9.2 ORGANIC COMPOUND ANALYSIS DELIVERABLES FOR QA

1. Case narrative that includes a summary of any quality control, sample, shipment, or analytical problems, and documentation of all internal decisions. Problems will be outlined and final solutions documented. A copy of the signed chain-of-custody form for each group of samples will be included in the narrative packet.

2. Sample concentrations reported on standard data sheets in proper units and to the appropriate number of significant figures (i.e., one significant figure for concentrations less than 10 and two significant figures for concentrations greater than 10). For undetected values, the lower limit of detection of each compound will be reported separately for each sample. Date of sample analysis must be included.

3. Surrogate percent recovery summary for all organic analyses.

4. Matrix spike/matrix spike duplicate results.

5. Method blank summary.

6. Check standard data.

7. Replicate sample results.

When conducting organic analyses on the GC/MS or HRGC/HRMS, the laboratories will also be asked to deport and tentatively identify major peaks beyond those specified by the method.

9.3 INORGANIC COMPOUND ANALYSES DELIVERABLES FOR QA

1. Case narrative that includes a summary of any quality control, sample, shipment, and analytical problems, and documentation of all internal decisions. Problems will be outlined and final solutions documented. A copy of the signed chain-of-custody form for each group of samples will be included in the narrative packet.

2. Sample concentrations reported on standard data sheets in proper units and to the appropriate number of significant figures (i.e., one for concentrations less than 10, two for concentrations greater than 10). For undetected values, the lower limits of detection of each element will be reported separately for each sample.

3. Matrix spike results.

4. Replicate sample results.

5. Method blank results.

6. Check standard data.

Data will be compared to the project data quality objectives to determine if the data are sufficient for project tasks.

Sample holding times will be calculated by comparing the date of sample collection, shown on the summary sampling logs, with the date of sample analysis (and extraction when appropriate), presented with sample results. Laboratory Certificates of Analysis with complete sample results will be due from the laboratories within 30 days after the laboratory receives each sample group.

9.4 CALCULATIONS

The equations presented below will be used to determine if data meet the data quality objectives.

The mean, $\overline{C}$, of a series of replicate measurements of concentration, C_i, for a given surrogate compound or analyte will be calculated as follows:

$$\overline{C} = \frac{1}{n} \sum_{i=1}^{n} C_i$$

where:

n = Number of replicate measurements.

The estimate of precision of a series of replicate measurements will usually be expressed as the relative standard deviation, RSD:

$$RSD = \frac{SD}{\overline{C}} \times 100$$

where:

SD = Standard deviation:

$$SD = \sqrt{\frac{\sum_{i=1}^{n} (C_1 - \bar{C})^2}{(n-1)}}$$

Alternatively, for data sets with a small number of points (e.g., duplicate measurements), the estimate of precision may be expressed as:

$$SD = \sqrt{\frac{C_1 - C_2}{2}}$$

where:

C_1 = First concentration value measured for a variable.

C_2 = Second concentration value measured for a variable.

The analytical precision can then be compared with overall precision for all duplicate results by the following equation:

$$SDp = \sqrt{\frac{(C_1 - C_2)^2}{2m}}$$

where:

SDp = Pooled standard deviation.

m = Pairs of duplicate results.

Accuracy as measured by matrix spike results will be calculated as:

$$\text{Recovery} = \frac{DC}{C_s} \times 100$$

where:

DC = The measured concentration increase due to spiking (relative to the unspiked portion)

C_s = The known concentration in the spike.

Completeness will be measured for each set of data received by dividing the number of valid measurements actually obtained by the number of measurements planned.

10.0 CORRECTIVE ACTIONS

Corrective actions taken during a sampling program fall into two categories: 1) analytical or equipment malfunctions, and 2) nonconformance or noncompliance with QA requirements set forth for the project.

The QA Officer listed in Table 1 is responsible for auditing performance of the field team and analytical laboratories for adherence to predetermined methods, limits of acceptability, and required sample handling described in this report. The QA Officer will outline the corrective actions required to conform to project specifications in the Corrective Actions Checklist (Figure 6). Corrective actions taken will be documented in the field logbook.

In terms of internal laboratory corrective action, all labs will be required to adhere to U.S. EPA and standard operating procedure guidelines and specifications. When instrument response, quality control sample (MS/MSD, check standard, or duplicate) precision or accuracy, or blank analyses indicate exceedance of control limits, the laboratory will investigate the problem before continuing with sample analysis.

10.1 CORRECTIVE ACTIONS CHECKLIST

The Quality Assurance Officer or his designee will issue a Corrective Actions Checklist for each nonconforming condition identified (i.e., when objectives for precision, accuracy, completeness, representatives, or comparability are not satisfied or when unacceptable procedural practices or conditions are identified). The Laboratory Quality Assurance Manager will issue a Corrective Actions Checklist concerning laboratory performance and will submit the report to the Project Manager and Quality Assurance Officer.

The Corrective Actions Checklist will fully describe the conditions requiring corrective action, will indicate the nature of the corrections required, and will specify a schedule for compliance. The final authority for issuance of a Corrective Actions Checklist rests with the Quality Assurance Officers who will notify the Project Manager.

CORRECTIVE ACTIONS CHECKLIST

SAMPLE PROGRAM IDENTIFICATION: ____________________

SAMPLING DATES: ____________________

MATERIAL TO BE SAMPLED: ____________________

MEASUREMENT PARAMETER: ____________________

ACCEPTABLE DATA RANGE: ____________________

____

CORRECTIVE ACTIONS INITIATED BY: ____________________

TITLE: ____________________ DATE: ____________________

PROBLEM AREAS REQUIRING CORRECTIVE ACTION: ____________________

____

____

____

____

____

MEASURES TO CORRECT PROBLEMS: ____________________

____

____

____

____

MEANS OF DETECTING PROBLEMS (FIELD OBSERVATIONS, SYSTEMS AUDIT, ETC.): ____________________

____

APPROVAL FOR CORRECTIVE ACTIONS: ____________________

____

____

TITLE: ____________________

SIGNATURE OF QA OFFICER: ____________________ DATE: ____________________

Figure 6. Typical Corrective Actions Checklist

10.2 CORRECTIVE ACTION

Upon the issuance of a Corrective Action Checklist, it will be delivered to the Laboratory Manager, the Project Manager and/or organization involved. The Corrective Actions Checklist will provide space for the responsible individual to indicate the nature of the corrective action taken and will include measures to preclude a repetition of the original deficiency. After the issue has been reviewed and the corrective action is acceptable, the Quality Assurance Officer and the Laboratory Quality Assurance Manager (if applicable) will sign the Corrective Actions Checklist to this effect and inform the involved parties that the nonconforming condition has been satisfactorily resolved.

10.3 CAUSE AND ACTION TO PREVENT RECURRENCE

The Quality Assurance Officer will track the Corrective Actions Checklist, analyze the corrective actions required, and take the necessary steps to resolve the causes of the non-conforming conditions in order to prevent recurrence.

11.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

Sample data will be subjected to a QA review upon receipt from the laboratory. Sample results will be reviewed for conformance with QA/QC guidelines specified for the methods used using U.S. EPA guidelines for data validation (U.S. EPA 1988a,b). Items reviewed during data validation will include sample holding times, results for laboratory methods blanks, matrix spike/matrix spike duplicates (MS/MSDs), check standards, field and laboratory duplicates, and laboratory performance (i.e., ability to achieve method detection limits and adherence to QA/QC criteria established for this project). An estimation of data quality (precision and accuracy) based on sample results will also be provided.

Data qualifiers will be assigned to sample results based on QA/QC criteria. Data qualifiers serve to modify the usefulness of the individual compound concentrations by evaluating the reliability of the data. The following are definitions for data qualifiers:

U – The material was analyzed for, but was not detected. The associated numerical value is the sample quantitation limit.

UJ – The material was analyzed for, but was not detected. The sample detection limit is an estimated quantity.

J – The associated numerical value is an estimated quantity.

R – The data are unusable, compound may or may not be present. Re-sampling and reanalysis are necessary for verification.

The Project QA officer will also summarize the field sampling procedures and data, and note significant QA problems that have occurred during the field investigation.

The final field survey report will contain copies of the following information, where appropriate:

1. Laboratory data packages (see Sections 9.2 and 9.3)
2. Summary sampling log
3. Sampling alteration checklist
4. Chain-of-custody forms
5. Sample analysis request/packing lists
6. Tracking form
7. Corrective actions taken

A QA report will also be included, which will 1) summarize the results of the data quality review, including the results of system audits; 2) assess data accuracy, precision, and completeness; and 3) discuss any significant problems and recommendations.

12.0 HEALTH AND SAFETY PLAN

The health and safety plan describes chemical and physical hazards associated with field sampling. It also presents safe work practices and emergency information in case medical assistance is required during field operations.

12.1 SAFETY OFFICER

To ensure safe and efficient shipboard operations, the chief scientist will be the safety officer responsible for all shipboard operations, including evaluation of hazardous conditions, ensuring compliance with safety precautions, and suspension of shipboard operations if necessary. A halt or suspension of operations can also be dictated by the vessel master.

12.2 HAZARDS

Hazards encountered during sampling are generally classified as either chemical or physical. Chemical hazards are twofold: chemicals used on deck to decontaminate sampling gear, and contaminants or hazardous materials potentially present within the sediments or water sampled. Physical hazards are associated with the sampling gear, vessel, and work conditions at sea.

12.2.1 Chemical Hazards

Stations to be sampled during the reconnaissance survey are not expected to contain hazardous materials that would require use of extraordinary precautions (i.e., Tyvek suits, respirators). During field operations, if evidence of contaminated sediments is observed, odors, colors, or the presence of debris, petroleum products or excessive organic enrichment, suitable protective measures for the crew will be instituted such as gloves, protective clothing or respirators.

12.2.2 Physical Hazards

Gear deployment and retrieval present hazards because of the heavy weight of the sampling gear, its suspension above the deck, and the risk of accidental and premature closure. Safety pins will be in place on the van Veen grab whenever it is inboard of the vessel rail. The triggering mechanism will always be set when the grab is resting on a stable surface. Special

care will be exercised when removing the safety pin to ensure personnel safety in the unlikely event of a gear or winch failure.

During retrieval of sampling equipment (van Veen grab or isokinetic water sampler), at least one crew member will watch for the appearance of the equipment and will alert the winch operator when the equipment is visible below the water surface and when it breaks the water surface. Failure to monitor equipment retrieval and slow the winch upon surfacing may lead to breakage of the cable, loss or damage of the gear, and possible injury from either the falling grab or the snapped cable end. In addition, monitoring the grab retrieval will alert other personnel to be positioned to safely bring the grab aboard.

After prolonged use, individual strands of the winch cable may break. Sampling personnel will be instructed to avoid contact with the moving cable unless protected by work gloves. On a periodic basis over the length of the sampling cruise, the chief scientist will inspect the cable for wear, especially where the wire is attached to the sampling gear. The chief scientist will also periodically inspect all shackles, pins, housing, swivels and thimbles to ensure the integrity of all points along the cable. Likewise, all on–deck crew members will be encouraged to periodically inspect these linkages.

The winch drum, the blocks, and the area between the sampling equipment and the rail, deck, or other large equipment all represent significant pinching and crushing hazards. Personnel will be instructed to keep their hands, feet, and clothing clear of these points.

Lines, hoses, hatch covers, coolers, and mud on the deck all present tripping, slipping, and falling hazards. Every crew member will make an effort to keep the working surfaces of the deck clear and clean by coiling hoses and lines, and rinsing accumulations of mud from the deck. Awareness of the locations and status of hatch covers and other gear in use will be maintained at all times.

A drowning hazard exists during work on the river. Sampling operations will be conducted to minimize the need for any personnel to work on or over the rail of the vessel. The most significant drowning hazard is associated with tripping (discussed above) or conditions of excessively rough weather. Life vests will be available for all personnel working on the rear deck, and must be donned when directed by the chief scientist/safety officer, or vessel operator. The vessel is also equipped with throwable life rings, and each crew member will be briefed on their storage location.

Fatigue presents a serious hazard when working on the river. It can be compounded by the motion of the vessel, exposure, or heat stress. Personnel shall monitor their own condition and capabilities and be responsible for taking appropriate measures (discussed below) to relieve fatigue, exposure, or heat stress. The chief scientist/safety officer and vessel operator can also direct any member of the crew to cease working.

12.3 SAFE WORK PRACTICES

An exclusion/contamination reduction zone will include the areas where sediments and meth-anal will be handled. Duct tape placed on the vessel deck will delineate the line between the clean zone and the exclusion/contamination zone.

Precautions employed in the handling of chemicals will include restricting their use to the deck, storing and dispensing them from narrow-mouth bottles, and exercising care in their use. Rinsing of sampling equipment will be conducted over a stainless steel basin, so that the excess solvent will not be spilled on the deck and vapors can freely escape. Latex gloves will be worn when handling the solvent, sediments, and sampling gear. All crew members will remain aware of the sea state and the presence of wakes or other disturbances that could lead to spillage.

Crew members may be required to wear hardhats when working on the rear deck as directed by the chief scientist/safety officer. Work gloves will be available, but are not required. Floatation vests will be provided and may be worn by the crew at their own discretion unless required by the chief scientist/safety officer or vessel operator if weather or work conditions warrant.

Each crew member is expected to bring clothing appropriate to the weather and task to minimize the hazards of exposure and heat stress. Boots and rain gear or other waterproof clothing will be required.

During sampling equipment deployment and retrieval, personnel will pay close attention to the position of the equipment grap, the motion of the boat, mobility impeding obstructions on deck, and actual or potential fouling of the equipment. Hands and feet must never be placed underneath the grab. Safety pins will be removed only when the equipment is over the rail.

Weather conditions will be monitored by the chief scientist and vessel operator. The vessel will be supplied with life rings or other emergency floatation equipment, and a fire extinguisher. Food and shelter (the vessel's cabin) will be provided to the sampling crew.

12.4 EMERGENCY PLANNING

If an emergency or accident occurs during sampling, the chief scientist/safety officer and vessel operator will be responsible for determining the appropriate response. They will assess the severity of the incident and, if appropriate, contact the appropriate personnel for emergency assistance. A cellular telephone and marine radio will be available to all crew members in the event that the vessel operator and chief scientist are incapacitated. The vessel operator will be responsible for moving the boat to an appropriate position for receipt of emergency aid, if necessary. A basic first-aid kit is kept aboard for the treatment of minor cuts or abrasions. All accidents will be required to be reported to the chief scientist and recorded in the cruise log.

Contact information on local emergency services, hospitals, and ambulance services will be aboard the boat in a location accessible to all personnel while using the cellular phone or marine radio. Emergency phone numbers for air-life ambulance services are listed below. They are not to be used for general information.

Air-Evac International	1-800-854-2569
Airlift Northwest	1-800-542-1646
EMS Helicopters	1-800-733-3096

12.5 DISTRIBUTION OF INFORMATION AND INSTRUCTION

All sampling crew and observers will be alerted to potential hazards, safe work practices, locations of the clean and exclusion/contamination reduction zones, and emergency responses prior to the initiation of field work. A number of measures will be undertaken to ensure appropriate response to emergency situations, including the following:

- A pre-cruise briefing of cruise members to provide an overview of safety and cruise plans;

- Each crew member will be given a copy of this safety plan prior to participation on the cruise;

- Copies of this safety plan will be available on the vessel and at the shore-support vehicle;

- Prior to the start of each day's sampling activities, the chief scientist will ensure that all safety equipment is on board; and

- The chief scientist and/or vessel operator will brief all guest observers concerning the safety requirements and procedures to be adhered to during sampling operations.

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APPENDIX A

GLOSSARY OF TERMS

APPENDIX A
GLOSSARY OF TERMS

AUDIT

A systematic check to determine the quality of operation of some function or activity. Audits may be of two basic types: 1) performance repeated audits in which quantitative data are independently obtained for comparison with routinely obtained data in a measurement system, or 2) system audits of a qualitative nature that consist of an onsite review of the field or laboratory QA system and physical facilities for sampling, calibration, and measurement.

DATA QUALITY

The totality of features and characteristics of data that influence their ability to satisfy a given purpose. The characteristics of major importance are accuracy, precision, completeness, representativeness, and comparability.

Accuracy
The degree of agreement of a measurement (or an average of measurements of the same thing), X, with accepted reference or true value, T. This is usually expressed as the difference between the two values, X–T, or the difference as a percentage of the reference or true value, 100 (X–T)/T. It may also be expressed as the ratio, X/T. Accuracy is a measure of bias in a system.

Precision
A measure of the amount of variability among individual measures of the same property, under prescribed similar conditions. Precision is expressed in terms of standard deviation, relative percent difference, or coefficient of variation. Various measures of precision exist depending upon the prescribed similar conditions.

Completeness

A measure of the amount of valid data obtained from a measurement system compared to the amount that was intended in the sampling design. A certain percentage of the intended amount of data must be successfully collected for conclusions based on the data to be valid. Missing or incomplete data may reduce the precision of estimates, introduce bias, and thus lower the level of confidence in the conclusions.

Representativeness

Expresses the degree to which data accurately and precisely represent a characteristic of a population, variations within a sampling point, a process condition, or an environmental condition.

Comparability

Expresses the confidence with which one data set can be compared to another.

DATA QUALITY OBJECTIVES

Data quality objectives (DQOs) are qualitative and quantitative statements regarding the minimum quality of data needed to support a specific objective or decision. For cost effective experimental design, it is necessary to anticipate the quality of data needed from the research project and to document this in terms of DQOs. DQOs are established prior to collecting data, which is necessary for a clear understanding of what is expected of the data.

DATA VALIDATION

A systematic process for reviewing a body of data against a set of criteria to provide assurance that the data are adequate for their intended use. Data validation consists of data editing, screening, checking, auditing, verification, and certification.

ENVIRONMENTALLY RELATED MEASUREMENTS

A term to describe essentially all field and laboratory investigations that generate data for 1) measuring chemical, physical, or biological variables in the environment; 2) determining violations of water quality criteria in waste streams; 3) assessing health and ecological effects;

4) conducting clinical and epidemiological investigations; 5) performing engineering and process evaluations; 6) studying laboratory simulation of environmental events; and 7) studying or measuring pollutant transport and fate, including diffusion models.

PERFORMANCE AUDITS

Procedures to quantitatively determine the accuracy and precision of the total measurement system or its component parts. Generally, samples of known concentration in a stable medium are analyzed to evaluate performance.

QUALITY ASSURANCE

The total program for assuring the reliability of monitoring and measurement data. QA is a system for integrating the quality planning, quality assessment, and quality improvement efforts to meet user requirements.

QUALITY ASSURANCE PROGRAM PLAN

An orderly assembly of detailed and specific procedures that delineate how data of known and accepted quality are generated to accomplish project objectives. (A given agency or laboratory would have only one quality assurance program plan, but would have a quality assurance project plan for each project.)

QUALITY CONTROL

The routine application of statistical procedures to control and document the accuracy of the measurement process.

STANDARD OPERATING PROCEDURES

Standard operating procedures (SOPs) include details of an operation, analysis, or action whose mechanisms are thoroughly prescribed and commonly accepted as the method for performing certain routine or repetitive tasks. SOPs are prepared for all routine activities that have known or suspected direct impact on the quality of environmental data.

APPENDIX B

STANDARD OPERATING PROCEDURES

APPENDIX B
CONTENTS

FISH TISSUE PREPARATION – PCB/PESTICIDES AND BNA ANALYSES B–1

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FISH TISSUE PREPARATION - PCB/PESTICIDES AND BNA ANALYSES

1.0 SCOPE AND APPLICATION

1.1 This method covers the extraction of Pesticides/PCBs and Polynuclear Aromatic Hydrocarbons from a tissue matrix (i.e., clams and worms).

2.0 SUMMARY OF METHOD

2.1 A measure volume of sample, usually 20 g for clams and 1-6 g for worms, is macerated and extracted with acetone using a sonicator. The extract is dried, concentrated, exchanged into hexane and brought to a 2 ml final volume.

2.2 A 0.5 ml aliquot of extract is then cleaned up by a 3% deactivated florisil micro column technique. The aliquot is brought to a final volume of 1.0 ml.

3.0 INTERFERENCES

3.1 Solvents, reagents, glassware and other sample processing hardware may yield residues and/or other interferences to sample analysis. All glassware which will come in contact with the sample must be washed in hot soapy water, rinsed with tap water, rinsed with reagent water and allowed to dry. All glassware/hardware is rinsed once with acetone and twice with methylene chloride prior to use.

3.2 Phthalate esters contaminate many types of products commonly found in the laboratory. Plastics, in particular, must be avoided because phthalates are commonly used as plasticizers and are easily extracted from plastic materials. Method blanks are extracted to show if any serious phthalate contamination is occurring.

4.0 SAFETY

4.1 The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; however, each chemical compound should be treated as a potential health hazard. From this viewpoint, exposure to these chemicals must be reduced to the lowest possible level by whatever means available.

4.2 Eye protection is to be worn in the lab at all times. Gloves and protective clothing are also worn. Methylene chloride creates excess pressure very rapidly, therefore, the separatory funnel should be vented several times during shaking.

5.0 APPARATUS AND MATERIALS

5.1 400 ml beaker

5.2 Long stem funnel: 125 mm diameter, 4" stem.

5.3 Kuderna-danish (K-D) apparatus:

5.3.1 Concentrator tube: 25 ml graduated. Ground-glass stopper is used to prevent evaporation of extracts.

5.3.2 Evaporation flask: 500 ml (Lab-Glass LG-6865-114). Attached to concentrator tube with springs.

5.3.3 Snyder-Column: Three ball macro. (Kontes K-503000-0121 or equivalent.)

5.4 Boiling chips: Solvent extracted, approximately 10/40 mesh Teflon.

5.5 Water bath: Heated, with concentric ring cover, capable of temperature control (+5°C). The bath is used in a hood.

5.6 N-EVAP: Organomation analytical evaporator or equivalent with tank of pure N2.

5.7 Vials: Borosilicate 8 ml capacity C teflon lined screw cap.

5.8 2 ml disposable transfer pipets, 9".

5.9 Graduated cylinder 100 ml.

5.10 Sonication: A horn-type sonicator equipped with a stainless steel tip. Heat Systems-Ultrasonics, Inc. Ultrasonic Processor W-385 and 3/4 inch tapped disrupter horn.

5.11 Top loading balance with an accuracy of +0.01 g.

5.12 2 ml disposable transfer pipettes, 9".

6.0 REAGENTS

6.1 Reagent water: This water is defined as water in which an interferant is not observed at the method detection limit of the compounds of interest. The water is produced by a Barnsted/Thermodyne NANOpure water system.

6.2 Sodium sulfate: (ACS) Granular and powdered anhydrous (can be purified by heating at 400°C for 4 hours in a shallow tray and stored in a glass container).

6.3 Extraction/exchange solvent: Acetone and hexane (pesticide residual or equivalent).

6.4 Solvent extracted glass wool, fine.

7.0 EXTRACTION

7.1 Weigh out 20 g of clams (previously macerated) or transfer pre-weighed worm sample (previously macerated) into a 400 mL beaker. Record weight to nearest 0.01 g. Add 60 g of sodium sulfate to clam sample only. Immediately add 100 mL of acetone. Add the appropriate amounts of the spiking standard to matrix spike and matrix spike duplicate on set for each analytical batch. Add appropriate amounts of surrogate stock to all samples. Check with analyst for amounts and type of spike and surrogate added.

7.2 Place the bottom surface of the sonicator disruptor horn about 0.5-inch below the surface of the solvent. The tip should not extend into the sediment layer.

7.3 Sonicate for 6 minutes, with output control knob set at 10 with mode switch on pulse and cycle percent knob set at 50 percent. The tissue should be visibly disrupted when sonicating.

7.4 Assemble a Kuderna-Danish (K-D) concentrator by attaching a 10 mL concentrator tube to a 500 mL evaporation flask.

7.5 Dry the extract by passing it through a long-stem funnel containing about 100 g of anhydrous sodium sulfate. Collect the dried extract in a K-D apparatus.

7.6 Repeat the extraction two more times with additional 100 mL portions of solvent.

7.7 Add one or two clean boiling chips to the flask and attach a three-ball Snyder column. Pre-wet the Snyder column by adding about 1 mL of methylene to the top of the column. Place the K-D apparatus on a hot water bath (95-100° F) so that the concentrator tube is partially immersed in the hot water and entire lower rounded surface of the flask is bathed with hot vapor. At the proper rate of distillation, the balls of the column will actively chatter, but the chambers will not flood. When the apparent volume of the liquid extract reaches 5 mL, remove the K-D apparatus from the water bath and allow it to cool for about 10 minutes, draining all the liquid extract into the concentrator tube. A water layer may be present in addition to the solvent.

7.8 Remove the Snyder column and rinse the flask and its lower joints into the concentrator tube with 1-2 mL of methylene chloride.

7.9 If further concentration is needed, place the concentrator tube containing the extract on the N-EVAP apparatus. Lower the metal tube down just above extract liquid. Pass a gentle stream of nitrogen over the top of the extract. Continue to N-EVAP until the volume of the extract is a little less than the desired final volume.

7.10 Quantitatively transfer the solvent excluding the aqueous layer to a 8 mL vial. The tube is rinsed and rinsate is added to vial to a final volume of 2 mL. Several small rinses is preferred over one large one.

8.0 CLEANUP

8.1 Due to matrix interference, all tissue extracts must be cleaned up by 3 percent deactivated florisil cleanup. Refer to SOP Florisil cleanup, method A3620, for procedure.

9.0 QUALITY CONTROL

9.1 A method blank, a matrix spike and a matrix spike duplicate must be prepared for each analytical batch 920 examples), to determine matrix effect and to assure that no interference is contributed by the glassware.

10.0 METHOD PERFORMANCE

10.1 The recovery of matrix spiking compounds indicates the presence or absence of unusual matrix effects.

11.0 REFERENCE

11.1 SW-846 3rd Edition, EPA Method 3550, "Soil Sonication."

LIPID CONTENT DETERMINATION

Fish Tissue: To determine the lipid content of fish tissue, concentrate 125 mL of the fish tissue extract in a tared 200 mL round bottom flask, on a rotary evaporator until a constant weight (W) is achieved.

TISSUE EXTRACTION FOR DIOXINS/FURANS (EXCERPT OF U.S. EPA METHOD 8290)

(Note: Section Numbers are as they appear in the procedure)

13.1 Add 60 g anhydrous sodium sulfate to a 20 g portion of a homogenous fish sample (Section 6.3) and mix thoroughly with a stainless steel spatula. After breaking up any lumps, place the fish/sodium sulfate mixture in the Soxhlet apparatus on top of a glasswool plug. Add w50 mL methylene chloride or hexane/methylene chloride (1:1) to the Soxhlet apparatus and reflux for 16 hours. The solvent must cycle completely through the system five times per hour. Follow the same procedure of the partially dewatered paper pulp sample (using a 10 g sample, 30 g of anhydrous sodium sulfate and 200 mL of toluene).

Note: As an option, a Soxhlet/Dean Stark extractor system may be used, with toluene as the solvent. No sodium sulfate is added when using this option.

13.2 Partition:

13.2.1 Partition the hexane extract against 40 mL of concentrated sulfuric acid. Shake for 2 minutes. Remove and discard the sulfuric acid layer (bottom). Repeat the acid washing until no color is visible in the acid layer (perform a maximum of four acid washings).

13.2.2 Omit this step for the fish sample extract. Partition the extract against 40 mL of 5 percent (w/v) aqueous sodium chloride. Shake for 2 minutes. Remove and discard the aqueous layer (bottom).

13.2.3 Omit this step for the fish sample extract. Partition the extract against 40 mL of 20 percent (w/v) aqueous potassium hydroxide (KOH). Shake for 2 minutes. Remove and discard the aqueous layer (bottom). Repeat the base washing until no color is visible in the bottom layer (perform a maximum of four base washings). Strong base (KOH) is known to degrade certain PCDDs/PCDFs, so contact time must be minimized.

13.2.4 Partition the extract against 40 mL of 5 percent (w/v)(aqueous sodium chloride. Shake for 2 minutes. Remove and discard the aqueous layer (bottom). Dry the extract by pouring it through a filter funnel containing anhydrous sodium sulfate on a glass wool plug, and collect it in a 50 mL round bottom flask. Rinse the funnel with the sodium sulfate with two 15-mL portions of hexane, add the rinses to the 50 mL flask, and concentrate the hexane solution to near dryness on a rotary evaporator (35° C water bath), making sure all traces of toluene (when applicable) are removed. (Use of blowdown with an inert gas to concentrate the extract is also permitted.)

MODIFICATION TO EPA 3050 FOR DIGESTION OF ANIMAL TISSUE METALS ANALYSES

Place sample into a 100 mL Kjeldahl flask. Add 25 mL of concentrated nitric acid, 5 mL of concentrated perchloric acid and 2 mL concentrated sulfuric acid to the flask and heat gently. Distill until the perchloric acid reaction has subsided, then increase the heat and digest until all residual perchloric acid has been distilled from the flask and copius fumes of sulfur trioxide are evolved.

The YSI Model 51B dissolved oxygen meter will be used to measure *in situ* dissolved oxygen concentration in the field.

- Calibrate dissolved oxygen probe using manufacturer's instructions for air calibration at the beginning of each day of use. Record calibration information in instrument logbook.

- Set instrument in position which measurements will be taken and zero the instrument.

- Insert probe into water column and allow probe to equilibrate. Select temperature scale and record temperature to the nearest 1° C.

- Set oxygen solubility factor dial to the sample temperature.

- Select (read oxygen) setting. (For shipboard monitoring, lower weighted probe into water column and record oxygen reading every 2 meters). Record dissolved oxygen concentration in mg/L in the field notebook.

Ysi MODEL 33 CONDUCTIVITY METER

- Zero the instrument using distilled water as a blank.

- Calibrate the instrument using the prepared KCl solution.

- Record calibration information in the field logbook.

- Pour water samples into a pre-cleaned 500 mL plastic beaker. The 500 mL beaker and conductivity probe should be rinsed a minimum of 3 times with sample water.

- Insert instrument probe and measure temperature to the nearest 0.5^{0} C.

- Adjust temperature setting on the instrument to the determined value.

- Gently swirl conductivity probe in the sample container to displace any air bubbles.

- Select the highest conductivity multiplier setting (range) that produces a conductivity reading. Record conductivity reading in the field logbook. If reading is off-scale, dilute the sample with distilled water, mix thoroughly, and taken another reading. Record the dilution information in the field logbook.

- Repeat measurement on an additional sample to compare results, and record the information in the field logbook.

ORION MODEL SA 250

The Orion is equipped with an automatic temperature compensator, therefore no conversions will be required for the pH readings obtained during the field survey.

- Calibrate the instrument with standard solutions of pH 4, 7, and 10. Record calibration information in the instrument logbook.

- Pre-clean a 500-mL plastic beaker and pH and temperature probes by rinsing with sample water a minimum of 3 times.

- Pour the water sample into a 500-mL beaker and insert the pH and temperature probes. Measure temperature to the nearest 0.1° C.

- Gently swirl the pH probe in the sample container and select the pH setting 0.01. Read the pH to the nearest 0.1 unit once the reading has stabilized.

- Repeat the pH measurement procedure on an additional sample to compare results, and record the information in the field logbook.

HACH PORTABLE TURBIDIMETER

- Select the middle scale (1–10 NTU).
- Zero the instrument using the blanks provided.
- Insert the 10 NTU standard and adjust the scale to read 10 NTU.
- Rinse the sample tube a minimum of three times with sample water.
- Shake the sample well and pour into the sample tube. Immediately take reading and record in field logbook. Do a duplicate reading.
- If sample reading is too low, switch scale to 0–1 NTU and calibrate for 1 NTU standard.
- If sample reading is too high, switch the scale to 10–100 NTU and calibrate using 100 NTU standard. Dilution is recommended for samples falling within this range or higher.
- Dilute sample to fall within 1–10 NTU range, and record dilution information in field notebook.

APPENDIX C

COLUMBIA RIVER FIELD SAMPLING CHECKLISTS

colored labeling tape (3 rolls)
electrical tape (5 rolls)
masking tape (1 roll)
strapping tape (1 roll)
clear packing tape (1 roll)
duct tape (1 large roll)
scissors
knife (2)
waterproof, permanent markers (4)
grease pencils (6)
pens, pencils, pencil sharpener, eraser
film (2 rolls 36 exposure print film for station log and sampling procedures documentation)
camera (1 35mm with telephoto and wide angle lenses)
aluminum foil (3 rolls heavy duty)
zip-lock bags (300 one gallon)
stainless steel tongs (2 small for handling crayfish)
waterproof notebook (2)
3-ring binder (1)
coolers (8 large)
dry ice (200 lbs with approximately another 300 lbs to be purchased in field)
ice (to be purchased in field, as needed)
triple-beam balance (1)
kimwipes (1 box)
forms: chain-of-custody
station location logs
sample description logs: crayfish
sample summary logs: crayfish
analysis request forms

stapler
clip board (2)
first aid kit
tool kit

approxpriate USGS 7.5 min. quad maps (30 laminated)
uoys (40)
gill nets (2)
crayfish traps (40)
cinder blocks (40 small)
nylon rope (2000 feet)
carabiners (40 small nonlocking)
metal clips (40 small)
crayfish bait (100 small cans of catfood)
awl (1)
GPS unit (1 with 2 battery packs)
2-way radio (2)
cellular phone (1)

COLUMBIA RIVER SEDIMENT/WATER SAMPLING CHECKLIST

GPS unit (1 with 2 battery packs)
2-way radio
cellular phone
0.1-m^2 and 0.06-m^2 van Veen grabs
integrated water sampler
Turbidimeter
pH probe and meter
DO probe and meter
CTD
plastic beakers for conventionals analyses
masking tape (2 rolls)
strapping tape (3 rolls)
clear packaging tape (2 rolls)
duct tape (2 large rolls)
electrical tape (5 rolls)
colored labelling tape (3 rolls)
scissors
waterproof fine-point permanent ink pens (3)
pens, pencils, pencil sharpener, eraser
rubber bands - medium size
film (4 rolls 36 exposure print film for station log; additional slide film for sampling procedures documentation)
camera (2 if possible - 1 for print film, 1 for slide film)
stainless steel bowls (minimum of two 12 qt)
stainless steel spoons (minimum of 2 large for compositing and 5 teaspoons)
Alconex (1 two-quart container)
distilled water
formalin, 10% buffered (1 five-gallon carbuoy)
squirt bottles (3)
aluminum foil (3 wide heavy-duty rolls)
Zip-lock bags (100 one gallon, 100 one or two quart)
waterproof notebooks (2)
3-ring binders, with dividers (two with at least 1.5 inch spine)
Tygon tubing (20 feet of roughly 3/8 inch internal diameter)

sieve box (2)
coolers (minimum of two for food only; six large for samples)
rubber gloves (one pair for each person)
ice (to be purchased in field)
rulers (2 stainless steel)
field log book
forms: chain-of-custody
    station location logs
    sample description logs: sediment, water
    sample summary logs: sediment, water
    analysis request forms
plastic file box
stapler
clip board (2)
first aid kit
bunji cords
appropriate USGS 7.5 min. quad maps (30 laminated)
tool kit
sample jars (to be supplied by labs)
plastic bags and rubber bands
2.5 L Niskin bottles (5) and trigger messengers
bottle rack (1)
carbuoy
refractometer
knife (2)
kimwipes
transmissometer (5 cm pathlength)
extra nylon rope
copies of sampling plan and QA/QC plan
sample labels

COLUMBIA RIVER BACTERIAL SAMPLING CHECKLIST

large ice chest (1)
ice (to be purchased in field)
bacterial sample bottles (will get from UW)
waterproof labels (from Coffey labs)
fine-point permanent ink pens (3)
pencils (2)
pens (4)
waterproof notebook (1)
duct tape (1 roll)
electrical tape (1 roll)
clipboard (1)
3-ring binder
camera
2 rolls print film
forms: chain-of-custody
  station location logs
  sample description logs: bacteria and water
  sample summary logs: bacteria and water
  analysis request forms
DO meter
pH meter
temperature/conductivity meter
Turbidimeter