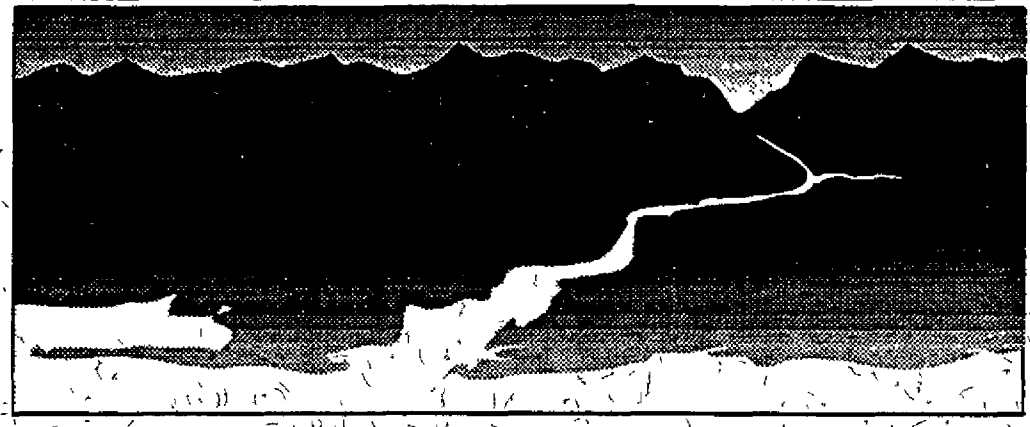
FINAL REPORT
TC 9497-01

LOWER COLUMBIA RIVER



BI-STATE PROGRAM

LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

SAMPLING AND QUALITY ASSURANCE/ QUALITY CONTROL (QA/QC) PLAN

JUNE 22, 1993

Prepared By:

TETRA TECH

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The Lower Columbia River
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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 in 1991 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.

This goal 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.

During the first year of the program, several baseline, modeling, and reconnaissance studies were performed. These included reviews of existing data (Tetra Tech 1992a), pollution sources (Tetra Tech 1992b), conceptual modeling approaches (Tetra Tech 1992c), beneficial uses of the river (Tetra Tech 1992d), and a reconnaissance survey which collected water, sediment, and tissue samples throughout the lower Columbia River (Tetra Tech 1993a). During the reconnaissance survey, samples were collected

from several different physical and/or habitat regimes; however, the majority of sites sampled were located in, or along, the main channel of the river. The chemistry results of the reconnaissance survey indicate that relatively finer-grained sediments located in low-energy backwater areas have the potential to harbor higher concentrations of contaminants than the coarser sediments of the main channel (Tetra Tech 1993a). The collection of samples from backwater areas [defined as locations isolated from the main river current with an outlet to the main channel (e.g., sloughs, back channels)] will extend the results of the 1991 reconnaissance survey to additional lower-energy river environments where finer-grained sediments have been deposited. The objectives of the backwater reconnaissance survey are to:

- Extend the water quality database of the original reconnaissance survey to additional freshwater and estuarine backwater areas with fine-grained sediments.
- Expand the list of analytes to additional contaminants of concern based on results of 1991 reconnaissance survey. Additional analytes include radionuclides and organotins in sediments and tissue, and bacteria (e.g., enterococcus, *E. coli*, and fecal coliform) in water.
- Measure and evaluate the toxicity of Columbia River sediments using established bioassay protocols as a tool for assessing/interpreting the results of sediment chemistry analyses.
- Confirm the results of the 1991 reconnaissance survey for a limited number of fine-grained sediment/backwater locations where potential water quality problems were identified.
- Evaluate water quality in fine-grained sediment/backwater areas of the lower river near or within wildlife refuges.

1.2 DOCUMENT PURPOSE AND SCOPE

This document provides guidance to ensure that a well-planned scientific investigation is conducted, and that the field measurements and analytical data obtained serve the project objectives described above.

To meet this goal, specific guidelines for data quality are presented (Section 3.0). Preparation of the plan helps the project manager focus on the factors affecting data quality during the planning stage of the project. The completed plan facilitates communication among field, laboratory, and management staff as the project progresses.

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, and toxicological and bacteriological tests. The sampling locations and sampling methodology are described in Section 4.0. Guidelines for the assessment and validation of the analytical data are presented in Sections 9.0 and 11.0.

2.0 PROJECT ORGANIZATION

This reconnaissance survey encompasses a wide geographical area (the entire lower Columbia River), will include sampling from three different media (water, sediment, and tissue), and will utilize seven different analytical laboratories. A project of such complexity needs to be well-organized and requires that the role of all participants be clearly defined. The responsibilities for each of the key personnel are listed in Table 1.

TABLE 1. PERSONNEL RESPONSIBILITIES
(Page 1 of 2)

Personnel	Responsibilities
Tetra Tech Project Manager Dr. Steve Ellis (206) 883-1912	Provide oversight of all program activities. Review work plan, health and safety plan, sampling plan, and QA project plan to ensure objectives for the program are met.
Bi-State Contract Officers Don Yon, Oregon DEQ (503) 229-5995 Brian Offord, Wash. DOE (206) 438-7062	Review final project QA objectives, needs, problems, and requests. Approve appropriate QA corrective actions as needed. Provide oversight for sampling activities.
Tetra Tech Field Leaders Tad Deshler Curtis DeGasperi (206) 883-1912	Implement necessary action and adjustments to accomplish 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 QA Officer Tad Deshler (206) 883-1912	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 Carlotta Frommer (206) 883-1912	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: PERSONNEL RESPONSIBILITIES
(Page 2 of 2)

Personnel	Responsibilities
Laboratory QA Coordinator (each lab)	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.
Analytical Resources, Inc. (Semi-vol., pesticides/PCBs, Radionuclides) John Hicks (206) 621-6490	
Pacific Analytical Laboratory (Dioxins/Furans, fish prep., TBT) Steve Parsons (619) 438-3100	
Aquatic Research, Inc. (Metals, nutrients) Steve Lazoff (206) 632-2715	
UW Oceanography (Dissolved, partic. organic C) Kathy Krogslung (206) 543-9235	
AmTest Inc. (Sediment conventionals) Mark Fugiel (206) 885-1664	
Columbia Analytical Services (Bacteria) Abbie Spielman (206) 577-7222	
Lauck's Testing Laboratories, Inc. (Microtox) Mark Babich (206) 767-5060	
Northwestern Aquatic Science (Amphipod toxicity) Dr. Richard Caldwell (503) 265-7225	

3.0 DATA QUALITY OBJECTIVES

The overall QA objective for analytical 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 of samples for each analyte is given in Table 2.

2. **Comparability:** Data will be calculated and reported in units consistent with those of other agencies and organizations (Table 3) 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 analyses for laboratory duplicates and matrix spike/matrix spike duplicates (MS/MSD) will be calculated to provide an estimate of laboratory precision.

TABLE 2. PROPOSED LIST OF ANALYTES AND NUMBER OF SAMPLES
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY
(Page 1 of 7)

Analyte[a]	Water[d]	Sediments[e]	Tissues[f]
METALS, CYANIDE, AND ORGANOTINS			
Aluminum[b]	90	17	34
Antimony	90	17	34
Arsenic[b,c]	90	17	34
Barium[b,c]	90	17	34
Beryllium[b]	90	17	34
Cadmium[b,c]	90	17	34
Chromium[b]	90	17	34
Copper[b,c]	90	17	34
Iron[b]	90	17	34
Lead[b,c]	90	17	34
Mercury[b,c]	90	17	34
Nickel[b,c]	90	17	34
Selenium[b]	90	17	34
Silver[b,c]	90	17	34
Thallium	90	17	34
Zinc[b,c]	90	17	34
Cyanide	17	17	34
Organotins[b]		17	34
ACID EXTRACTABLE ORGANICS (SEMIVOLATILES)			
Phenolic Compounds			
Phenol[c]		17	34
2-Methylphenol		17	34
4-Methylphenol		17	34
2,4-Dimethylphenol		17	34
4-Chloro-3-methylphenol[c]		17	34
Pentachlorophenol		17	34
2-Chlorophenol[c]		17	34
2,4-Dichlorophenol		17	34
2,4-Dinitrophenol		17	34
2-Nitrophenol		17	34

TABLE 2 PROPOSED LIST OF ANALYTES AND NUMBER OF SAMPLES
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY
(Page 2 of 7)

Analyte[a]	Water[d]	Sediments[e]	Tissues[f]
4-Nitrophenol[c]		17	34
4,6-Dinitro-2-methylphenol*		17	34
2,4,5-Trichlorophenol*		17	34
2,4,6-Trichlorophenol		17	34
BASE/NEUTRAL EXTRACTABLE ORGANICS (SEMIVOLATILES)			
Halogenated Ethers (Other than those listed elsewhere)			
bis(2-chloroethyl)ether		17	34
bis(2-chloroethoxy)methane		17	34
bis(2-chloroisopropyl)ether		17	34
4-Bromophenylphenylether		17	34
4-Chlorophenylphenylether		17	34
Nitroaromatics			
2,4-Dinitrotoluene[c]		17	34
2,6-Dinitrotoluene		17	34
Nitrobenzene		17	34
Anilines			
4-Nitroaniline*		17	34
3-Nitroaniline*		17	34
2-Nitroaniline*		17	34
4-Chloroaniline*		17	34
Nitrosamines			
N-nitroso-di-n-propylamine[c]		17	34
N-nitrosodiphenylamine		17	34
Other Naphthalenes			
2-Methylnaphthalene[c]		17	34
2-Chloronaphthalene		17	34

TABLE 2. PROPOSED LIST OF ANALYTES AND NUMBER OF SAMPLES
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY
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Analyte[a]	Water[d]	Sediments[e]	Tissues[f]
Polynuclear Aromatics			
Acenaphthene[c]		17	34
Acenaphthylene		17	34
Anthracene		17	34
Benzo(a)anthracene[b]		17	34
Benzofluoranthenes(b,k)[b]		17	34
Benzo(a)pyrene[b]		17	34
Benzo(g,h,i)perylene[b]		17	34
Chrysene[b]		17	34
Dibenzo(a,h)anthracene		17	34
Fluoranthene[b]		17	34
Fluorene		17	34
Indeno(1,2,3-cd)pyrene[b]		17	34
Naphthalene[c]		17	34
Phenanthrene[b]		17	34
Pyrene[b,c]		17	34
Chlorinated Benzenes			
1,3-Dichlorobenzene		17	34
1,2-Dichlorobenzene		17	34
1,4-Dichlorobenzene[c]		17	34
1,2,4-Trichlorobenzene[c]		17	34
Hexachlorobenzene		17	34
Hexachlorinated Organic Compounds			
Hexachlorobutadiene		17	34
Hexachloroethane		17	34
Hexachlorocyclopentadiene		17	34
Benzidines			
3,3'-Dichlorobenzidine		17	34

TABLE 2. PROPOSED LIST OF ANALYTES AND NUMBER OF SAMPLES
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY
(Page 4 of 7)

Analyte[a]	Water[d]	Sediments[e]	Tissues[f]
Phthalate Esters			
Dimethylphthalate		17	34
Diethylphthalate		17	34
Di-n-butylphthalate[c]		17	34
Butylbenzylphthalate		17	34
bis-2-(ethylhexyl)phthalate[b,c]		17	34
Di-n-octylphthalate		17	34
Miscellaneous compound			
Benzyl alcohol*		17	34
Benzoic acid*		17	34
Isophorone[c]		17	34
Carbazole*		17	34
Dibenzofuran*		17	34
PESTICIDES/PCBs			
Pesticides			
o,p'-DDE[b,c]		17	34
o,p'-DDD[b,c]		17	34
o,p'-DDT[b,c]		17	34
4,4'-DDT[b,c]		17	34
4,4'-DDE[b,c]		17	34
4,4'-DDD[c]		17	34
Heptachlor[b,c]		17	34
Heptachlor epoxide		17	34
Alpha chlordane		17	34
Dicofol		17	34
Aldrin[b,c]		17	34
Dieldrin[b,c]		17	34
Mirex (dechlorane)[b,c]		17	34
Methyl parathion[b,c]		17	34
Toxaphene		17	34
Endosulfan I[c]		17	34
Endosulfan II[c]		17	34
Endosulfan sulfate[c]		17	34

TABLE 2 PROPOSED LIST OF ANALYTES AND NUMBER OF SAMPLES
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY
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Analyte[a]	Water[d]	Sediments[e]	Tissues[f]
Endrin[b,c]		17	34
Endrin aldehyde[c]		17	34
Methoxychlor[c]		17	34
alpha-BHC[b]		17	34
beta-BHC[c]		17	34
delta-BHC[b]		17	34
gamma-BHC (Lindane)[c]		17	34
PCBs			
Aroclor 1016		17	34
Aroclor 1221		17	34
Aroclor 1232		17	34
Aroclor 1242[c]		17	34
Aroclor 1248		17	34
Aroclor 1254[b,c]		17	34
Aroclor 1260[c]		17	34
DIOXINS AND FURANS			
2,3,7,8-TCDD[b,c]		17	34
1,2,3,7,8-PeCDD[b,c]		17	34
1,2,3,4,7,8-HxCDD[b,c]		17	34
1,2,3,6,7,8-HxCDD[b,c]		17	34
1,2,3,7,8,9-HxCDD[b,c]		17	34
1,2,3,4,6,7,8-HpCDD[b,c]		17	34
Octachlorodibenzo-p-dioxin[b,c]		17	34
2,3,7,8-TCDF[b,c]		17	34
1,2,3,7,8-PeCDF[b,c]		17	34
2,3,4,7,8-PeCDF[b,c]		17	34
1,2,3,4,7,8-HxCDF[b,c]		17	34
1,2,3,7,8,9-HxCDF[b,c]		17	34
1,2,3,6,7,8-HxCDF[b,c]		17	34
2,3,4,6,7,8-HxCDF[b,c]		17	34
1,2,3,4,6,7,8-HpCDF[b,c]		17	34
1,2,3,4,7,8,9-HpCDF[b,c]		17	34
Octachlorodibenzofuran[b,c]		17	34

TABLE 2 PROPOSED LIST OF ANALYTES AND NUMBER OF SAMPLES
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY
(Page 6 of 7)

Analyte[a]	Water[d]	Sediments[e]	Tissues[f]
RADIONUCLIDES			
Americium-241		17	34
Cesium 137[b]		17	34
Cobalt-60		17	34
Europium-152[b]		17	34
Europium-154/155		17	34
Plutonium-238		17	34
Plutonium-239/240[b]		17	34
CONVENTIONALS (Field and Laboratory)			
Nitrogen (TKN, NO_3+NO_2, NH_3)	45	17 (NH_3, TKN only)	
Phosphorus (Total P, SRP*)	45		
Total suspended solids	17		
Hardness	17		
Conductivity (at 25°C)	17		
Turbidity (Field)	45		
pH (Field)	45		
Temperature (Field)	45		
Dissolved oxygen (Field)	45		
Chlorophyll *a*/Phaeophytin *a**	17		
Organic carbon (Total, Diss , Particulate)	17	17 (TOC only)	
Grain size		17	
Total sulfides*		17	
Total volatile solids*		17	
Total moisture		17	34
Lipids			34
TOXICITY TESTS			
Hyalella or *Eohaustorius* (amphipods)		15	
Microtox		15	

TABLE 2. PROPOSED LIST OF ANALYTES AND NUMBER OF SAMPLES LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Analyte[a]	Water[d]	Sediments[e]	Tissues[f]
INDICATOR BACTERIA			
Fecal coliform	45		
E. coli[c]	45		
Enterococcus	45		

[a] All analytes were included in original reconnaissance survey (Tetra Tech 1993a) except those indicated with an asterisk (*).

[b] Detected in one or more sediment samples from original reconnaissance survey (Tetra Tech 1993a)

[c] Detected in one or more tissue samples from original reconnaissance survey (Tetra Tech 1993a)

[d] All metals and nutrients to be analyzed in triplicate at every station. Conventional parameters and cyanide to be measured in triplicate at Goering Slough (alternate Multnomah Channel).

[e] All analytes to be analyzed in triplicate at Goering Slough (alternate Multnomah Channel).

[f] All analytes to be analyzed in triplicate at Goering Slough (alternate Multnomah Channel) for each of two species.

Note. No organic pollutants are proposed for water. Footnotes b and c are not applied to conventional parameters, bacteria, or toxicity tests.

TABLE 3. DATA QUALITY OBJECTIVES
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY
(Page 1 of 3)

Analyte	Method	Matrix	Quantitation Limit	Accuracy	Precision (RPD)	Completeness
Semi-volatiles	EPA 8270 (GC/MS; SIM for PAHs)	Sediment	3-200 µg/kg (dry)	18-137%[a]	50%[a]	95%
		Tissue	15-1000 µg/kg (wet)	10-141%[a]	50%[a]	95%
Pesticides/PCBs	EPA 8081 (GC/ECD)	Sediment	0.05-2 µg/kg (dry)	60-150%[a]	50%[a]	95%
		Tissue	0.25-10 µg/kg (wet)	60-150%[a]	50%[a]	95%
Dioxins/Furans	EPA 1613	Sediment	1-10 pg/g (dry)	50-150%[b]	20%[a]	95%
		Tissue	1-10 pg/g (wet)	50-150%[b]	20%[a]	95%
Metals	ICP, GFAA, CVAA (Total Recov. Digest. for sed., tiss.; Dissolved and Total Recov. Digestions for Water)	Sediment	0.1-10 mg/kg (dry)	75-125%[c]	20%[d]	95%
		Tissue	0.0004-0.4 mg/kg (wet)	75-125%[c]	20%[d]	95%
		Water	0.1-5 µg/L	75-125%[c]	20%[d]	95%
Radionuclides	EPA 901.1 EMSL-LV-0539-17	Sediment	0.001-0.1 pCi/g	50-150%[e]	30%[d]	95%
		Tissue	0.005-0.5 pCi/g	50-150%[e]	30%[d]	95%
TBT	Uhler et al. (1989) (GC/FPD)	Sediment	4 µg/kg (dry)	50-150%[a]	30%[d]	95%
		Tissue	4 µg/kg (dry)	50-150%[a]	30%[d]	95%
Grain Size	PSEP	Sediment	0.0001 g	5%[f]	10%[g]	95%
Total Sulfides	PSEP	Sediment	20 mg/kg	60-140%[c]	30%[h]	95%

TABLE 3. DATA QUALITY OBJECTIVES
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY
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Analyte	Method	Matrix	Quantitation Limit	Accuracy	Precision (RPD)	Completeness
Cyanide	SM 4500CN-E	Sediment	0.5 mg/kg	NA	25%[b]	95%
		Water	10 µg/L	NA	25%[b]	95%
Organic Carbon (Total, dissolved, particulate)	SM 5310.C	Sediment (TCC only)	200 mg/kg	75-125%[c]	25%[b]	95%
		Water	50 µg/L	75-125%[c]	25%[b]	95%
TVS	PSEP	Sediment	0.01%	NA	20%[d]	95%
Total Solids (moisture)	PSEP	Sediment	0.01%	NA	20%[d]	95%
TSS	SM 2540D	Water	0.5 mg/L	NA	25%[b]	95%
Ammonia	Plumb 1981	Sediment	10 mg/kg	72-128%[c]	30%[b]	95%
	SM 4500NH3H	Water	10 µg/L	80-120%[c]	25%[b]	95%
TKN	SM 4500NORGC	Water	100 µg/L	80-120%[c]	25%[b]	95%
		Sediment	10 mg/kg	NA	30%[b]	95%
Nitrate+Nitrite	SM 4500NO3F	Water	10 µg/L	80-120%[c]	25%[b]	95%
Total P	SM 4500PF	Water	2 µg/L	80-120%[c]	25%[b]	95%
SRP	SM 4500PF	Water	1 µg/L	80-120%[c]	25%[b]	95%
Chlorophyll *a*/Phaeophytin *a*	SM 10200 H	Water	0.5 µg/L	NA	25%[b]	95%

TABLE 3. DATA QUALITY OBJECTIVES
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY
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Analyte	Method	Matrix	Quantitation Limit	Accuracy	Precision (RPD)	Completeness
Conductivity (at 25° C)	SM 2510B	Water	10 µmho/cm	±5%[e]	5%[h]	95%
Hardness	SM 2340C	Water	2 mg/L	±5%[e]	5%[h]	95%
Toxicity Tests	SM E. 1383-90 (amphipod)	Sediment	NA	NA	NA	95%
	PSEP (Microtox)					
Bacteria	SM 9221C (fecal coliform)	Water	2 MPN/100 mL	NA	NA	95%
	SM 9230B (enterococcus)					
	SM 9221C modified (*E. coli*)					

NA = Not applicable

[a] Based on surrogate recovery results
[b] Based on performance and recovery (PAR) sample results
[c] Based on matrix spike and matrix spike duplicate recovery
[d] Based on laboratory duplicate results
[e] Based on analysis of standard reference material or check standard
[f] Based on difference between original dry weight and calculated final of sediment
[g] Based on laboratory triplicate results; value represents a coefficient of variation (CV)
[h] Based on laboratory duplicate results if value is ≥5X detection limit; if less than 5X, precision objective is ± detection limit

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, spiked compounds, certified reference materials, and check standards. Surrogate compounds will be added to each sample and analyzed for organic compounds. The percent recovery will be reported with sample results. Re-analysis will be required for samples in which surrogate recoveries are outside established control limits. All corrective actions taken for samples requiring re-analysis will be reported with sample results. Certified reference materials will be analyzed where appropriate. 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. Results of calibration standards will 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 ideal conditions. Completeness of the data will be calculated by dividing the number of valid measurements obtained by the number of measurements planned.

Quality assurance objectives setting requirements for precision, accuracy, and completeness have been established for each measurement variable where possible, and are presented in Table 3. The quantitation limit ranges specified in Table 3 are for all the compounds in the specified analytical group. Quantitation (i.e., reporting) limits for each individual compound are specified in Table 4. The QA objectives outlined above will be evaluated and submitted in data validation reports (see Section 6.1). The QA results will also be summarized as part of the Backwater Reconnaissance Survey Analysis Report.

TABLE 4. METHOD REPORTING LIMIT FOR EACH ANALYTE
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY
(Page 1 of 6)

Chemical	Sediment Reporting Limit (µg/kg dry)	Tissue Reporting Limit (µg/kg wet)	Water Reporting Limit (µg/L)
METALS			
Aluminum	10 mg/kg	--	100
Antimony	300	12	3
Arsenic	300	12	3
Barium	300	12	3
Beryllium	200	--	2
Cadmium	10	0.4	0.1
Chromium	100	--	1
Copper	100	4	1
Iron	500	--	5
Lead	80	3.2	0.8
Mercury	2	0.4	0.1
Nickel	500	20	5
Selenium	300	12	3
Silver	100	4	1
Thallium	100	--	1
Zinc	300	12	3
Triethyl butyltin	4	4	--
Diethyl dibutyltin	4	4	--
Ethyl tributyltin	4	4	--
MISCELLANEOUS PARAMETERS			
Cyanide	0.5 mg/kg	--	10
TKN	10 mg/kg	--	100
NO2 + NO3	--	--	10
NH3	--	--	10
Total P	--	--	2
SRP	--	--	1
Total suspended solids	--	--	0.5

TABLE 4. METHOD REPORTING LIMIT FOR EACH ANALYTE
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY
(Page 2 of 6)

Chemical	Sediment Reporting Limit (µg/kg dry)	Tissue Reporting Limit (µg/kg wet)	Water Reporting Limit (µg/L)
Hardness	--	--	2
Conductivity	--	--	10 µmho/cm
Turbidity	--	--	
pH	--	--	
Dissolved oxygen	--	--	0.1
Chlorophyll a/Phaeophytin a	--	--	0.1
Organic carbon (TOC, DOC, POC)	200 mg/kg	--	50
Grain size	0.0001 g	--	--
Total sulfides	20 mg/kg	--	--
Total volatile solids	0.01%	--	--
Total solids (moisture)	0.01%	--	--
Lipids	--	0.01%	--
Fecal coliform bacteria	--	--	2 MPN/100 mL
Enterococcus bacteria	--	--	2 MPN/100 mL
E. coli	--	--	2 MPN/100 mL
ORGANIC COMPOUNDS Pesticides			
o,p'-DDD	0.1	0.5	
o,p'-DDE	0.1	0.5	
o,p'-DDT	0.1	0.5	
4,4'-DDD	0.1	0.5	
4,4'-DDE	0.1	0.5	
4,4'-DDT	0.1	0.5	
Heptachlor	0.05	0.25	
Heptachlor epoxide	0.05	0.25	
alpha-Chlordane	0.05	0.25	
Aldrin	0.5	2.5	
Dieldrin	0.1	0.5	

TABLE 4. METHOD REPORTING LIMIT FOR EACH ANALYTE
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY
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Chemical	Sediment Reporting Limit (µg/kg dry)	Tissue Reporting Limit (µg/kg wet)	Water Reporting Limit (µg/L)
Mirex	0.1	0.5	
Dicofol	20	100	
Methyl parathion	20	100	
Toxaphene	5	25	
Endosulfan I	0.05	0.25	
Endosulfan II	0.1	0.5	
Endosulfan sulfate	0.1	0.5	
Endrin	0.1	0.5	
Endrin aldehyde	0.1	0.5	
Methoxychlor	0.5	2.5	
alpha-BHC	0.05	0.25	
beta-BHC	0.05	0.25	
delta-BHC	0.05	0.25	
gamma-BHC	0.05	0.25	
Polychlorinated Biphenyl Compounds (PCBs)			
Aroclor 1016	1	5	
Aroclor 1221	2	10	
Aroclor 1232	1	5	
Aroclor 1242	1	5	
Aroclor 1248	1	5	
Aroclor 1254	1	5	
Aroclor 1260	1	5	
Semi-volatiles			
Phenol	20	100	
2-Methylphenol	20	100	
4-Methylphenol	20	100	
2,4-Dimethylphenol	20	100	
Pentachlorophenol	40	200	

TABLE 4. METHOD REPORTING LIMIT FOR EACH ANALYTE
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY
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Chemical	Sediment Reporting Limit (µg/kg dry)	Tissue Reporting Limit (µg/kg wet)	Water Reporting Limit (µg/L)
2-Chlorophenol	20	100	
2,4-Dichlorophenol	60	300	
4-Chloro-3-methylphenol	40	200	
2,4-Dinitrophenol	200	1000	
2-Nitrophenol	120	600	
4-Nitrophenol	120	600	
4,6-Dinitro-2-methylphenol	200	1000	
2,4,6-Trichlorophenol	120	600	
2,4,5-Trichlorophenol	120	600	
bis(2-chloroethyl)ether	20	100	
bis(2-chloroethoxy)methane	20	100	
bis(2-chloroisopropyl)ether	20	100	
4-Bromophenylphenylether	20	100	
4-Chlorophenylphenylether	20	100	
2,4-Dinitrotoluene	120	600	
2,6-Dinitrotoluene	120	600	
Nitrobenzene	20	100	
Isophorone	20	100	
N-nitroso-di-n-propylamine	20	100	
N-nitrosodiphenylamine	20	100	
2-Chloronaphthalene	20	100	
2-Methylnaphthalene	20	100	
Acenaphthene	3	15	
Acenaphthylene	3	15	
Anthracene	3	15	
Benzo(a)anthracene	3	15	
Benzofluoranthenes(b,k)	3	15	
Benzo(a)pyrene	3	15	

TABLE 4. METHOD REPORTING LIMIT FOR EACH ANALYTE
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY
(Page 5 of 6)

Chemical	Sediment Reporting Limit (µg/kg dry)	Tissue Reporting Limit (µg/kg wet)	Water Reporting Limit (µg/L)
Benzo(g,h,i)perylene	5	25	
Chrysene	3	15	
Dibenzo(a,h)anthracene	5	25	
Fluoranthene	3	15	
Fluorene	3	15	
Indeno(1,2,3-cd)pyrene	5	25	
Naphthalene	3	15	
Phenanthrene	3	15	
Pyrene	3	15	
1,3-Dichlorobenzene	20	100	
1,2-Dichlorobenzene	20	100	
1,4-Dichlorobenzene	20	100	
1,2,4-Trichlorobenzene	20	100	
Hexachlorobenzene	20	100	
Hexachlorobutadiene	20	100	
Hexachloroethane	40	200	
Hexachlorocyclopentadiene	120	600	
3,3'-Dichlorobenzidine	120	600	
Dimethylphthalate	20	100	
Diethylphthalate	20	100	
Di-n-butylphthalate	20	100	
Butylbenzylphthalate	20	100	
bis-2-(ethylhexyl)phthalate	20	100	
Di-n-octylphthalate	20	100	
Benzoic acid	200	1000	
Benzyl alcohol	20	100	
2-Nitroaniline	120	600	
3-Nitroaniline	120	600	

TABLE 4. METHOD REPORTING LIMIT FOR EACH ANALYTE
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY
(Page 6 of 6)

Chemical	Sediment Reporting Limit (µg/kg dry)	Tissue Reporting Limit (µg/kg wet)	Water Reporting Limit (µg/L)
4-Nitroaniline	120	600	
4-Chloroaniline	40	200	
Dibenzofuran	20	100	
Carbazole	20	100	
Dioxins and Furans			
2,3,7,8-TCDD	1 pg/g	1 pg/g	
1,2,3,7,8-PeCDD	5 pg/g	5 pg/g	
1,2,3,4,7,8-HxCDD	5 pg/g	5 pg/g	
1,2,3,6,7,8-HxCDD	5 pg/g	5 pg/g	
1,2,3,7,8,9-HxCDD	5 pg/g	5 pg/g	
1,2,3,4,6,7,8-HpCDD	5 pg/g	5 pg/g	
OCDD	10 pg/g	10 pg/g	
2,3,7,8-TCDF	1 pg/g	1 pg/g	
1,2,3,7,8-PeCDF	5 pg/g	5 pg/g	
2,3,4,7,8-PeCDF	5 pg/g	5 pg/g	
1,2,3,4,7,8-HxCDF	5 pg/g	5 pg/g	
1,2,3,6,7,8-HxCDF	5 pg/g	5 pg/g	
2,3,4,6,7,8-HxCDF	5 pg/g	5 pg/g	
1,2,3,7,8,9-HxCDF	5 pg/g	5 pg/g	
1,2,3,4,6,7,8-HpCDF	5 pg/g	5 pg/g	
1,2,3,4,7,8,9-HpCDF	5 pg/g	5 pg/g	
OCDF	10 pg/g	10 pg/g	

4.0 SAMPLING PROCEDURES

This section identifies the navigation methodology (4.1), station locations (4.2), general sampling considerations (4.3), and the methods to be used for sampling each of the three media (4.4-4.6). In addition, the protocol to be followed for handling field samples will be discussed (4.7-4.8).

The project manager and field team leaders will thoroughly review the sample plan (including QA/QC criteria) before each sampling effort. Prior to sampling, the sampling crew should be familiar with:

- The responsibilities of each member of the field team
- Statement and prioritization of study objectives
- Description of survey area, including background information and station locations
- Identification of variables to be measured and containers and preservatives required
- 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)
- Location and availability of an alternate survey vessel
- All special equipment needed for the survey (e.g., sampling equipment, navigation equipment, communication devices).

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. Study objectives and their prioritization will be understood by all members of the field team. 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. Contingency plans for alternate sampling strategies are outlined in the sections for each of the three media (4 4-4.6).

4.1 NAVIGATION AND STATION POSITIONING

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 Trimble Transpak Portable 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, Selective Availability is in place; therefore, the navigation system used for this survey is expected to have an accuracy of approximately 100 m.

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 (± 1 m) 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 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.

4.2 STATION LOCATIONS

Based on the decision of the Bi-State Committee, a total of 15 primary target sampling locations, and 5 additional alternate locations, were selected for initial investigation (Tetra Tech 1993b). These 15 stations were selected from a list of 61 possible backwater sampling locations (Table 5). This list was compiled using information from the original reconnaissance survey (Tetra Tech 1993a), USGS quad maps, a survey of beneficial uses and locations (Tetra Tech 1992a), and discussions with natural resource professionals familiar with the geography of the lower Columbia River. The final list of 15 stations and five alternate stations was developed in coordination with the Bi-State program and selected reviewers. The final site selections were based upon five perceived data needs for the lower Columbia River Bi-State Program. These data needs are listed below.

1) Collect data from additional fine-grained backwater areas in the estuary and freshwater sections of the river.

2) Provide more thorough coverage of fine-grained/backwater areas in the estuary.

TABLE 5 RELATIONSHIP OF POSSIBLE SAMPLING LOCATIONS TO PERCEIVED DATA NEEDS

No.	Approximate River Mile	Backwater Name	Estuary Portion of River	Freshwater Portion of River	Original Reconnaissance Survey Station	Identified as Problem Area In Orig. Recon.	Nearby National Wildlife Refuges
1	144-145	Greenleaf Slough		x			
2	143	Hamilton Is backwater		x			x
3	140.5	Steamboat Landing		x			
4	138	Franz Lake		x			
5	*128*	*Rooster Rock St. Pk.*		*x*	*x*		
6	124-128	Reed Island		x	x	x	
7	126-125	Gary and Flag Islands		x			
8	119-120	Camas Slough		x			
9	120 5	Sandy River		x			
10	117	Govt. and McGuire Islands		x			
11	113-115	Government Island		x			
12	101	Columbia Slough		x			
13	*100*	*Bachelor Slough*		*x*			
14	94-95	Willow Bar Islands		x	x		x
15	95	Post Office Lake		x			
16	92.5	Campbell Lake		x			x
17	91.5	Bachelor Island Slough		x			
18	89	Bachelor Island		x			
19	90	Multnomah Channel		x			
20	85	Wallace Slough		x			
21	84	Gearing Slough		x			
22	82	Deer Island Slough		x			
23	81	Burke Slough		x			
24	80	Martin Slough		x	x	x	
25	80.5	Goat Island		x			
26	69-71.5	Conrad Channel		x			
27	*71*	*Carr Slough*		*x*			
28	63	Lord Island		x	x	x	
29	59-60	Fisher Island Slough		x	x	x	
30	56	Coal Creek Slough		x			
31	57 5	Bradbury Slough		x	x		
32	52	Poyaky Slough		x			
33	50-55	Beaver Slough		x			
34	*50*	*Wallace Slough*		*x*			
35	43-49	Westport Slough		x			
36	44	Jackson Inlet		x			
37	44	Bernie Slough		x			
38	41	Welcome Slough		x			
39	39	Grove Slough		x			
40	35.5	Westport Slough	x				x
41	35	Ellison Slough	x				x
42	34.5	Tenasillahe Island	x				x
43	33	Steamboat Slough	x				
44	33	Brooks Slough	x				x
45	33	Welch and Quinns Islands	x				x
46	26-30	Lower Gnat Creek, Wahk. Ref.	x				x
47	26	Blind Slough	x				x
48	27	Grizzly Slough	x				x
49	*29*	*Seapal Slough*	*x*				*x*
50	26	Warren Slough	x				x
51	26	Deer Island	x				x
52	25.5	Big Creek Slough	x				x
53	25.5	Calendar Slough	x				x
54	23	Russian and Seal Islands	x				x
55	20	Sweet Home Island	x				x
56	21-23	South Channel	x				x
57	22-23	Gray Bay	x				x
58	10	Cathlamet Bay	x				x
59	13-15	Youngs Bay	x		x		
60	4-5	Baker Bay near Chinook	x				
61	1-2	Baker Bay near Illwaco	x				

Recommended stations are shaded; alternate stations are in italics

3) Sample backwater areas representative of fine-grained/backwater areas in wildlife refuges.

4) Confirm potential problems areas identified in fine-grained/backwater areas sampled in the original reconnaissance survey.

5) Confirm results of the original reconnaissance survey sampling of fine-grained/backwater areas that were not identified as problem areas.

The sampling of alternate stations may be necessary if the primary stations are not accessible or if it is later determined that the primary stations have no natural connection with the main stem of the Columbia River. The proposed sampling locations are indicated below, in Table 5, and in Figures 1-4. Table 5 also includes a column for each of the five perceived data needs. An 'X' is used to signify which of the perceived data needs are met for each station.

Primary Stations

1. Youngs Bay
2. Cathlamet Bay
3. Svensen Island
4. Knappa Slough
5. Lewis and Clark National Wildlife Refuge
6. Elochoman Slough
7. Fisher Island Slough
8. Carrolls Channel
9. Goering Slough
10. Multnomah Channel (Scappoose Bay)
11. Willow Bar Islands
12. Bachelor Island Slough
13. Camas Slough
14. Gary and Flag Islands
15. Skamania Landing

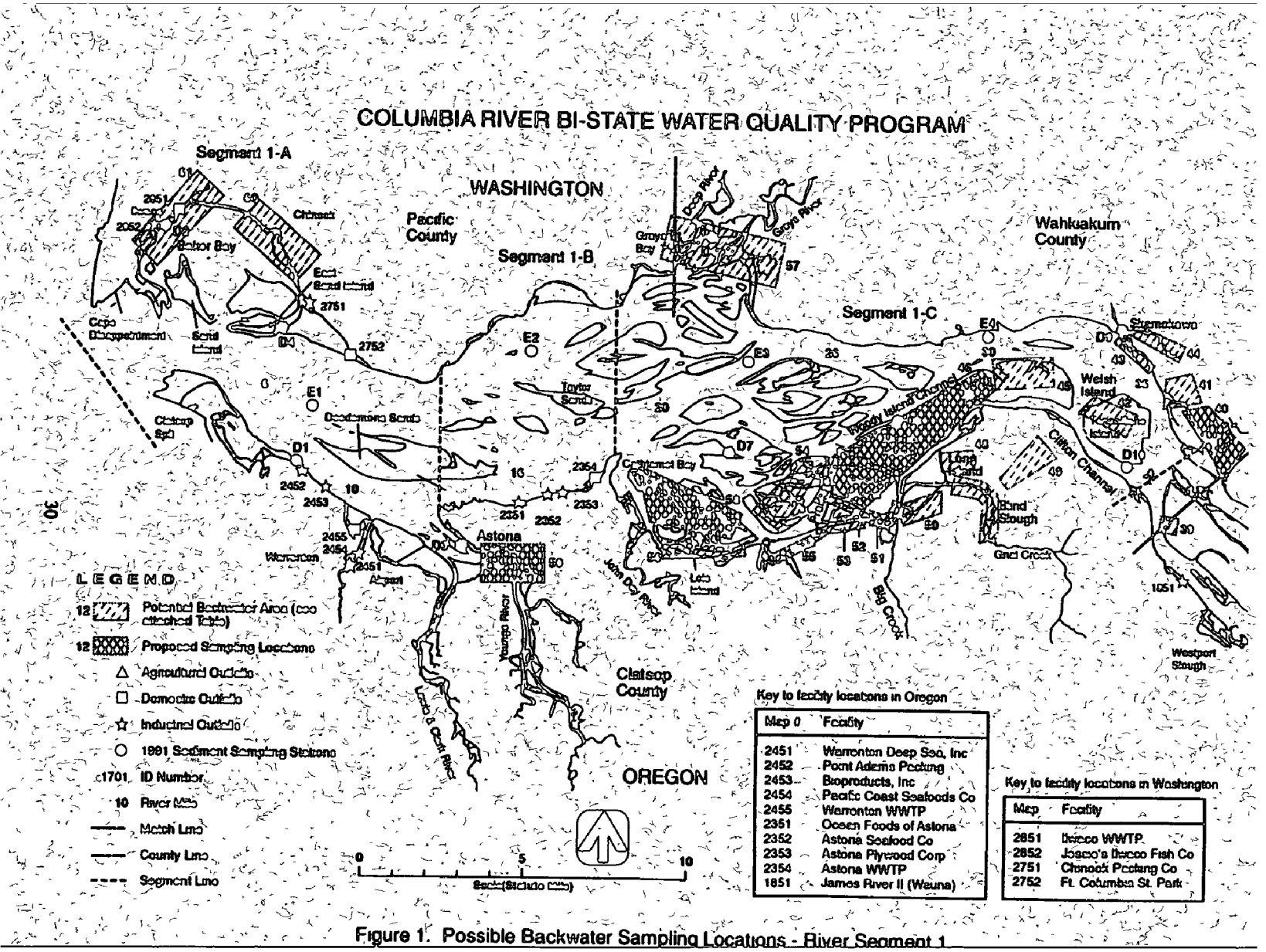

Figure 1. Possible Backwater Sampling Locations - River Segment 1

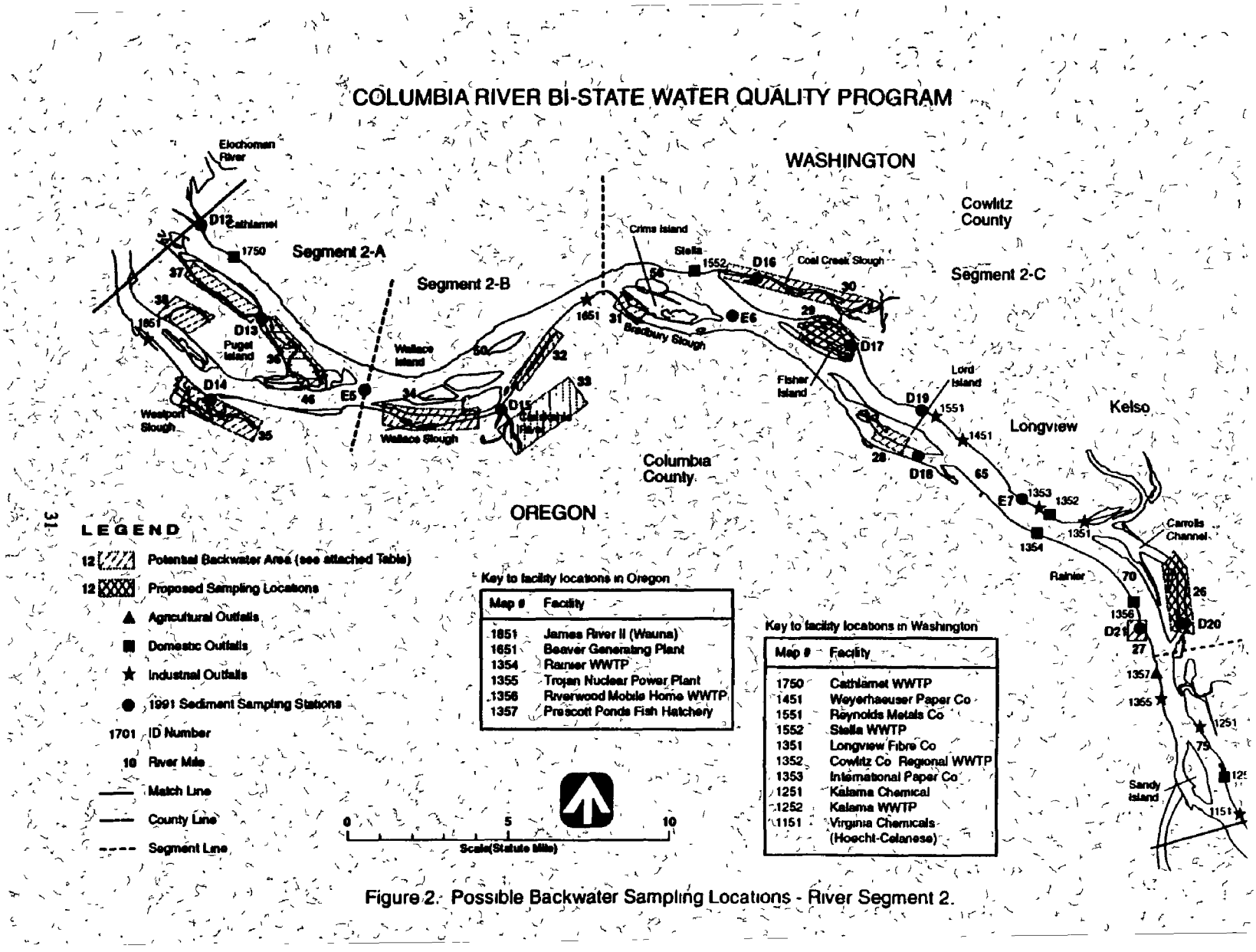

Figure 2. Possible Backwater Sampling Locations - River Segment 2.

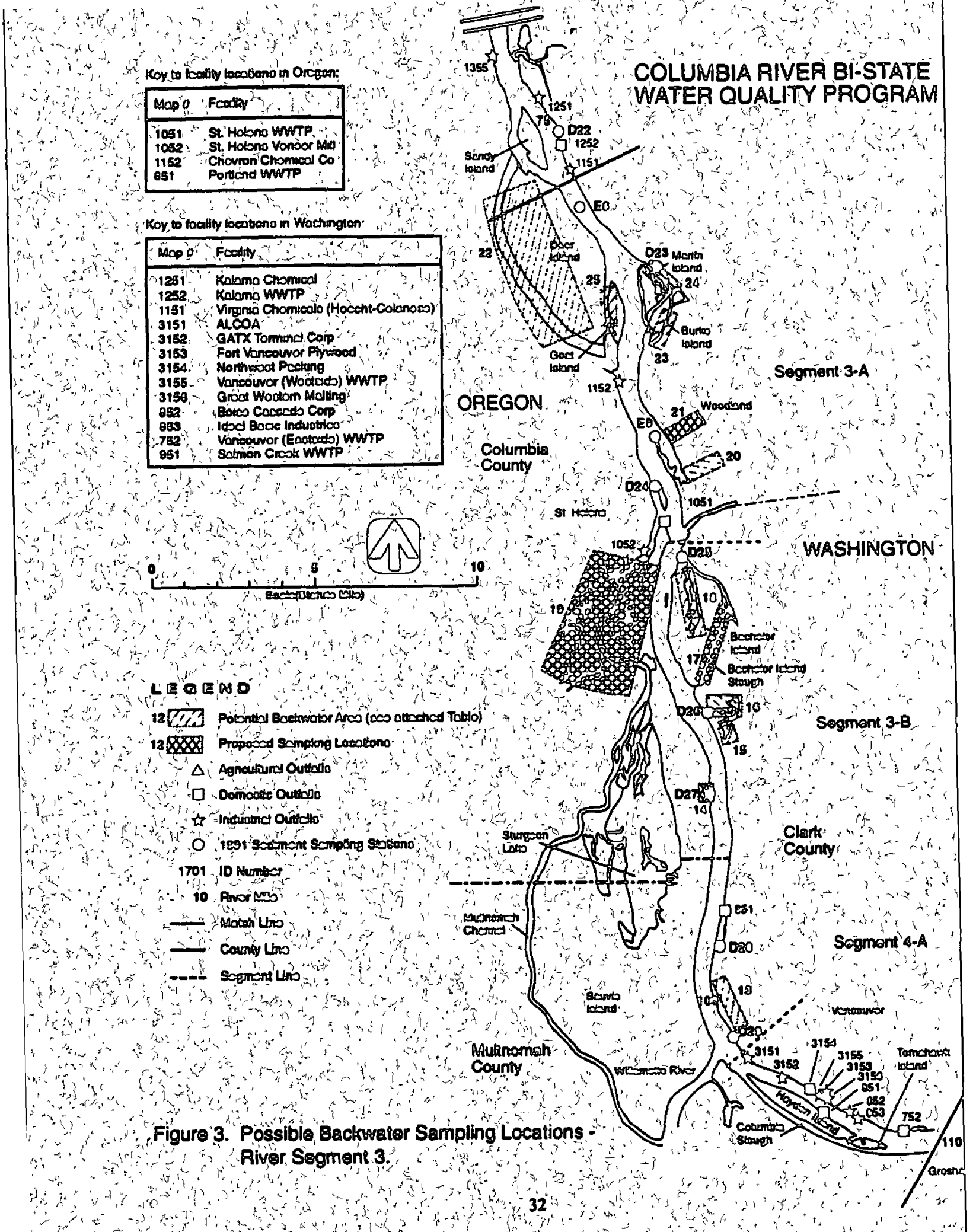

Figure 3. Possible Backwater Sampling Locations - River Segment 3.

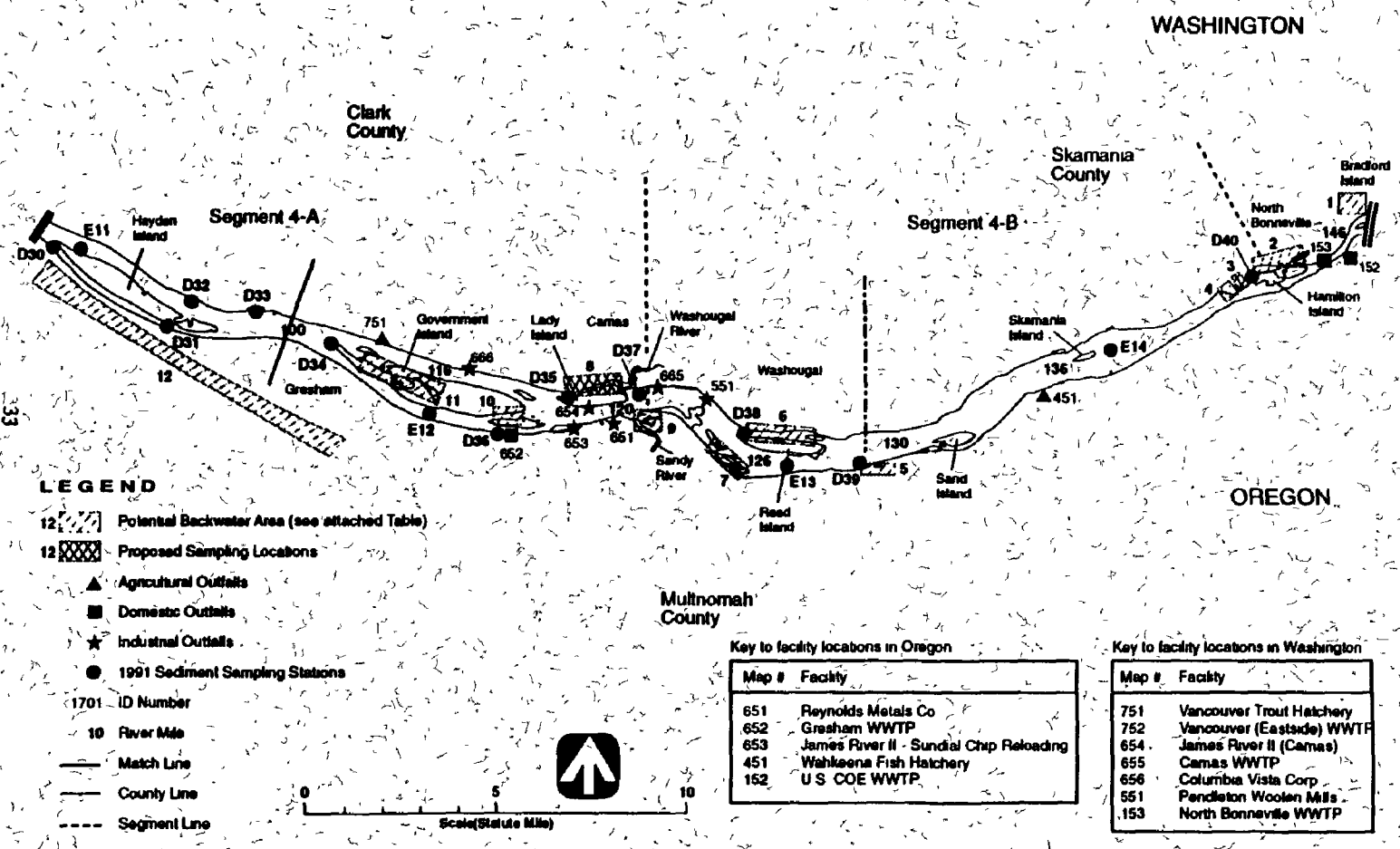

Figure 4. Possible Backwater Sampling Locations - River Segment 4.

Alternate Stations

16. Saspal Slough
17. Wallace Slough
18. Carr Slough
19. Buckmire Slough
20. Rooster Rock State Park

The actual location at which samples will be collected from each of the above stations will be determined in the field based on accessibility of the site and the grain size of the sediments obtained in the test grabs. Few data are available on the sediment grain sizes to be expected in the backwater areas selected for sampling. Therefore, contingency plans have been developed which outline the field sampling protocols to be followed in determining whether or not suitable fine-grained sediment and the target aquatic species are available at the selected primary sampling location. These contingency plans are discussed in detail in Section 4.4 and 4.5 for sediment and tissue, respectively.

4.3 SAMPLE COLLECTION AND ANALYSIS

The number of samples and the analytes for which the samples will be analyzed are listed in Table 2. These numbers include field replicate samples. Field replicates are defined as completely independent samples taken at the same location and analyzed separately by the laboratory. Field replicates provide an estimate of the total variability (from the field and the laboratory) associated with measurements at a particular station. Field replicates can provide a good estimate of the random error due to sampling. Where possible, field replicates will be selected from stations where concentrations of contaminants are expected to be at measurable levels. All field replicate samples will be submitted as blind samples to the laboratory.

Table 6 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. Tissue samples will be frozen with dry ice in the field. 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

TABLE 6. -CONTAINERS, COLLECTION VOLUMES, PRESERVATION, AND HOLDING TIMES
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY
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Parameter	Matrix	Container	Size	Preservation	Holding Time
Metals and Cyanide	Water	Polyethylene	500 mL	HNO_3 to pH 2, 4°C	6 mo., Hg 28 days
	Sediment	Glass	4 oz.	4°C	6 mo., Hg 28 days
	Tissue	Glass[a]	4 oz.	Frozen, -20° C	6 mo , Hg 28 days
TBT	Sediment	Amber Glass	8 oz.	4°C	14 days to extraction, 40 days to analysis
	Tissue	Aluminum foil wrap, plastic zip-lock bags	Variable	4°C	14 days to extraction, 40 days to analysis
Semi-volatile organic compounds	Sediment	Glass	8 oz.	4°C	14 days to extraction, 40 days to analysis
	Tissue	Glass[a]	8 oz.	Frozen, -20° C	14 days to extraction, 40 days to analysis
Pesticides/PCBs	Sediment	Glass	8 oz.	4°C	14 days to extraction, 40 days to analysis
	Tissue	Glass[a]	8 oz.	Frozen, -20° C	14 days to extraction, 40 days to analysis

TABLE 6. CONTAINERS, COLLECTION VOLUMES, PRESERVATION, AND HOLDING TIMES
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY
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Parameter	Matrix	Container	Size	Preservation	Holding Time
Dioxins/Furans	Sediment	Amber glass	8 oz.	4°C	14 days to extraction, 40 days to analysis
	Tissue	Aluminum foil wrap, plastic zip-lock bags	Variable	Frozen, -20° C	14 days to extraction, 40 days to analysis
Radionuclides	Sediment	Glass	8 oz.	None	6 months
	Tissue	Glass[a]	8 oz.	None	6 months
SRP, NH_3, NO_3+NO_2	Water	Polyethylene	500 mL	filtered, 4°C	48 hr
TKN, Total P	Water	Polyethylene	500 mL	H_2SO_4 to pH 2, 4°C	28 days
TOC	Water	Amber glass	125 mL	H_2SO_4 to pH 2, 4°C	28 days
	Sediment	Glass	4 oz.	4°C	28 days
DOC, POC	Water	Amber glass	125 mL	freeze	6 mo.
Hardness, Conductivity (at 25°C)	Water	Polyethylene	100 mL	4°C	28 days
Chlorophyll *a*/Phaeophytin *a*	Water	Polyethylene	1 L	$MgCO_3$, filter/freeze	28 days
TSS	Water	Polyethylene	1 L	4°C	7 days
Total Sulfides	Sediment	Glass	4 oz.	4°C, 1 N zinc acetate	14 days

TABLE 6. CONTAINERS, COLLECTION VOLUMES, PRESERVATION, AND HOLDING TIMES
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY
(Page 3 of 3)

Parameter	Matrix	Container	Size	Preservation	Holding Time
Grain Size, TVS, NH_3, TKN, Total solids	Sediment	Glass	8 oz.	4°C	6 mos.
Amphipod toxicity	Sediment	Glass	1 L	4°C	14 days
Microtox	Sediment	Glass	1 L	4°C	14 days
Bacteria	Water	Glass	250 mL	4°C	30 hr

[a] Will be shipped as previously homogenized tissue

sampling location. A description of the QC samples to be collected, frequency of QC sample collection, and collection techniques is provided below under separate headings for each of the specific media.

4.4 SEDIMENT SAMPLING

The specific location to be sampled for sediments will be determined in the field based on site accessibility and the grain size of the sediments as determined by test grab samples. Since quantitative determinations of grain size can not be obtained prior to the field sampling, qualitative determinations will be made by visual and tactile inspection. If the test grab samples do not contain fine (i e., silt or clay) sediments, another test grab will be taken in a different location until fine sediments are obtained. If no fine sediments are obtained after 10 test grabs in different locations at the primary station, an alternate sampling location will be chosen.

Sediment samples will be collected in a consistent, repeatable manner with a stainless steel modified 0.02-m^2 Ponar grab sampler. The grab sampler was modified so that the screen doors at the top of the sampler could be easily removed to allow access to an undisturbed sediment sample. This sampler will operate well in soft sediments. This sampler was chosen rather than a van Veen grab because of its small size. Because of the shallow water and narrow channels expected in many of the backwater areas, a small Zodiac boat will be used to deploy the grab sampler. The size of the boat precludes the use of a winch system typically used on a larger boat to deploy the heavier van Veen grab. The Ponar grab will be deployed by hand using a davit system installed at the side of the zodiac. The sampler will be attached to the line with a ball-bearing swivel to prevent twisting movements by the sampler during deployment and retrieval. The sampler will be lowered slowly to ensure that it does not flip over on descent and that disturbance of the sediment surface upon retrieval is prevented. Once the sampler is brought on board, it will be placed on the hard bottom of the zodiac. 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 minimum penetration depth for silt/clay samples using the ponar grab is 6 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, surface sediments will be removed from the grab to a depth of 2 centimeters using a stainless steel spoon. Only portions of the sample away from the edges of the grab will be collected.

Sediment from four or more grab samples will be composited and homogenized prior to being placed in sample containers. The sample containers to be used are listed in Table 6. The sediment will be placed in a pre-cleaned (detergent wash, distilled water rinse, methanol rinse) stainless-steel bowl and carefully homogenized until uniform color and consistency are achieved. All sediment handling devices will be rinsed, washed with detergent, and then rinsed with river water, methanol, distilled water, and a final rinse with river water prior to use at each station.

One set of three field replicates will be collected at one station for each of the analytical groups listed in Table 3. The replicate samples will be collected at a site slightly away from (up to 50 m) the original collection sites. The station at which the field replicates will be taken will be decided in the field based

on the degree of contamination expected and the percentage of fine sediments. At this time, the most likely station at which replicates will be taken is Goering Slough (No. 9), with Scappoose Bay (No. 10) serving as an alternate.

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. Prior to, and following the collection of a set of field samples at a sampling station, sampling equipment will be decontaminated. Following decontamination, one grab sample will be collected, then discarded, before collecting the samples to be retained for analysis. Additional field QC procedures to be followed are discussed in Section 7.1.1.

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 will be stored on ice until they are delivered 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.

4.5 TISSUE SAMPLING

Two different species will be collected at each of the 15 backwater stations. The primary target species are largescale sucker and crayfish. Based on the tissue sampling efforts from the 1991 Lower Columbia River Reconnaissance Survey, crayfish can probably be obtained at each of the sites. Largescale suckers, however, may not be easily obtained at all stations, particularly in the estuary. Alternate species, in the order of preference, are carp, peamouth chub, and Northern squawfish. If the primary target species can not be obtained within 3 hours of electrofishing time (including searching time), alternate species will be retained for analysis. The electroshocking boat has two live wells onboard, so alternate species can be collected and maintained alive until the final decision is made on which species will be analyzed. At every station, an attempt will be made to collect five fish from the primary or the alternate species. If, after a total of 8 hours of electrofishing time, five fish can not be obtained from either the primary or alternate species, one of the alternate sampling locations will be chosen. The field QC procedures to be followed are discussed in Section 7.1.2.

4.5.1 Largescale Sucker

Largescale suckers will be collected, if possible, from each of the 15 backwater stations by electrofishing. The actual location of each station will roughly coincide with the sediment location, although electrofishing will usually take place in slightly deeper and faster water, due to the larger size of the electrofishing boat. The range over which electrofishing may take place could extend as much as ± 1 kilometer from the site of the sediment and water sampling.

At each site, five individuals will be collected. Upon capture, the fish will be stored in a live well aboard the boat. When five fish of the primary species (or alternate species, as described above) have been captured, the standard length and weight of each fish will be recorded. Each fish will then be wrapped in aluminum foil (dull side against fish), placed in a single large plastic bag, placed on dry ice and frozen. Every two days, all fish samples will be shipped to the analytical laboratory which will perform the homogenization (Pacific Analytical). Each collection of five whole fish will be composited into a single large sample in the laboratory for chemical analysis. One field triplicate will also be submitted (a total of three composites of five fish each). The field replicates will be collected at the same station at which sediment field replicates will be collected (possibly Goering Slough or Scappoose Bay).

4.5.2 Crayfish

Crayfish samples will be collected from each site using baited traps. Up to ten traps will be set out at each station and left overnight. If an insufficient number of crayfish are obtained, the traps will be redeployed at a slightly different location. It is anticipated that crayfish can be captured at the same locations from which sediment was collected. A single composite sample will be collected from each site. A composite sample will consist of at least 30 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 and frozen. Every two days, all crayfish samples will be shipped to the analytical laboratory which will perform the homogenization (Pacific Analytical). One field triplicate will also be submitted (a total of three composites of 30 or more crayfish each). The field replicates will be collected at the same station at which sediment field replicates will be collected (possibly Goering Slough or Scappoose Bay).

4.5.3 Tissue Preparation and Storage Procedures

The preparation of the fish and crayfish for chemical analysis will be performed by Pacific Analytical Laboratories. Tissue samples 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. Pacific Analytical will be performing the dioxin/furan and the TBT analyses. The homogenized tissue will then be distributed (shipped frozen on ice) to the other laboratories for analysis of the other parameters (i.e., metals and organic compounds).

4.6 WATER SAMPLING

Water samples will be collected by withdrawing river water from below the surface (approximately 0.5 m deep) using a peristaltic pump. The pump will be equipped with a teflon sampling tube. However, a short piece of more flexible Tygon™ tubing (approximately 20 cm long) will be used in the pump housing. The Tygon™ tubing will be replaced between each station to minimize the chance of cross-contamination. Additional details on the QC procedures to be followed in the field are given in Section 7.1.3.

During water sampling, care will be taken to avoid disturbing bottom sediments in the shallow backwater areas that are to be sampled. In general, water sampling will be conducted after the collection of at least one test grab for sediment samples, but before the collection of the additional grab samples necessary for the composite sample. Water samples will be collected at a nearby undisturbed location to avoid collecting suspended sediment that may have been produced by disturbing the bottom with the sediment sampling device during the test grab.

4.6.1 Metals

At each station three replicate samples will be collected for analysis of total recoverable metal concentration by pumping water directly into labeled, pre-cleaned (acid-washed, distilled water rinsed) 500-mL polyethylene sample bottles. Each bottle will be rinsed three times with sample water prior to collection of the sample. The sample will be acidified with concentrated nitric acid (HNO_3)(Ultrex™) to

pH less than 2 (approximately 2.5 mL of concentrated HNO_3). The bottle cap will also be rinsed with sample water and then fastened securely on the acidified sample.

Three field-replicated filtered samples will also be collected at each station for analysis of dissolved metal concentrations. These samples will be collected by pumping water from 0.5-m water depth through an in-line filter apparatus directly into labeled 500-mL polyethylene sample bottles. The in-line filter holder will be composed of polyethylene and will accommodate a 47-mm diameter filter. A different, pre-cleaned filter holder will be used for every station. Acid-washed and distilled water-rinsed 0.45-μm pore size cellulose acetate membrane filters will be used for filtration of the samples at each station. Each sample bottle will be rinsed three times with sample water prior to collection of the sample. The sample will be acidified with concentrated nitric acid (Ultrex™) to pH less than 2. The bottle cap will also be rinsed with sample water and then fastened securely on the acidified sample.

All samples collected for metals analysis will be placed on ice until they can be shipped or delivered to the laboratory for analysis.

4.6.2 Conventional Parameters

Conventional parameters are defined for this project as nutrients (limited to nitrogen and phosphorus compounds), chlorophyll and phaeophytin *a*, cyanide, total suspended solids (TSS), turbidity, conductivity, hardness, temperature, pH, dissolved oxygen, and organic carbon [total (TOC), dissolved (DOC), and particulate (POC)]. For the description of sampling methods the conventional parameters will be further divided into nutrients, chlorophyll *a*/phaeophytin *a*, and miscellaneous conventional parameters.

4.6.2.1 Nutrients. The nutrients to be sampled include total Kjeldahl nitrogen (TKN), ammonia nitrogen, nitrate plus nitrite nitrogen, total phosphorus (TP), and soluble reactive phosphorus (SRP). Three replicate nutrient samples will be collected from the 0.5-m water depth using a peristaltic pump equipped as described above. Whole water samples will be collected for analysis of TKN and total phosphorus. Sample bottles (composition and size) and preservation methods that will be used are provided in Table 6. Each sample bottle will be rinsed three times with sample water prior to collection of the sample.

The samples collected for analysis of SRP, ammonia nitrogen, and nitrate plus nitrite nitrogen will be filtered in the field using the in-line filter apparatus described above. Distilled water-washed 0.45-μm pore size cellulose acetate membrane filters will be used for filtration of the samples at each station.

All samples collected for nutrient analysis will be placed on ice until they can be shipped or delivered to the laboratory for analysis. Because of the short holding time for SRP, water samples for this analysis will be shipped to the laboratory daily.

4.6.2.2 Chlorophyll a/Phaeophytin a. Samples for analysis of chlorophyll *a*/phaeophytin *a* will be collected from the 0.5-m water depth using a peristaltic pump equipped as described above. At one station, three field replicate samples will be analyzed. The samples will be collected in labeled opaque 1-L polycarbonate bottles. The samples will be placed on ice in the dark prior to filtration in the laboratory for analysis.

4.6.2.3 Miscellaneous Conventional Parameters. Miscellaneous parameters include parameters that will be analyzed using field instruments, and samples that will be collected and returned to the laboratory for analysis. Miscellaneous conventional parameters that will be measured in the field include conductivity, salinity, turbidity, pH, temperature, and dissolved oxygen. Miscellaneous conventional parameters that will be measured in the laboratory include cyanide, total suspended solids (TSS), hardness, conductivity, and organic carbon (TOC, DOC, and POC). The field sampling methods for miscellaneous field and laboratory conventional parameters are described below.

Field Measured Conventionals: Triplicate measurements of conductivity, salinity, turbidity, pH, temperature, and dissolved oxygen will be made at each station using a Yellow Springs Instruments (YSI) and Grant Instruments Ltd. model 3800 water quality data logger. The instrument will be calibrated each day prior to initiation of sampling and instrument calibration for pH and turbidity will be checked before sampling at each station using standard solutions. The instrument will be re-calibrated if the pH reading is not within 0.1 pH units or within 1 NTU of the known standards. The temperature reading of the instrument will be checked against a mercury thermometer prior to initiation of sampling, and thereafter it will be checked daily, to ensure that the temperature reading of the instrument is accurate. The instrument will be calibrated for dissolved oxygen using the air calibration method. Three field samples will be collected for laboratory analysis of DO using the Winkler method. The results of these analyses

will be compared to the DO values obtained using the data logger as an independent check of the field method.

All calibration and calibration check results will be recorded in the field notebook. Any difficulties encountered with the field instrument will also be noted in the field notebook.

Laboratory Measured Conventionals. Conventional parameters that will be measured in the laboratory include cyanide, hardness, conductivity (at 25°C), TOC, DOC, POC, and TSS. At each station, samples will be collected from the 0.5-m water depth for each of these parameters using the peristaltic pump described above. Samples for DOC will be filtered using a pre-combusted glass-fiber filter (GF/F) and a glass syringe apparatus. At one station, three field replicate samples will be analyzed. The field replicates will be collected at the same station at which sediment field replicates will be collected (possibly Goering Slough or Scappoose Bay). Sample containers and preservation will be as described in Table 6.

4.6.3 Indicator Bacteria

Indicator bacteria that will be sampled include fecal coliform bacteria, enterococcus, and *Escherichia coli*. Three replicate samples will be collected from each station from the 0.5-m water depth using the peristaltic pump described above. The sample will be pumped into a pre-sterilized 250 mL bottle. The bottle will not be rinsed with sample water, but will be immediately capped and placed on ice in the dark for transport to the laboratory.

4.7 SAMPLE IDENTIFICATION

The labeling scheme for the survey will be composed of two parts, the station numbers and the sample numbers. Stations will be numbered sequentially from 1-15, starting from the estuary. Alternate stations will be labeled 16-20, starting from the estuary.

Sample numbers will consist of the station number, followed by one of the prefixes below:

- S for sediment

- W for water
- LS for largescale sucker
- CF for crayfish
- C for carp (alternate species)
- P for peamouth chub (alternate species)
- NS for Northern squawfish (alternate species).

Field replicate samples will be collected at all stations for certain analytes. The number of field replicate samples to be collected is discussed in Section 5.0. For the purposes of sample numbering, the number of the field replicate sample will be appended to the station number and the prefixes for the sample media noted above. For example, 3 field replicates collected in sediment at Station 1, would be given sample numbers of 1S1, 1S2, and 1S3. For water samples to be analyzed for metals, an additional suffix will be added to signify whether the sample has been filtered to be analyzed for dissolved metals (suffix = d) or not filtered to be analyzed for total recoverable metals (suffix = t).

4.8 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.

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, and then locked or otherwise sealed so that tampering will be evident.
- It is kept in a secure area, restricted to authorized personnel only.

4.8.1 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. 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 Persons 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 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 that no samples have been 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.

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.

4.8.2 Transfer of Custody and Shipment Procedures

All samples will be accompanied by a Chain-of-Custody Record (Figure 5) indicating sample numbers and the requested analyses. 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 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 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 delivery is preferred, due to holding times of 7 days or less (see Table 6).

TETRA TECH, INC
15400 NE 90th, Suite 100
Redmond Washington 98052
(206) 883-1912
FAX (206) 881-6997

CHAIN OF CUSTODY

DOCUMENT ________

PROJECT NAME			PROJECT NO																		
SAMPLERS (*signature*)																					
Ti Contact			MEDIA							NUMBER OF CONTAINERS	ANALYSIS										REMARKS
SAMPLE ID	TIME	DATE	Air	Surface Water	Ground Water	Soil	Sediment														

RELINQUISHED BY (*signature*)	DATE/TIME	TOTAL NUMBER OF CONTAINERS		RECEIVED FOR LAB BY (*Signature*)	DATE/TIME
RECEIVED BY (*signature*)	DATE/TIME	RELINQUISHED BY (*signature*)	DATE/TIME	CONDITION OF CONTENTS	TEMPERATURE UPON RECEIPT
RELINQUISHED BY (*signature*)	DATE/TIME	RECEIVED BY (*signature*)	DATE/TIME	REMARKS	
RECEIVED BY (*signature*)	DATE/TIME	METHOD OF SHIPMENT	AIRBILL NO		

Distribution Original Lab Copy Yellow copy Final Tetra Tech Copy Pink Copy Field File Copy

Figure 5. Chain of Custody Form.

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 a courier, to the analyst at the laboratory. Copies of the original Chain-of-Custody 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).

4.8.3 Sample Custody of Tissue Homogenate

For tissue analyses, Pacific Analytical will be responsible for the homogenization and distribution of all tissue samples. Separate Chain-of-Custody Forms (see Figure 5) must be prepared for those samples and marked to indicate with whom the samples are 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. The original will be retained by Pacific Analytical and a copy will be forwarded to Tetra Tech.

4.8.4 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. The laboratory sample custodian will also maintain a Lab Tracking Report to follow each sample through all stages of laboratory processing. 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.

5.0 ANALYTICAL PROCEDURES

The field measurement and laboratory protocols prescribed for this project are based primarily on U.S. EPA-approved methods Table 2 includes the analytical methods to be used for each analytical group/matrix combination. This table also includes the target quantitation limits to be used for this project. Analytical techniques for sediment and tissue will be performed in accordance with EPA SW-846, 3rd edition (1986), except where noted in Table 2. Analytical procedures for water are based primarily on Standard Methods for the Examination of Water and Wastewater (APHA 1992).

5.1 ANALYTICAL PROCEDURES FOR SEDIMENT AND TISSUE

Analysis of sediment and tissues will be performed using methods given in Table 2. Sediment samples will be collected and shipped to the six different laboratories performing analyses on sediments. All tissue samples will initially be processed by Pacific Analytical. The homogenized, ground samples will be distributed by Pacific Analytical to ARI (organic analyses - 60 g per sample and radionuclides analyses - 200-400 g per sample) and Aquatic Research (metals analyses - 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.

5.1.1 Metals

Sediment and tissue samples to be analyzed for metals will be digested in the laboratory using the method specified in PSEP (1989) using nitric acid and hydrogen peroxide instead of hydrochloric acid to avoid matrix effects induced by use of hydrochloric acid in the analyses conducted by graphite furnace. This digestion procedure yields what is usually referred to as "total recoverable" metals. Each metal will be analyzed by either graphite furnace atomic absorption spectroscopy (GFAA) or inductively-coupled plasma emission spectroscopy (ICP), except for mercury, which will be analyzed by cold-vapor atomic absorption spectroscopy (CVAA). Of the 15 other metals listed in Table 2, all but five (barium, beryllium, nickel, thallium, and iron) will be measured by GFAA. Several metals which are being

measured in sediment will not be measured in tissue. Aluminum, beryllium, chromium, iron, and thallium are not expected to bioaccumulate and will not be measured in tissue samples.

5.1.2 Organic Compounds

Sediment and tissue samples will be analyzed for semi-volatile organic compounds, pesticides and PCBs, tributyltin (TBT), and dioxins and furans using methods specified in Table 3. A subset of the semi-volatile compounds, the polycyclic aromatic hydrocarbons (PAHs), will be separately analyzed by selective ion monitoring (SIM). This method should allow detection limits to be reduced up to one order of magnitude lower than those typically achievable by U.S. EPA Method 8270. Tributyltin will be quantified using a gas chromatograph equipped with a flame photometric detector (GC/FPD). A second megabore column will be used for compound confirmation.

5.1.3 Radionuclides

Sediment and tissue samples will be analyzed for radionuclides using the methods specified in Table 2. Cesium-137, cobalt-60, europium-152, and europium-154/155 will be analyzed by gamma spectroscopy (U.S. EPA Method 901.1), while plutonium-238, plutonium-239/240, and americium-241 will be analyzed by alpha spectroscopy (EMSL-LV-0539-17).

5.1.4 Sediment Conventionals

Sediment conventionals are defined for this project as total sulfides, ammonia, total solids, total volatile solids (TVS), total Kjeldahl nitrogen (TKN), and grain size. Sediment samples will be analyzed for these parameters by AmTest Inc., using procedures outlined in PSEP (1989).

5.1.5 Toxicity

Sediment samples from each of the 15 sites will be analyzed for toxicity using both an acute test and chronic test. The acute test will utilize either the amphipod *Hyalella azteca* or the amphipod *Eohaustorius estuarius* (Standard Method E. 1383-90). This test measures the survival of the amphipods over the 10-day test period. *Hyalella* will be used for all freshwater sediments, while *Eohaustorius* will be used for the estuarine sediments. A salinity tolerance test will be performed using the two species to determine which species should be used in the transition zone between the estuarine and freshwater portions of the river. At the time of sample receipt, the laboratory (Northwestern Aquatic Sciences) will measure the interstitial salinity. This information will be considered in conjunction with the results of the salinity

tolerance test to decide which species will be used at each site. Five replicate test chambers will be used for each of the test sediments, each of which will contain 20 amphipods.

Two of the 15 test sediments will be considered reference sites. One site (Willow Bar Islands) is located in the freshwater portion of the river and will serve as the reference site for all tests performed using *Hyalella*. This site is located near a station (D27) sampled in the original reconnaissance survey for which no contaminants of concern were identified (Tetra Tech 1993a). The grain size at Station D27, however, consisted primarily of coarse sand, making it unsuitable as a reference site for the fine-grained sediments which will be collected from backwater areas. For the backwater survey, the nearest fine-grained sediments to Station D27 will be collected. It is assumed that sediments in the vicinity of Station D27 will also be relatively free of contaminants and will be suitable for a reference sediment. This assumption will be evaluated Backwater Reconnaissance Survey Analysis Report.

The second reference sediment will be collected in the estuarine portion of the river, near Lewis and Clark National Wildlife Refuge. This sediment will serve as the reference sediment for all *Eohaustorius* tests. This site is located near a station (D11) sampled in the original reconnaissance survey for which no contaminants of concern were identified (Tetra Tech 1993a). The grain size at this station was fine sand. An attempt will be made to collect even finer sediments in vicinity of Station D11. It is assumed that sediments in the vicinity of Station D11 will also be relatively free of contaminants and will be suitable for a reference sediment. This assumption will be evaluated Backwater Reconnaissance Survey Analysis Report.

In addition to the 13 test sediments and the 2 reference sediments, a control sediment will be tested for each of the two species of amphipod. The survival of the amphipods in the control sediments is expected to be high. For the test results to be considered acceptable, the survival of the amphipods in the control sediments must be at least 90 percent.

The mean survival for each sediment treatment will be compared to means from the other sediments and the reference sediments using a Student's *t*-test or a one-way analysis of variance (ANOVA) F test.

The chronic toxicity test to be used is the Microtox test (PSEP 1989). This test measures the effect of test sediments on the luminescence of the bacterium *Photobacterium phosphoreum*. Contaminated

sediments are likely to decrease the luminescence of this bacterium. The solid-phase test will be used for both estuarine and freshwater sediments. The two reference sediments described above will also serve that role for the Microtox test. The Microtox test includes a control which represents a reagent blank needed to measure spontaneous decay in bacterial luminescence independent of any sediment treatment.

For each sediment treatment, the concentration at which a 50 percent decrease in luminescence would be expected (known as the EC_{50}) is calculated by using a least-squares regression of percent decrease in luminescence on the logarithm of sample dilution.

5.2 ANALYTICAL PROCEDURES FOR WATER

Water samples will be collected as described in Section 4.6 and distributed to Aquatic Research, who will perform the metals, nutrients, and conventional parameter analyses, and Columbia Analytical Services, who will perform the bacterial analyses.

5.2.1 Metals

Total recoverable metals samples will be digested in the laboratory using the method specified in U.S. EPA (1983) using nitric acid only to avoid matrix effects induced by use of hydrochloric acid in the analyses conducted by graphite furnace. Each metal will be analyzed by either graphite furnace atomic absorption spectroscopy (GFAA) or inductively-coupled plasma emission spectroscopy (ICP), except for mercury, which will be analyzed by cold-vapor atomic absorption spectroscopy (CVAA). Of the 15 additional metals (other than mercury) listed in Table 2, all but five (barium, beryllium, nickel, thallium, and iron) will be measured by GFAA. Dissolved metals samples will be analyzed directly by GFAA or ICP as specified above.

5.2.2 Conventional Parameters

The methods used for the analysis of conventional parameters are described below.

5.2.2.1 Nutrients. The nutrients TKN, ammonia nitrogen, nitrate plus nitrite nitrogen, TP, and SRP will be analyzed by the methods specified in Table 3. Analytical holding times for these analyses are specified in Table 6.

5.2.2.2 Chlorophyll a/Phaeophytin a. Analyses for chlorophyll *a* and phaeophytin *a* will be conducted using the fluorometric method specified in APHA (1992). Although there are no specified holding times for these substances, samples will be filtered within 48 hours and frozen filters will be analyzed within 2 weeks.

5.2.2.3 Miscellaneous Laboratory Parameters. TSS, TOC, DOC, POC, hardness, and conductivity (specific conductance) will be analyzed using the methods specified in Table 3. POC will be analyzed using a CHN analyzer. Analytical holding times for these analyses are specified in Table 6.

5.2.3 Bacteria

Fecal coliform bacteria, enterococcus bacteria, and *E. coli* will be analyzed by the Standard Methods given in Table 3. Ideally, the holding time for these analyses is 6 hours, but 30 hours is considered acceptable for data that are not collected for legal purposes.

6.0 DATA VALIDATION, REVIEW, AND REPORTING

This section describes data validation, which is the process of converting raw data to final results, the peer review of the analytical data, and the reporting requirements for each of the analytical laboratories for this project.

6.1 DATA VALIDATION

The quality assurance/quality control data collected during field and laboratory analysis for the backwater reconnaissance survey samples will be reviewed to determine the validity of the data reported. Data will be evaluated for precision and accuracy. QA/QC data will be compared to established control limits to identify the need for the qualification of any data. As part of this effort, data tables will be prepared which will include all of the analytical data with any applicable data qualifiers added. 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. Data will be compared to the project data quality objectives (Table 3) to determine if the data are sufficient for project tasks.

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.

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

E - 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.

6.1.1 Validation of Metals and Organics Data

The evaluation of QA/QC results for analysis of samples for metals and organic compounds will follow the protocols established for the U.S. Environmental Protection Agency's Contract Laboratory Program (CLP) guidelines for data validation (U.S. EPA 1991a; 1988a,b). For analytes which are not covered in the guidance documents (e.g., radionuclides, organotins), the QC data provided by the laboratories will be evaluated using best professional judgement to determine if any of the data should be qualified.

6.1.2 Validation of Conventional Parameters

Conventional parameters as defined for this project are the water column measurements of the nutrients nitrogen and phosphorus, total suspended solids, water hardness, conductivity, turbidity, pH, temperature, dissolved oxygen, chlorophyll *a*/phaeophytin *a*, and total organic carbon; the sediment analyses for grain size, ammonia, total organic carbon, total sulfides, acid volatile sulfides, total volatile solids, and total solids; and the analysis of tissue lipid concentration. There are no published guidelines for the validation of these data, although the method protocols do typically list reporting requirements and QC data that should be collected (PSEP 1989). These QC data (e.g., calibration checks and standards, matrix spikes, laboratory duplicates) will be used to validate the conventional parameter data reported for the backwater reconnaissance survey.

6.1.3 Validation of Toxicity Data

For both the amphipod and Microtox tests, both positive and negative control tests will be performed. The positive control tests are also known as reference toxicant tests. The test organisms are expected to be adversely effected by the test substances. For these tests, a serial dilution of a known concentration of toxicant (copper chloride and sodium arsenate for amphipods and Microtox, respectively) is tested to evaluate the sensitivity of the test organisms. If the LC_{50} (concentration lethal to 50 percent of the test population) or the EC_{50} are well outside (i.e., outside the 95 percent confidence interval for that test at the laboratory) what is typically observed for these species, the results of tests may not be legitimately compared to other toxicity results where the sensitivity of the test organisms was within expected values.

For the negative control tests, the test organisms are not expected to be adversely effected. For the amphipod tests, if the mean survival of the amphipods in the negative control sediment is less than 90 percent, the toxicity results of the test sediments run concurrently are considered invalid. For the Microtox test, the negative control is equivalent to a reagent blank. The results of this control test can be subtracted from the other dilutions to indicate whether a decrease in luminescence is due to the test sediments or due to spontaneous decay.

6.1.4 Validation of Bacterial Data

Positive confirmation tests are run on approximately 10 percent of the bacterial samples. These tests confirm the identity of the bacterium or bacterial group the tests are designed to identify. The results of these tests will be reviewed to confirm that the number of colonies reported for each test are actually of the correct species or group.

6.2 DATA REVIEW

The results and the methodology of the data validation performed on the analytical data will be reviewed by a person familiar with the examination of analytical data and the protocols typically followed for a data validation. If discrepancies are noted, the reviewer and the original analyst for the data validation will confer to decide upon the proper course of action.

6.3 REPORTING REQUIREMENTS

This section describes the deliverables that each analytical laboratory will be expected to provide. Laboratory Certificates of Analysis with complete sample results will be due from the laboratories within 30 days after the laboratory receives each sample group.

6.3.1 Organic Data

In general, the deliverables specified in U.S. EPA's CLP program (U.S. EPA 1991b) will be requested from the analytical laboratories. These deliverables include forms which summarize GC/MS tuning, initial and continuing calibration, method blanks, matrix and blank spikes, surrogate recoveries,

laboratory duplicates, precision and recovery samples (dioxins/furans), internal standard recoveries, and certified reference material. In addition, a case narrative will be requested that includes a summary of any quality control, sample, shipment, or analytical problems, and documentation of all internal decisions. A copy of the signed chain-of-custody form for each group of samples will be included in the narrative packet. Copies of all raw data will be requested so that calculations can be verified and questionable results can be investigated.

6.3.2 Inorganic Data

For metals, the deliverables specified in U.S. EPA's CLP program (U.S. EPA 1991b) will be requested from the analytical laboratories. These deliverables include forms summarizing initial and continuing calibration, method blanks, matrix and blank spikes, ICP interference check sample and serial dilution results, laboratory duplicates, and certified reference materials. In addition, a case narrative will be requested that includes a summary of any quality control, sample, shipment, or analytical problems, and documentation of all internal decisions. A copy of the signed chain-of-custody form for each group of samples will be included in the narrative packet. Copies of all raw data will be requested so that calculations can be verified and questionable results can be investigated.

For inorganic analytes other than metals, all QC data required by each method will be requested, along with the laboratory bench sheets. The QC data that the laboratory will provide may include method blanks, calibration data, check standards, laboratory duplicates, and matrix spikes.

6.3.3 Toxicity

For the amphipod toxicity test, the requested deliverables include tables presenting the results for each sediment treatment, a description of data analysis methods employed and documentation of statistical test results, and a 96-hr LC_{50} calculated from the reference toxicant test. For the Microtox tests, the requested deliverables include percent decrease in luminescence for each concentration of supernatant tested; determination of a significant dose-response relationship by least-squares regression of percent decrease in luminescence on the logarithm of sample dilution; and determination of an EC_{50} value and 95-percent confidence limits for the reference toxicant test.

6.3.4 Bacteria

In addition to the sample results, the results of all positive confirmation tests will be requested.

7.0 QUALITY CONTROL PROCEDURES

7.1 FIELD QC PROCEDURES

This section describes the QC procedures to be practiced in the field to insure that the analytical data collected are of high quality.

7.1.1 Sediment Sampling

At one of the fifteen backwater stations (possibly Goering Slough or Scappoose Bay), three field replicate samples will be collected and analyzed for all of the sediment variables listed in Table 2. The results of these field replicates will give an indication of the total variability (i.e., field-plus laboratory) between measurements at a particular location, and may provide an estimate of random error due to sampling.

Standard reference materials will be submitted to the laboratory as performance evaluation (PE) samples. Reference materials certified for metals are available for both estuarine and freshwater sediments (NIST 1646 and 2704, respectively) and will be submitted to Aquatic Research. A marine sediment sample (NIST 1941) which has been certified for semi-volatile organic compounds and a soil sample (NIST 4353) certified for plutonium, uranium, and Americium will be submitted to ARI for analysis. A soil sample certified for dioxins/furans (EDF-2514) will be submitted to Pacific Analytical for analysis.

Cross-contamination between stations will be prevented by thorough decontamination of the sediment sampling gear between stations and the discarding of the first grab at each station.

All sampling bottles will be pre-labeled before the sampling begins. The accuracy of the labels will be checked by a person not involved in the labeling of the containers. The completed sample summary logs and chain of custody forms will also be double-checked by a different person. These procedures should insure that all sample jars which arrive at the laboratory are correctly labeled.

7.1.2 Tissue Sampling

At one of the fifteen backwater stations, three field replicate samples will be collected and analyzed for all of the tissue variables listed in Table 2. A separate set of three field replicates will be collected for each of the two target species. The results of these field replicates will give an indication of the total variability between measurements at a particular location, and may provide an estimate of random error due to sampling.

Standard reference materials will be submitted to the laboratory as performance evaluation (PE) samples. The marine tissue sample (NIST 1974) originally intended for analysis is not currently available. A fish sample (EDF-2524) currently under development will be certified for dioxins/furans. If this sample is certified before the analyses for the project begins, it will be submitted to Pacific Analytical for analysis.

Inter-laboratory variability will be assessed by the analysis of one largescale sucker composite for metals, semi-volatile organics, and pesticides/PCBs at two different laboratories (Analytical Resources, Inc. and Pacific Analytical, Inc.).

All zip-lock bags will be pre-labeled before the sampling begins. The accuracy of the labeling will be checked by a person not involved in the labeling of the bags. The completed sample summary logs and chain of custody forms will also be double-checked by a different person. These procedures should insure that all samples which arrive at the laboratory are correctly labeled.

7.1.3 Water Sampling

Samples for several of the water parameters will be collected in triplicate (i.e., three field replicates) at every station. These parameters include metals, bacteria, and nutrients. Triplicate samples will be collected for these parameters because the natural field variability is expected to be high. For the other water parameters, three field replicates will be collected at only one of the fifteen stations (possibly Goering Slough or Scappoose Bay). The results of these field replicates will give an indication of the total variability (i.e., field plus laboratory) between measurements at a particular location, and may provide an estimate of random error due to sampling.

A standard reference material (NIST 1643c) will be analyzed for metals as a check on the accuracy of the analytical methodology.

Several procedures will be followed to prevent cross-contamination between stations. All filters used at a particular station will be discarded before sampling at a new station. At each station, the Tygon™ tubing in the pump head and the polycarbonate filter holder will also be replaced. Prior to the collection of any water in the sampling bottles, at least 2 L of water will be pumped through the sampling equipment.

Two equipment blanks will be analyzed for dissolved metals as a check on the potential contamination contributed by the membrane filters and the sampling apparatus. One blank will be prepared in the laboratory by the field team leader for water sampling by filtering reagent water (from the analytical laboratory responsible for the metals analyses) through the peristaltic pump and a membrane filter acid-washed in an identical manner to those to be used in the field. The second blank will be prepared in an identical manner but will be collected during the field sampling. This blank will also serve to check for cross-contamination between sites.

All sampling bottles will be pre-labeled before the sampling begins. The accuracy of the labels will be checked by a person not involved in the labeling of the containers. The completed sample summary logs and chain of custody forms will also be double-checked by a different person. These procedures should insure that all sample jars which arrive at the laboratory are correctly labeled.

7.2 LABORATORY QC PROCEDURES

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 calibration methodology 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, ARI, Pacific Analytical, and Aquatic Research, 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 Redmond, 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.

8.0 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.

9.0 DATA ASSESSMENT PROCEDURES

9.1 COMPARISON WITH DATA QUALITY OBJECTIVES

The analytical data generated as part of this project will be compared with the data quality objectives listed in Table 3. In most cases, if the data for a particular sample did not meet the objectives in Table 3, the data will be qualified in some way (e.g., qualifier code 'E' for an estimated value) as per the procedures discussed in Section 6.1. The results of these comparisons with data quality objectives will be summarized in the Quality Assurance Report (see Section 11.0).

9.2 COMPARISON WITH AVAILABLE CRITERIA

In order to assess the water quality of the backwater areas sampled, the analytical data collected as part of this survey will be compared to the applicable criteria. The potential negative effects of the measured contaminant levels on aquatic organisms, terrestrial wildlife, and humans will be made based on comparison to these criteria and guidelines.

Water column sample analysis results will be evaluated based on state (Oregon and Washington) and federal water quality criteria for the protection of aquatic organisms and humans. Sediment contaminant data will be evaluated based on the Washington Marine Sediment Quality Standards (WAC 173-204-315), the effects-range low concentrations of Long and Morgan (1990), Ontario's freshwater Provincial Sediment Quality Guidelines (Persaud et al. 1991), and the available draft U.S. EPA criteria for dieldrin, endrin, acenaphthene, fluoranthene, and phenanthrene (U.S. EPA 1991c,d,e,f,g). The aquatic organism tissue concentrations will be evaluated using the New York State fish flesh guidelines (Newell et al. 1987).

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 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.

11.0 REFERENCES

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APPENDIX A

HEALTH AND SAFETY PLAN

APPENDIX A – 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.

A.1 SAFETY OFFICER

To ensure safe and efficient shipboard operations, the field team leader 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.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.

A.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.

A.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 Ponar 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 davit failure.

During retrieval of sampling equipment, at least one crew member will watch for the appearance of the equipment and will alert the operator of the davit system when the equipment is visible below the water surface and when it breaks the water surface. Failure to monitor equipment retrieval may lead to breakage of the line, loss or damage of the gear, and possible injury from either the falling grab or the snapped line. 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 nylon line may break. Sampling personnel will be instructed to avoid contact with the moving line unless protected by work gloves. On a periodic basis over the length of the sampling cruise, the chief scientist will inspect the line for wear, especially where the line is attached to the sampling gear. The field team leader will also periodically inspect all shackles, pins, housing, swivels and thimbles to ensure the integrity of all points along the line. Likewise, all on-deck crew members will be encouraged to periodically inspect these linkages.

Lines, 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 lines, and rinsing accumulations of mud from the deck. Awareness of the locations and status of 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, and must be donned when directed by the field team leader/safety officer.

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 field team leader/safety officer can also direct any member of the crew to cease working.

A.3 SAFE WORK PRACTICES

An exclusion/contamination reduction zone will include the areas where sediments and methanol 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 field team leader/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 field team leader/safety officer 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 grab sampler, 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.

A.4 EMERGENCY PLANNING

If an emergency or accident occurs during sampling, the field team leader/safety officer 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 will be available to all crew members in the event that the field team leader is incapacitated. All accidents will be required to be reported to the field team leader 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. 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

A.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 field team leader will ensure that all safety equipment is on board; and
- The field team leader and/or vessel operator will brief all guest observers concerning the safety requirements and procedures to be adhered to during sampling operations.