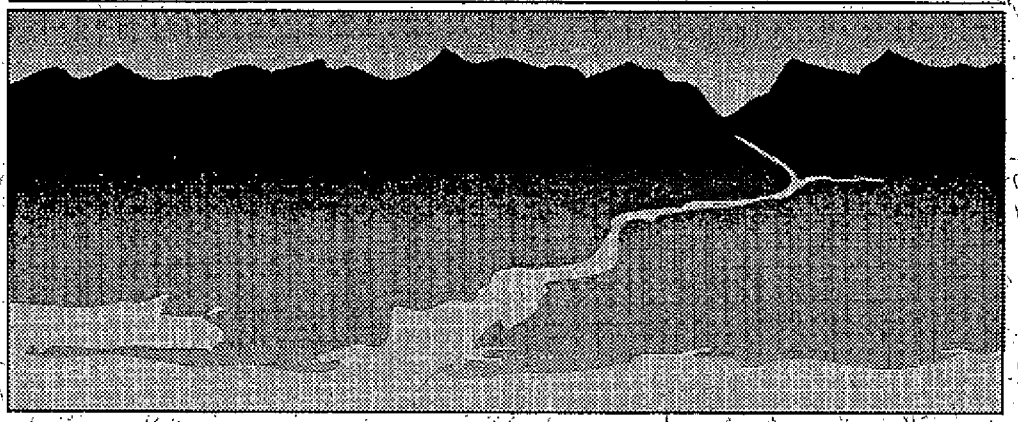
FINAL REPORT
TC 9968-02

LOWER COLUMBIA RIVER



BI-STATE PROGRAM

ASSESSING HUMAN HEALTH RISKS FROM CHEMICALLY CONTAMINATED FISH IN THE LOWER COLUMBIA RIVER

Sampling and Quality Assurance/ Quality Control Plan

SEPTEMBER 16, 1994

Prepared By:

TETRA TECH

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The Lower Columbia River
Bi-State Water Quality Program

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ACKNOWLEDGMENTS

This report was prepared by Tetra Tech, Inc. of Redmond, Washington for the Lower Columbia River Bi-State Water Quality Program under Contract Nos: C0091228 (WDOE) and 78-91 (ODEQ). The Project Coordinators for the Bi-State Program were Mr. Don Yon of Oregon Department of Environmental Quality and Mr. Brain Offord of Washington Department of Ecology. Tetra Tech's Project Manager for the Lower Columbia River Bi-State Water Quality Program was Dr. Steven Ellis. The authors of this report were Dr. Ellis and Mr. Tad Deshler. Word processing was provided by Ms. Lisa Fosse. Graphical support was provided by Ms. Kim Tapia.

1.0 INTRODUCTION

The Oregon and Washington state legislatures directed the formation of the Lower Columbia River Bi-State Water Quality Program in 1990. The Program developed a four-year plan designed to characterize water quality in the lower Columbia River, identify water quality problems, determine whether beneficial uses of the river are impaired, and develop solutions to problems identified in the river below Bonneville Dam (Bi-State Steering Committee 1990). The four-year plan proposed a framework and precedence for conducting studies to evaluate water quality that consisted of: 1) inventory of existing information; 2) reconnaissance surveys; 3) further evaluation of water quality (baseline studies); and 4) advanced studies. Since the inception of the Bi-State Program, a number of studies have been completed, or are in progress, to help accomplish the legislative mandate for the Bi-State Program. These studies have attempted to characterize historical and current contaminant levels in water, sediment, and a small number of fish species and crayfish throughout the river; quantify the amount and sources of pollutants entering the river; document beneficial uses of the river; and provide recommendations for addressing concerns about potential impacts of river contaminants on fish and wildlife populations and human health. As the Bi-State Program approaches its final year of existence, attention has been focused on utilizing the information that has been assembled in earlier data inventory and reconnaissance studies to design and accomplish specific baseline studies (e.g., ambient monitoring of tributaries, localized contaminant investigations) and advanced studies that attempt to quantify, or characterize, the potential risks to fish, wildlife, and humans from habitat modification and contaminant levels in the lower Columbia River. This Work Plan describes a scope of work for assessing the human health risks associated with the consumption of fish from the lower Columbia River.

1.1 HISTORICAL OVERVIEW

Prior to describing the study approach for this scope of work, it may be helpful to provide a historical

overview of activities within the Bi-State Program that contributed to the development of the study described in this document. During 1991, the Bi-State Program completed several studies designed to inventory and characterize existing water quality data. Following this effort, a reconnaissance survey of the lower river was conducted in the fall of 1991 to collect data that would enable a preliminary assessment of water quality to be made and could be used to direct future studies (Tetra Tech 1993a). This survey, which represents the most extensive collection of water quality data to date for the lower Columbia River, analyzed water, sediment, and tissue samples for a large list of chemicals of potential concern to aquatic life, wildlife, and humans. The data collected during the reconnaissance survey showed elevated levels of certain contaminants in a number of water, fish tissue, and sediment samples. After reviewing the information obtained in these initial studies, the Lower Columbia River Bi-State Program Steering Committee met on October 20. 1992 to review and prioritize future study objectives for the Program during 1993. The implementation of a study to assess potential human health risks was ranked among the top four study objectives by the Bi-State Steering Committee members (Lower Columbia River Bi-State Program 1992). Subsequently, the Lower Columbia River Bi-State Program convened a work group in March 1993 to provide specific recommendations regarding how a human health risk assessment should be conducted to determine whether contaminant levels in the river pose a risk to human health.

The Human Health Risk Work Group (HHRWG) met on three occasions during the spring of 1993 to discuss objectives, methodologies, data needs, and uncertainties associated with conducting a human health risk assessment as part of the Lower Columbia River Bi-State Program. At each meeting, several technical issues relevant to conducting a risk assessment were thoroughly discussed and evaluated by HHRWG members and attempts were made to formulate consensus, or when necessary, majority, recommendations for conducting a human health risk assessment. Readers interested in the content of these discussions should consult the approved minutes of these meetings (Lower Columbia River Bi-State Program 1993a; 1993b; 1993c). One of the first issues discussed by the HHRWG was whether all potential risk exposure pathways (e.g., water consumption, dermal contact, fish consumption) should be evaluated, or whether efforts should focus on particular pathways of interest. The consensus opinion of the HHRWG was that initial efforts should consider only risks associated with the consumption of fish (Lower Columbia River Bi-State Program 1993a). This decision was reached with the following qualifications:

- Time constraints and resources do not presently allow the Bi-State Program to make detailed assessments of all potential exposure pathways contributing to potential human health risks associated with beneficial uses of the lower Columbia River.

- HHRWG members acknowledged that ideally all human health risk exposure pathways should be evaluated or, if not, pathways with the greatest relative risk should be evaluated first.

- It was noted that the relative risk associated with different exposure pathways would vary among individuals depending upon their uses of the river, and that the Bi-State Program did not have immediate access to data that would allow determination of which pathways held the greatest potential risk to populations in the vicinity of the lower Columbia River.

- It was noted that following public presentations of the results of the Bi-State Program's 1991 reconnaissance survey, the public was asked to supply written suggestions as to what issues the Program should address in future studies. Determining whether it was safe to eat fish from the river ranked high among the items indicated by respondents.

Having made the decision to initially focus on human health risks associated with the consumption of fish from the lower Columbia River, the HHRWG recommended that an initial human health risk-based screening analysis of tissue contaminant levels measured in the lower Columbia River be conducted to provide a basis for focusing future risk assessment activities on the contaminants, exposure routes, and locations of greatest potential risk to human health. In March 1993, the Bi-State Program authorized Tetra Tech to conduct a risk-based screening analysis of tissue contaminant levels measured during the Bi-State Program's 1991 reconnaissance survey. A draft report was submitted to the Bi-State Program in July 1993 (Tetra Tech 1993b). Data analyses presented in the screening report addressed the following objectives: 1) determine whether contaminant levels in fish may potentially pose an unacceptable risk to human consumers; 2) identify the contaminants that may potentially be of greatest concern; and 3) to obtain a preliminary assessment of whether contaminant levels of concern are localized or widely distributed throughout the lower Columbia River.

In July 1993, the Lower Columbia River Bi-State Program Steering Committee members met to establish study priorities for the remainder of the Bi-State Program. A consensus decision was reached that further evaluation of human health risk is important to carrying out the mission of the Lower Columbia River Bi-State Program (Kent Layden Solutions 1993). The scope of work described in the following sections of this document builds upon the earlier efforts of the Bi-State Program to assess human health risks associated with consumption of fish from the lower Columbia River.

Prior to designing the sampling plan, the screening analysis performed using the 1991 data collected for the Bi-State program was expanded to include all available tissue contaminant data for the lower Columbia River. A list of data sets evaluated in the update of the screening analysis is presented in Appendix A. The results of this screening analysis were used to select the target analytes for this investigation (see Section 6.2).

1.2 PROJECT OBJECTIVES

Three main objectives have been established for the project. They are:

- To evaluate existing tissue contaminant data in the lower Columbia River and to develop a sampling plan and protocols for collecting additional data needed to characterize risk associated with the consumption of fish

- To generate the data necessary for an evaluation of potential risks associated with the consumption of selected resident and migratory fish for individuals over a range of consumption rates.

- To perform the risk assessment using previously collected tissue contaminant data from the lower Columbia River and the data generated during this sampling effort and to present this information in a form that can be clearly interpreted by a lay audience.

This document represents the attainment of the first objective. The evaluation of existing tissue data and its implications on target species and sampling locations is discussed in detail in Section 4.0. By

implementing the Sampling Plan, it should be possible to attain the second objective as well. The manner in which the third objective will be realized will not be addressed in this document, but is discussed in detail in the Work Plan (Tetra Tech 1994a) for the project.

1.3 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). The results of several tasks performed during the preparation of the plan (i.e., questionnaire of fishing professionals, evaluation of existing data, screening analysis to identify target analytes) are discussed in Section 4.0. 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 sample collection and handling, field documentation, and chain of custody. The laboratory section discusses protocols for sample receipt, processing, tracking and storage, as well as analytical methods and QA procedures for the analysis of selected contaminants in fish tissue. The field and laboratory procedures are described in Sections 5.0 and 6.0, respectively. Sections on data validation, review, and reporting (7.0); quality control procedures (8.0); preventive maintenance (9.0); data assessment (10.0); and corrective actions (11.0) include sufficient detail to allow an interested reader to understand how the analytical data are to be treated and the decision-making processes to be followed in both the field and the laboratory.

2.0 PROJECT ORGANIZATION

This survey encompasses a wide geographical area (a 146-mile section of the Columbia River) and may include sampling of more than one species with various fishing gear. 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

Personnel	Responsibilities
Tetra Tech Project Manager Dr. Steve Ellis (206) 883-1912	Provide oversight of all program activities. Review work 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 Leader Dr. Steve Ellis (gillnetting) Tad Deshler (electrofishing) (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. Select and coordinated with analytical prior to sampling. Oversee laboratory performance and adherence to QA/QC plan. Ensure that data quality objectives have been met. Perform filleting and sample preparation activities. 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.
Laboratory QA Coordinators Steve Parsons Pacific Analytical (619) 931-1766 Eric Crecelius Battelle Marine Science Lab (206) 683-4151	Establish analytical program QC procedures; oversee preparation of laboratory QA/QC plan. Monitor compliance with laboratory's QA/QC plan and serve as QA/QC point of contact. Perform all required QC sample analyses including analytical duplicates, blanks, matrix spikes, performance evaluation samples, and standard reference materials. Initiate and document required corrective action. Perform preliminary review of data for completeness and transcription or analytical error. Follow good laboratory practices and U.S. EPA guidelines.

3.0 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 species is given in Table 2. This table is discussed in greater detail in Section 5.0.

2. **Comparability:** Data will be calculated and reported in units consistent with those of other agencies and organizations to allow comparability of databases. The units given in Table 3 are consistent with other tissue contaminant monitoring programs. 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 for this project will be determined by the relative percent difference (RPD) between the analyses of matrix spike/matrix spike duplicate (MS/MSD), ongoing performance and recovery (OPR) samples (for dioxins/furans), and laboratory duplicates.

TABLE 2. SUMMARY OF STUDY DESIGN FOR ASSESSING HUMAN HEALTH RISK FROM CONSUMPTION OF LOWER COLUMBIA RIVER SPORTFISH

Species	Size Class	Sample Type	Sampling Strategy	Location[b]	No. of Samples
Walleye	18-24 in.	scaled fillet with skin	Composite[a]	middle upper	3 3
Smallmouth Bass	8-12 in.	scaled fillet with skin	Composite[a]	middle upper	3 3
Carp	15-21 in.	scaled fillet with skin	Composite[a]	estuary middle upper	3 3 3
Largescale Sucker	15-21 in.	scaled fillet with skin	Composite[a]	estuary middle upper	3 3 3
Steelhead	18-24 in.	fillet with skin	Composite[a]	hatchery[c]	3
Coho Salmon	18-24 in.	fillet with skin	Composite[a]	hatchery[c]	3
Fall Chinook Salmon	18-24 in.	fillet with skin	Composite[a]	hatchery[c]	3

[a] 8 fish per composite; each fish homogenized individually; equal aliquots of each homogenate

[b] Estuary: RM 0-48
Middle: RM 48-101
Upper: RM 101-146

[c] Salmonids will be collected at hatcheries located on Columbia River tributaries on both the Oregon and Washington sides of the river. The exact locations and number of fish to be collected at each hatchery can not be determined at the present time.

4. **Accuracy:** Accuracy is a measure of bias in the measurement system. For this survey, the accuracy of the analytical data will be evaluated through a combination of surrogate compounds, spiked samples, certified reference materials, and check standards. Surrogate compounds will be added to each sample and analyzed for organic compounds. Assessment of the dioxin/furan analytical data will be made by evaluating the recovery of OPR samples. The recovery guidelines for these analyses are given in Method 1613A (EPA 1990). Reanalysis will be required for samples in which OPR recoveries are outside established control limits. All corrective actions taken for samples requiring reanalysis 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.

The QA objectives setting requirements for precision, accuracy, and completeness have been established for each analyte 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. The QA objectives outline above will be evaluated in conjunction with the data validation (see Section 7.1).

TABLE 3. DATA QUALITY OBJECTIVES
LOWER COLUMBIA RIVER HUMAN HEALTH RISK FROM FISH CONSUMPTION

Analyte	Method	Quantitation Limit	Accuracy	Precision (RPD)	Completeness
Semi-volatiles	EPA 8270 (GC/MS; SIM for PAHs)	10-500 µg/kg (wet)	18-137%[a] 11-142%[c] 70-130%[e]	50%[c] 30%[d]	95%
Pesticides/PCBs	EPA 8081 (GC/ECD)	0.02-5 µg/kg (wet)	60-150%[a] 23-139%[c]	50%[c] 30%[d]	95%
Dioxins/Furans	EPA 1613A	1-10 pg/g (wet)	59-142%[b] 70-130%[e] 25-150%[f]	30%[d]	95%
Metals	ICP/MS, CVAA, Hydride AA	0.003-0.05 mg/kg (wet)	75-125%[c] 70-130%[e]	30%[d]	95%

RPD = relative percent difference

[a] Based on surrogate recovery results
[b] Based on ongoing precision and recovery (OPR) sample results
[c] Based on matrix spike and matrix spike duplicate recovery
[d] Based on laboratory duplicate results
[e] Based on analysis of Certified Reference Materials (CRM) - EDF 2524 (Cambridge Isotope Labs) for dioxins/furans, NIST 1974 for semi-volatiles, and DORM-2 (NRC) for metals
[f] Based on recovery of internal standards

4.0 DEVELOPMENT OF STUDY DESIGN

Several tasks were undertaken prior to finalization of the study design. These results of these tasks were presented and discussed at a meeting of the HHRWG on 29 August, 1994. The first task was to evaluate existing tissue contaminant data for the lower Columbia River. This task was intended to provide information on data gaps. The second task was a survey of fishing professionals (e.g., guides, fishing shop owners), which was designed to gather information on preferred target species and fishing locations. The third task was a screening analysis of existing tissue contaminant data, which was intended to identify chemicals which have been previously detected at concentrations high enough to warrant concern from a human health perspective. The results of this task were used to develop the target analyte list for this sampling effort. Each of these tasks is described in greater detail below.

4.1 EVALUATION OF EXISTING DATA

In addition to tissue contaminant data collected for the Bi-State Program (Tetra Tech 1993a, 1994b), several other studies have presented tissue contaminant data for the lower Columbia River. These studies are referenced in Appendix A, which also includes a table describing the number of samples, species collected, and target analytes in each study. A review of the data in these reports enabled several conclusions to be made.

- Tissue contaminant data are available from all areas of the lower Columbia River.
- No tissue contaminant data are available for resident game-fish species, with the exception of white sturgeon.
- Fish samples which were analyzed for a broad range of contaminants (e.g., metals, semi-volatiles, dioxins/furans) are largely whole body, with the exception of white sturgeon

and Northern squawfish. These data may not accurately represent the contaminant concentrations to which consumers of lower Columbia River fish may be exposed.

The second and third bullets represent data gaps which the study design detailed in Table 2 were designed to address.

4.2 SURVEY OF FISHING PROFESSIONALS

A questionnaire was developed and sent to a variety of individuals who are likely to be knowledgeable about fishing on the lower Columbia River. These individuals were primarily fishing professionals (e.g., guides), but also included owners of sporting goods, tackle, and bait shops. The questionnaire is reproduced in Figure 1. The questionnaire was designed to help in the identification of target species and sampling locations for this project. Only 6 questionnaires were returned out of the 56 that were mailed. A summary of the information obtained from these questionnaires is given below.

- Smallmouth bass, walleye, and white sturgeon were consistently identified as important resident game fish species.

- Approximately 10 specific areas, most located in the St. Helens region, were identified which are commonly fished for walleye.

- Difficulties might be encountered in catching resident game fish species in the summer months.

Based on the results of this questionnaire, smallmouth bass and walleye were added to the list of target species for this project (see Table 2 and Section 5.2).

4.3 SCREENING ANALYSIS

A screening analysis was performed using available tissue contaminant data from the lower Columbia

River to identify chemicals which have been detected at concentrations high enough to represent a potential risk to human health. The methods used for the screening analysis have been described in detail in Tetra Tech (1993b). Briefly, Screening Tissue Concentrations (STCs) were calculated for every chemical for which toxicity data (reference doses or slope factors) have been published. These STCs, which were calculated separately for carcinogenic and non-carcinogenic risk, represent concentrations above which adverse health effects could be expected. The most conservative exposure assumptions from Tetra Tech (1993b) were used. Mean concentrations for each analyte/species combination which exceeded the applicable STC were designated chemicals of concern. These chemicals of concern are listed in Table 4, which also includes both the carcinogenic and non-carcinogenic STC. The contaminants listed in Table 4 represent the target analyte list for this project. The proposed analytical method and the target detection limit for each analyte are also included in Table 4.

TABLE 4. SCREENING TISSUE CONCENTRATIONS, PROPOSED ANALYTICAL METHODS, AND TARGET DETECTION LIMITS FOR LOWER COLUMBIA RIVER CHEMICALS OF CONCERN (Page 1 of 2)

Chemical	Cancer [1]	Non-cancer [2]	Proposed method	Target detection limit [3]
Antimony	n/a	2.80	ICP/MS	**7.5**
Arsenic	0.01	2.10	Hydride AA	**7.5**
Barium	n/a	489.51	ICP/MS	25
Cadmium	n/a	3.50	ICP/MS	2.5
Copper	n/a	259.44	ICP/MS	10
Mercury	n/a	2.10	CVAA	2
Nickel	n/a	139.86	ICP/MS	5
Selenium	n/a	34.97	ICP/MS	**50**
Silver	n/a	34.97	ICP/MS	2.5
Aldrin	1.44E-03	0.21	8081 (modified)	**0.02**
Chlordane	0.02	0.42	8081 (modified)	0.02
Dieldrin	1.54E-03	0.35	8081 (modified)	**0.03**
Endosulfan I	n/a	0.35	8081 (modified)	0.03
Endosulfan II	n/a	0.35	8081 (modified)	0.03
Endrin	n/a	2.10	8081 (modified)	0.02
Heptachlor	0.01	3.50	8081 (modified)	**0.17**
Methoxychlor	n/a	34.97	8081 (modified)	0.1
Methyl parathion	n/a	1.75	8141	1
Mirex	0.01	1.40	8081 (modified)	**0.02**
alpha-BHC	3.90E-03	n/a	8081 (modified)	**0.02**
beta-BHC	0.01	n/a	8081 (modified)	0.02
gamma-BHC	0.02	2.10	8081 (modified)	0.02
o,p'-DDD	0.10	3.50	8081 (modified)	0.02
o,p'-DDE	0.07	3.50	8081 (modified)	0.02
o,p'-DDT	0.07	3.50	8081 (modified)	0.04
p,p'-DDD	0.10	3.50	8081 (modified)	0.02
p,p'-DDE	0.07	3.50	8081 (modified)	0.02
p,p'-DDT	0.07	3.50	8081 (modified)	0.04
Aroclor-1242	3.19E-03	0.49	8081 (modified)	**1**
Aroclor-1254	3.19E-03	0.49	8081 (modified)	**1**
Aroclor-1260	3.19E-03	0.49	8081 (modified)	**1**
Total PCBs	3.19E-03	0.49	8081 (modified)	**1**

TABLE 4. SCREENING TISSUE CONCENTRATIONS, PROPOSED ANALYTICAL METHODS, AND TARGET DETECTION LIMITS FOR LOWER COLUMBIA RIVER CHEMICALS OF CONCERN (Page 2 of 2)

Chemical	Cancer [1]	Non-cancer [2]	Proposed method	Target detection limit [3]
1,2,4-Trichlorobenzene	n/a	69.93	8270/SIM	10
1,4-Dichlorobenzene	1.02	n/a	Tetra Tech 1986	1
2,4-Dinitrotoluene	n/a	13.99	8270/SIM	10
2-Chlorophenol	n/a	34.97	8270/SIM	10
4-Methylphenol	n/a	34.97	8270/SIM	10
4-Nitrophenol	n/a	433.57	8270/SIM	10
Di-n-butylphthalate	n/a	699.30	8270/SIM	10
bis(2-Ethylhexyl)phthalate	1.75	139.86	8270/SIM	**10**
Hexachlorobenzene	0.02	5.59	8081 (modified)	0.02
Hexachlorobutadiene	0.31	13.99	8081 (modified)	0.02
Isophorone	25.85	1398.60	8270/SIM	10
N-nitrosodi-n-propylamine	3.50E-03	n/a	8270/SIM	**10**
Phenol	n/a	4195.80	8270/SIM	10
Acenaphthene	n/a	419.58	8270/SIM	10
Chrysene	3.36E-03	n/a	8270/SIM	**10**
Pyrene	n/a	209.79	8270/SIM	10
1,2,3,4,6,7,8-HpCDD	1.64E-06	n/a	1613A	**0.00015**
1,2,3,4,6,7,8-HpCDF	1.64E-05	n/a	1613A	**0.00015**
1,2,3,4,7,8,9-HpCDF	1.64E-05	n/a	1613A	**0.0001**
1,2,3,4,7,8-HxCDD	1.64E-06	n/a	1613A	**0.0001**
1,2,3,4,7,8-HxCDF	1.64E-06	n/a	1613A	**0.0001**
1,2,3,6,7,8-HxCDD	1.64E-06	n/a	1613A	**0.00015**
1,2,3,6,7,8-HxCDF	1.64E-06	n/a	1613A	**0.0001**
1,2,3,7,8,9-HxCDD	1.64E-06	n/a	1613A	**0.00015**
1,2,3,7,8,9-HxCDF	1.64E-06	n/a	1613A	**0.00015**
1,2,3,7,8-PeCDD	3.27E-07	n/a	1613A	**0.00015**
1,2,3,7,8-PeCDF	3.27E-06	n/a	1613A	**0.00015**
2,3,4,6,7,8-HxCDF	1.64E-06	n/a	1613A	**0.00015**
2,3,4,7,8-PeCDF	3.27E-07	n/a	1613A	**0.00015**
2,3,7,8-TCDD	1.64E-07	6.99E-06	1613A	**0.0001**
2,3,7,8-TCDF	1.64E-06	6.29E-05	1613A	**0.0002**
OCDD	1.64E-04	n/a	1613A	**0.0003**
OCDF	1.64E-04	n/a	1613A	**0.00015**

Exposure assumptions	Cancer [1]	Non-cancer [2]
Target risk	1 x 10E-7	0.1
Ingestion rate	285 g/day	143 g/day
Exposure frequency	365 days/year	365 days/year
Exposure duration	70 years	10 years
Body weight	70 kg	10 kg

For screening analysis, chemicals which were not detected in any samples were deleted
For chemicals which were not detected for a given sample, one-half detection limit was used
[3] Detection limits in bold do not meet the lowest calculated Screening Tissue Concentration

5.0 FIELD SAMPLING PROCEDURES

This section identifies the station locations (5.1), target species (5.2), and the fish collection methods to be used for sampling each species (5.3). In addition, the protocol to be followed for handling, identifying, and shipping field samples will be discussed (5.4-5.6).

The project manager and field team leaders will thoroughly review the sampling 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 all sample splits or performance samples to be submitted with the survey samples
- Sampling methods, including 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, 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.

Field sampling is to be conducted during the time period of October 1-November 15. At this time, none of the potential resident target species (see Section 5.2) will be spawning.

5.1 STATION LOCATIONS

The target species selected for this investigation (see Section 5.2) are typically highly mobile (with the possible exception of carp) and would not be expected to reside in a single location over the entire year. Thus, a station, for the purposes of this investigation, must be a much larger area than would typically be sampled for an investigation which included the collection of water or sediment samples. Three different river segments will be sampled, each of which includes approximately one-third of the lower Columbia River.

- Estuary - River Mile 0 (Mouth) to River Mile 48
- Middle Section - River Mile 48 to River Mile 101 (Portland)
- Upper Section - River Mile 101 to River Mile 146 (Bonneville)

The division of sampling areas was based in part on the divisions proposed by the Oregon Department of Fish and Wildlife (Melcher and King 1993) for their recent survey of lower Columbia River recreational fisheries. Each of the three areas has distinctly different characteristics. The estuary region supports different assemblages of flora and fauna compared to the freshwater sections. The middle section of the river includes the majority of the industrial sites (e.g., Longview, St. Helens, Portland) on the lower river. The upper section, with the exception of Camas/Washougal, contains relatively little input from municipal or industrial sources.

The selection of multiple sampling areas is typically made with the aim of comparing sample concentrations between the different areas. Examination of the existing tissue contaminant data for largescale sucker and carp for the lower Columbia River (see Section 4.1), however, indicates that tissue contaminant concentrations are generally not significantly different between the three regions for these two species (Table 5). Based on data for these two species only, there is no statistical justification for dividing the river into different sampling areas. However, because there are no available tissue contaminant data in the lower Columbia River for the other two target resident species (smallmouth bass and walleye, see Section 5.2), it has yet to be demonstrated that contaminant concentrations do not vary between locations for these species. By proposing to sample these fish in different areas, statistical tests of significant difference (e.g., ANOVA) can be employed to determine if the concentrations are significantly different between the areas. If significant differences are observed, separate presentations of risk (the eventual product of this study design) may be appropriate. If significant differences are not observed, combining all of the data from the entire study area for a given species may be more appropriate. This flexibility in how the data are evaluated is only possible if different sampling areas are established prior to the field efforts. The proposed distribution of sampling effort between the different species and sampling areas is given in Table 2.

For each of the three sampling areas, an attempt will be made to capture the 24 individuals of each target species from several locations within the 40-50 mile sections. Initially, each section will be divided into thirds and equal sampling effort expended in each third. Ideally, eight fish from each species would be collected in each third of the section. This strategy would increase the representativeness of the composite samples. If eight fish can not be captured in a particular third of a section, additional effort will be expended in a third of a section where the fish can be more easily captured.

Table 5. Differences in Mean Tissue Concentrations in Largescale Suckers for Three Segments of Lower Columbia River as Measured by ANOVAs

Dioxins/Furans	Mean concentration in ng/kg wet weight(n,sd)			p value
	Segment 1[1]	Segment 2[2]	Segment 3[3]	
1,2,3,4,6,7,8-HpCDD	1.62 (9, 1.02)	1.90 (12, 1.14)	1.11 (7, 0.75)	0.29
1,2,3,4,6,7,8-HpCDF	0.92 (9, 1.73)	0.60 (12, 0.36)	1.08 (7, 1.42)	0.69
1,2,3,4,7,8,9-HpCDF	0.24 (9, 0.18)	0.28 (12, 0.34)	0.13 (7, 0.04)	0.44
1,2,3,4,7,8-HxCDD	0.40 (9, 0.21)	0.25 (12, 0.13)	0.24 (7, 0.14)	0.08
1,2,3,4,7,8-HxCDF	0.30 (9, 0.16)	0.26 (12, 0.14)	0.16 (7, 0.11)	0.15
1,2,3,6,7,8-HxCDD	0.57 (9, 0.32)	0.56 (12, 0.35)	0.31 (7, 0.24)	0.20
1,2,3,6,7,8-HxCDF	0.81 (9, 1.65)	0.23 (12, 0.13)	0.20 (7, 0.12)	0.31
1,2,3,7,8,9-HxCDD	0.42 (9, 0.31)	0.31 (12, 0.14)	0.21 (7, 0.11)	0.15
1,2,3,7,8,9-HxCDF	1.60 (9, 1.52)	1.01 (12, 1.18)	1.08 (7, 1.00)	0.55
1,2,3,7,8-PeCDD	0.53 (9, 0.26)	0.47 (12, 0.19)	0.39 (7, 0.20)	0.41
1,2,3,7,8-PeCDF	2.51 (9, 3.27)	1.00 (12, 1.14)	0.55 (7, 0.74)	0.13
2,3,4,6,7,8-HxCDF	1.51 (9, 1.52)	0.77 (12, 0.49)	1.28 (7, 1.08)	0.28
2,3,4,7,8-PeCDF	0.48 (9, 0.31)	0.45 (12, 0.31)	0.54 (7, 0.59)	0.89
2,3,7,8-TCDD	0.63 (9, 0.44)	0.71 (12, 0.43)	0.57 (7, 0.43)	0.79
2,3,7,8-TCDF	5.05 (9, 1.54)	4.79 (12, 2.49)	6.18 (7, 3.77)	0.53
OCDD	8.34 (9, 10.8)	9.08 (12, 6.36)	3.46 (7, 1.77)	0.28
OCDF	0.82 (9, 1.04)	0.94 (12, 0.86)	2.03 (7, 3.84)	0.45
Metals	Mean concentration in mg/kg wet weight (n, sd)			p value
	Segment 1[1]	Segment 2[2]	Segment 3[3]	
Barium	1.59 (10, 1.04)	2.06 (16, 0.88)	3.43 (8, 1.09)	**0.001**
Cadmium	0.03 (10, 0.01)	0.03 (16, 0.01)	0.05 (8, 0.01)	**0.002**
Copper	0.89 (10, 0.29)	0.89 (16, 0.17)	0.99 (8, 0.23)	0.57
Lead	0.14 (10, 0.15)	0.16 (16, 0.20)	0.18 (8, 0.17)	0.90
Mercury	0.14 (10, 0.07)	0.11 (16, 0.06)	0.13 (8, 0.06)	0.38
Other Organics	Mean concentration in μg/kg wet weight (n, sd)			p value
	Segment 1[1]	Segment 2[2]	Segment 3[3]	
bis(2-Ethylhexyl)phthalate	195.5 (10, 234.1)	282.9 (16, 345.6)	357.1 (8, 372.8)	0.58
p,p'-DDD	18.2 (9, 9.84)	20.6 (16, 10.3)	22.8 (8, 7.02)	0.62
p,p'-DDT	9.74 (9, 4.39)	10.7 (16, 12.7)	9.59 (8, 7.33)	0.96
Aroclor-1254	89.4 (10, 49.0)	272.1 (16, 652.7)	90.3 (8, 70.9)	0.52

[1] Segment 1 includes river mile 0-48
[2] Segment 2 includes river mile 48-101
[3] Segment 3 includes river mile 101-146

No special navigation procedures will be employed during the fish collection efforts. If possible, the collection location (i.e., river mile) of each fish will be estimated by examining USGS topographical maps. This information will be compiled in an appendix which will be included with the data report.

5.2 TARGET SPECIES

A key objective of this sampling effort is to provide information to evaluate human exposure to toxic substances in fish tissue. It is of particular interest to be able to describe exposure for those persons who might be most exposed, either because of frequent fish consumption, or because they consume species of fish that have higher levels of contaminants. An additional consideration is whether a target species can be captured in sufficient numbers to form composite samples.

Prior to finalizing the sampling design, a survey of sportfishing guides and shops was undertaken to gather information that could be used to select the target species. This survey was summarized in Section 4.2. Based on the results of this questionnaire, smallmouth bass and walleye were selected as target resident game fish species for this project. Although white sturgeon was identified as an important resident game fish species, the contaminant data that have been previously collected by the Bi-State Program for this species provide geographical coverage of the lower Columbia River and should be adequate for the risk assessment goals of the project.

In addition to the two target resident game species, two resident non-game species, largescale sucker and carp, are proposed. Both of these fish are abundant and widespread over the entire lower Columbia River and are frequently consumed by certain segments of the population, particularly near urban areas such as Portland (Smith, A., 30 June 1994, personal communication). Resident non-game fish species were included in this project so as not to bias the collection efforts towards fish species that are typically captured by individuals from sportfishing boats. Largescale sucker and carp are commonly caught from the banks of the river. Also, by collecting fillets from these species (Table 2), the utility of the existing largescale sucker and carp data, which consist primarily of analyses of whole-body composite samples, for characterizing risks to human health can be improved.

Three composite samples, each made up of 8 fish, will be collected for each of the four resident species in both the middle and the upper sections of the river. In the estuary section, three composites of both largescale sucker and carp will be collected. Smallmouth bass and walleye are not expected to reside in the estuary portion of the river.

Although this study is primarily focused on resident species, game fish species which only reside in the river at the beginning and end of their lives (i.e., salmonids) are the focus of a very large amount of fishing effort. Because these fish may potentially contribute to the risk to human health from the consumption of fish on the lower Columbia River, it is appropriate that salmonids be added to the target species list. At the time sampling is expected to take place (October), at least three salmonid species are expected to be present in the study area: fall chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*Oncorhynchus kisutch*), and steelhead trout (*Oncorhynchus mykiss*). Three composite samples from each of these species will be collected from hatcheries located on the tributaries of the lower Columbia River (see Section 5.3).

For each target species, a single size class will be targeted (Table 2). The chosen size classes were intended to encompass the size of fish most commonly caught by recreational fishermen.

5.3 FISH COLLECTION

The four resident target species selected have a variety of life history characteristics and abundance/distribution patterns. This diversity may make it difficult to collect all of the target species at the same time and place with the same collection gear.

The collection methods to be used for this project will include electrofishing and gill netting. The different types of collection gear are described below in separate sections, along with the intended targets of each gear.

The fish collection procedures to be used for this study have been designed to minimize the potential adverse impacts to endangered salmon species [Snake River sockeye (*Oncorhynchus nerka*), Snake River spring/summer chinook salmon (*Oncorhynchus tshawytscha*), and Snake River fall chinook salmon

(*Oncorhynchus tshawytscha*)] that may be present in the sampling area. The precautions that will be taken are described below.

5.3.1 Electrofishing

Electrofishing is the most efficient method for collecting a variety of species, however, it is not effective in water depths greater than approximately 10 ft. As cited by Hughes and Gammon (1987), Hendricks et al. (1980) considered the boat-mounted electroshocker to be the most applicable gear for sampling fishes in large rivers because it is easily standardized and less selective than alternative gears. The electroshocking boat to be used for this project includes a Model 7.5 GPP electrofishing unit, which uses two anodes swing-mounted off the bow of the boat. Together, these anodes generate approximately 3 amps DC (direct current) pulsed at 120 cycles/sec.

It is anticipated that all four of target species can be captured by electrofishing, although smallmouth bass and walleye may not be easily captured using this method. Only fish that appear to be in the desired target size range will be brought aboard using a dip net. Individuals of the target species will be measured (length), sacrificed with a blow to the head from a wooden club, and placed on ice (see Section 5.4). The fish that are not netted will be allowed to recover from the electroshocking pulse, a process that usually takes less than 10 seconds.

The following characteristics of and modifications to the typical electrofishing procedures have been proposed to ensure that endangered salmon species are not adversely affected by electrofishing.

- Pulsed DC (direct current), rather than DC or AC (alternating current) will be used. Pulsed DC, at a frequency of 40-120 cycles/sec, has been shown to produce the least amount of physiological damage of any of the three current regimes (Smith 1989).

- Pulsed DC will be transmitted in only 10 second bursts, rather than continuously. In this manner, galvanotaxis, the tendency for a fish to be attracted to the anode, will be less likely to proceed to galvanonarcosis, whereby a fish is stunned by the current. Galvanotaxis rarely produces any permanent physiological damage, but does still allow fish to be captured (Smith 1989).

- If a salmon is encountered, the fish will not be handled in any way. Even from 20-30 feet away, it is relatively easy to differentiate salmon from any of the resident target species, so there will not be any need to bring the salmon aboard using a dipnet.

In addition to these field procedures, a fundamental characteristic of salmonid fish tissue, its high conductivity, makes it unlikely that endangered salmon species will be adversely affected. The maximum current, and hence the maximum galvanotaxis/galvanonarcosis effect, is applied to a fish whose conductivity closely matches the surrounding water (Smith 1989). The average conductivity of Columbia River water above the estuary is approximately 100 µMhos/cm (Tetra Tech 1993a), while the conductivity of freshwater fish ranges from about 500-1,500 µMhos/cm (Smith 1989). Salmonid fish are at the higher end of that range (approximately 1,250 µMhos/cm), making them harder to stun than many other freshwater fish.

5.3.2 Gillnetting

Gill nets capture fish by entanglement. They are particularly well-suited for the capture of highly mobile fish which are not easily captured by electrofishing. Although all four species may potentially be captured by gillnets, it is anticipated that the primary target species will be walleye and smallmouth bass. Individuals of any of the four species captured by either method will be retained.

As many as 4 sinking gill nets will be deployed simultaneously, each of which are 200 feet long, 10 feet high, with 3 inch mesh. These nets will be set at various times throughout the day and night, and left in the water for up to 6 hours at a time. All individuals of any species captured in the nets will be identified to species and measured (length). Individuals of the target species will be collected using a dipnet, sacrificed with a blow to the head from a wooden club (if still alive), and placed on ice (see Section 5.4). Individuals of a non-target species will be returned to the water, whether alive or dead.

The mesh size of the nets to be used for this project (3 inch), will allow juvenile salmon to pass freely through the net without being entangled.

5.3.3 Hatcheries

The three non-resident game fish species identified for this project (fall chinook salmon, coho salmon, and steelhead) will be collected from state-run hatcheries located on tributaries of the lower Columbia River. Three composites of each of the three species will be collected (Table 2). At the present time,

it is not possible to definitively state which hatcheries will be able to provide specimens. Three of the most likely locations, however, are the state-run hatcheries located on the Sandy River in Oregon and the Lewis and Washougal Rivers in Washington.

Up to 24 individuals (3 composite samples of 8 fish) of each species will be collected at various hatcheries. Ideally, both male and female fish will be collected, although at some hatcheries, only males will be available. The fish will be collected by dipnet from holding tanks or raceways located inside the hatchery. Fish will only be collected from those hatcheries that have not treated the fish with antibiotics. Care will be taken to minimize the exposure of the fish to plastics, which contain phthalates which could contaminate the fish. The fish will be sacrificed with a blow to the head with a wooden club, wrapped in aluminum foil, placed on ice, and returned to the processing lab.

5.4 SAMPLE HANDLING, PREPARATION, AND STORAGE PROCEDURES

The methods used for sample handling, preparation, and storage must be consistently employed to insure that the chemical data collected in this study are representative of contaminants present in fish tissue that people eat and comparable to data collected in other studies using similar procedures. Upon retrieval from the sampling equipment, each fish will be identified to species by personnel familiar with the taxonomy of the fish in the lower Columbia River. In addition, a taxonomic key will be readily available should the need for one arise. Individual specimens of the target species will be measured (total length) to determine if they are within the target size class. If the specimen is within the target size class, it will be double-wrapped in heavy-duty aluminum foil. A waterproof tag will be included between the foil layers which identifies the specimen. The wrapped fish will be immediately placed on ice.

At frequent intervals (<4 hours), the fish collected by the personnel aboard the sampling vessel will be delivered to the sample processing trailer, which will serve as a base of operations. At this point, each specimen will be assigned a unique identification number consisting of species abbreviation, a sequential number starting from 1, and region of the river. Each specimen to be retained will be logged on a collection form. In addition to the above information, any incidence of external abnormalities (e.g., fin erosion, skin ulcers, skeletal anomalies, tumors) will be noted on the forms. Each individual specimen will be resected to prepare a large muscle fillet.

A single individual with experience filleting fish or who has received training by a person experienced with resecting fish shall be responsible for collecting the fillet samples. This individual shall be referred to as the "filleter". The filleter will adhere to the following procedures recommended by the U.S. EPA (1993a) for collecting the large muscle fillet.

Step 1. The filleter will wash his hands with ivory soap, rinse with tap water, and then rinse with distilled water prior to filleting. Fish will be filleted on a cutting board covered with heavy duty aluminum foil which will be changed between fish. Prior to filleting each specimen, stainless steel utensils used for filleting will be washed with soap, rinsed with tap water, and then rinsed with distilled water. If the whole samples have become frozen, they will not be thawed completely before filleting.

Step 2. Remove the scales by placing the specimen flat against the cutting board and scraping with the edge of a knife. Rinse with distilled water to remove the scales.

Step 3. Make a shallow incision through the skin on either side of the dorsal fin from the top of the head to the base of the tail. Make an incision behind the entire length of the gill cover, cutting through the skin and flesh to the bone. Make a shallow incision along the belly from the base of the pectoral fin to the tail. A single cut is made from behind the gill cover to the anus followed by an incision made on both sides of the anal fin. Care should be taken not to cut into the gut cavity as this may contaminate fillet tissues. Remove the fillet and discard any remaining bones.

Step 4. Wrap the fillet in heavy duty aluminum foil and place in a plastic bag. Include the waterproof tag previously prepared in the field. Seal the plastic bag and store frozen.

5.5 SAMPLE COMPOSITION AND IDENTIFICATION

Composite samples will be collected for all of the target species (Table 2). It should be noted that these numbers are targets only. In actuality, the number of samples and number of fish/composite will not actually be determined until after the sampling has been completed. U.S. EPA (1993a) has prepared a guidance manual which discusses the effect the number of samples and the fish per composite has on the power of a sampling design. This guidance will be used in preparing composite samples at the end of

the sampling effort.

The sample identification scheme will be composed of two parts: identification of individual specimens for each species and recognition of composite samples for each species. As discussed above, sample numbers will consist of the species abbreviation, sequential numbers starting from 1, and region of the river where collected. Composite samples will also use the above identification scheme with the addition of a composite designation immediately following the species abbreviation (e.g., WCMP...). The following abbreviations will be used for identifying samples:

- W for walleye
- S for smallmouth bass
- L for largescale sucker
- C for carp
- K for chinook
- H for coho
- D for steelhead
- Cmp for composite
- Est for estuary sampling section
- Mid for middle sampling section
- Up for upper sampling section

For example, the second walleye composite sample collected from the upper sampling area would receive the sample number WCmp2Up.

5.6 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. 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 relinquished 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 conditions 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.

5.6.1 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 each sample. Samples will be wrapped in foil and placed in a resealable plastic bag. Labels written with waterproof ink containing the following information will be placed between the two plastic bags:

Project Name/Number
Station Location
Sampling Date
Sample Number
Initials of Persons Sampling

In addition, the following field custody procedures will be followed:

a) 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.

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

c) 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.

5.6.2 Transfer of Custody and Shipment Procedures

All samples will be accompanied by a Chain-of-Custody Record indicating sample numbers and the requested analyses. Copies of all forms will be retained by Tetra Tech.

a) Prior to shipping, samples 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 overnight delivery.

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 to the sample custodian at the laboratory. The laboratory will be requested to send a return receipt in order to ensure delivery. Copies of the original Chain-of-Custody Forms will be retained by the Field Team Leader for inclusion in the project files.

5.6.3 Laboratory Custody Procedures

The laboratories selected for this project have implemented well-documented custody procedures. These procedures are briefly summarized below.

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, date received, sample integrity, 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) Upon completion of sample analyses and necessary quality assurance checks by the laboratory, the unused portion of the sample will be retained by the laboratory until further notice. All identifying tags, data sheets, chain-of-custody, and laboratory records will be retained as part of the permanent documentation.

6.0 LABORATORY ANALYTICAL PROCEDURES

The sample processing, target analytes, and laboratory analytical protocols prescribed for this project for the analysis of fish tissue samples are described below.

6.1 SAMPLE PROCESSING

All preparation of fillets to be homogenized by the laboratory will be performed in the field as described in Section 5.4. Each fillet will be homogenized separately using guidelines in U.S. EPA (1993a). For composite samples, an equal aliquot from each individual tissue homogenate will be combined to make up the final homogenate of approximately 200 g. By forming composite samples in this manner, bias is reduced because all fillets, no matter what size, contribute equal amounts to the composite sample (National Biological Survey 1994).

6.2 TARGET ANALYTES

The list of target analytes was derived using a screening analysis of available fish contaminant data. An automated database system (Paradox) was used in the manner described in Tetra Tech (1993b) to determine which contaminants might pose a risk to human health. Chemicals which were never detected were excluded from this analysis. This analysis differs from that performed previously (Tetra Tech 1993b), in that all available tissue contaminant data for the lower Columbia River were screened, rather than just data collected in the original reconnaissance survey performed for the Bi-State program (Tetra Tech 1993a). A list of all chemicals which exceeded their respective screening tissue concentrations is given in Table 4. Based on this analysis, the target analytes for this project can be classified into four groups: semi-volatile organics, pesticides/PCBs, metals, and dioxins/furans (PCDDs/PCDFs)(Table 3). For semi-volatiles and pesticides/PCBs, all of the analytes normally quantified using the proposed methodology

(Section 6.3, Table 3) will be reported. For dioxins/furans, only the 17 2,3,7,8-substituted congeners will be reported. For the metals, antimony, arsenic, barium, cadmium, copper, mercury, nickel, selenium, and silver will be reported.

6.3 ANALYTICAL METHODOLOGY

The laboratory analytical procedures to be used for this project are listed next to each target analyte in Table 4. For the metals, arsenic will be measured by hydride generation atomic absorption spectroscopy (AA); mercury by cold vapor AA (CVAA); and all other metals by inductively-coupled plasma/mass spectroscopy (ICP/MS). The method used to quantify arsenic will allow for the differentiation of organic and inorganic arsenic.

Several modifications to the standard methods will be implemented to lower the detection limits. These modifications include:

- Method 8081 (Pesticides) - The final extract will be concentrated to 1 mL from the 10 mL volume specified in the method. This should effectively reduce the detection limits by a factor of 10.

- Method 8081 (PCBs) - An aliquot of the extract will undergo a sulfuric acid cleanup, which will serve to eliminate all pesticide interferences. The final extract will be reduced to 50 µL. By running PCBs and pesticides separately, the PCB detection limit can be reduced by a factor of 10-50.

- Method 1613A (Dioxins/Furans) - The sample size to be extracted will be increased to 50 g from the 20 g specified in the method. Although this increase will necessitate extra acid cleanups, the detection limits should be reduced by a factor of 2-3.

Lipid will be determined using a gravimetric method as described in U.S. EPA (1993a). Petroleum ether will be used as the extraction solvent for all lipid analyses.

7.0 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 the analytical laboratory for this project.

7.1 DATA VALIDATION

The quality assurance/quality control data collected during the laboratory analysis of the fish samples will be reviewed by Tetra Tech to determine the validity of the data reported. 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 extraction and analysis, presented with sample results. Data will be compared to the project data quality objectives 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.

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

J - The associated numerical value is an estimated quantity.

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

The evaluation of QA/QC results will follow the guidelines established by the U.S. Environmental Protection Agency (U.S. EPA 1994; 1993b; 1988) and the criteria cited in Section 3.0 of this document. Most of the data validation guidelines to be used for this project were developed for U.S. EPA's Contract Laboratory Program (CLP). Although this project is not part of CLP, the data validation guidelines for CLP are the very clearly written and have been used for all data collected for the Bi-State Program. The laboratories will adhere to the QA/QC specifications of the analytical methods (Table 3).

7.2 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.

7.3 REPORTING REQUIREMENTS

This section briefly describes the deliverables that the analytical laboratory will be expected to provide. For pesticides/PCBs, semi-volatiles, and metals, these deliverables include forms which summarize initial and continuing calibration, method blanks, matrix and blank spikes, accuracy of reference material analysis, surrogate recoveries (for organic compounds), and laboratory duplicates. 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. Copies of all raw data will be requested so that calculations can be verified and questionable results can be investigated.

For dioxins/furans, in addition to providing similar deliverables to those described above for the other analytes, the laboratory shall provide all original documentation to support that all requirements of Method 1613A have been met. All raw data shall be submitted, along with example calculations, such that an

independent data reviewer may recreate the calculations reported by the laboratory. In order to check for polychlorinated diphenyl ether (PCDPE) interference, the laboratory shall submit simultaneous offset display of single ion chromatograms for each GC column for analyte peaks and for PCDPE peaks which may co-elute with native target compounds.

8.0 QUALITY CONTROL PROCEDURES

This section describes the quality control (QC) procedures that will be followed in the field and in the laboratory to insure that the analytical data collected are of high quality.

8.1 FIELD QC PROCEDURES

Both whole fish transported to the sample processing trailer in the field and fillets shipped to the laboratory will be labelled using a waterproof label inserted between the foil layers. The accuracy of the labeling will be checked by a person not originally involved in the labeling. 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.

8.2 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 manual submitted by the laboratories for this project (Pacific Analytical and Battelle MSL) to ensure that an ongoing rigorous QA/QC program is part of standard laboratory practice. The review was conducted according to the EPA guidance manual for preparing laboratory QA plans (U.S. EPA 1992). The QA/QC plans are on file at the Tetra Tech office in Redmond, WA. The plan should describe the QA and QC programs, equipment, training, analytical procedures, sample tracking, sample storage and disposal, and health and safety programs in the lab. Tetra Tech will also review all laboratory Standard Operating Procedures (SOPs) for methods to be used to measure project samples.

9.0 PREVENTIVE MAINTENANCE

The laboratory will adhere to calibration procedures, calibration frequency, and standards for laboratory measurement variables and equipment set forth in each of the analytical methods listed in Table 3. 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.

For field equipment (e.g., scale, electrofishing unit), the preventive maintenance approach for specific pieces of equipment used in sampling, monitoring, and documentation will follow manufacturer specifications. Performance of these maintenance procedures will be documented in field logbooks.

10.0 DATA ASSESSMENT PROCEDURES

The analytical data generated as part of this project will be compared with the data quality objectives described in Section 3.0. In most cases, if the data for a particular sample did not meet these objectives, the data will be qualified in some way (e.g., qualifier code 'J' for an estimated value) as per the procedures discussed in Section 7.1. The results of these comparisons with data quality objectives will be summarized in the Data Report.

11.0 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 is responsible for evaluating performance of the field team for adherence to required field procedures described in this report. The QA Officer will outline the corrective actions required to conform to project specifications in the field logbook. The QA officer will be in daily contact with the Program Manager, who in turn can frequently brief the Bi-State contract officers. In this way, if modifications to the sampling design are necessary, they can be made quickly without delaying the ongoing field sampling.

Once the samples have been submitted to the laboratory, the QA officer is also responsible for evaluating performance of the analytical laboratory for adherence to predetermined methods and limits of acceptability. The QA officer will not perform a formal audit of the laboratory, but will be in frequent contact with the laboratory by telephone once the samples have been received by the laboratory. Any deviation from the QC limits specified in the method protocols will be resolved before sample analyses continue.

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 correct the problem before continuing with sample analyses.

12.0 REFERENCES

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APPENDIX A

LIST OF DATA SETS TO BE EVALUATED FOR ASSESSING FISH CONSUMPTION RISKS TO HUMANS

TC-9968-01

ASSESSING HUMAN HEALTH RISKS FROM CHEMICALLY-CONTAMINATED FISH IN THE LOWER COLUMBIA RIVER:

LIST OF DATA SETS TO BE EVALUATED FOR ASSESSING FISH CONSUMPTION RISKS TO HUMANS

Prepared by:

Tetra Tech, Inc.

Prepared for:

The Lower Columbia River Bi-State Water Quality Program

May 2, 1994

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TABLES

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1.0 INTRODUCTION

The Lower Columbia River Bi-State Water Quality Program (Bi-State Program) is conducting a study to characterize the human health risks associated with the consumption of fish from the lower Columbia River. This study has been organized into several discrete tasks: 1) compilation and evaluation of existing data; 2) development of a sampling plan to collect additional data; 3) field sampling; 4) data analysis; and 5) risk characterization. The information provided in this document is part of the first task noted above.

2.0 DATA COMPILATION

Table 1 provides citations for the eight studies that have collected data on chemical concentrations in fish tissue in the lower Columbia River from 1985 to 1994. Summary statistics for these eight studies are provided in Table 2. A total of 273 tissue samples have been analyzed to determine chemical concentrations in aquatic biota within the lower Columbia River. Dioxins, PCBs, pesticides, and mercury are the constituents most frequently analyzed. Data is available for eleven species within the lower Columbia River including nine fish (bridgelip sucker, carp, chinook salmon, coho salmon, largescale sucker, peamouth, northern squawfish, steelhead, and white sturgeon) and two crustaceans (crayfish and dungeness crab). Three sample portions have been analyzed in these studies: whole-body, steak, and fillet. Whole-body samples comprise the majority of the data (67 percent), followed by fillet (32 percent) and steak samples (1 percent). Most studies have analyzed composite (91 percent) rather than individual samples (9 percent).

Additional references that use the data collected by the studies indicated in Table 1 are listed in Table 3. Appendix A provides a list of individuals that have been contacted to obtain data on chemical concentrations in fish from the lower Columbia River.

Table 1. References Containing Data on Chemical Concentrations in Fish from the Lower Columbia River (1985-1994)

Reference ID	Citation
1	Tetra Tech, Inc. 1993. Reconnaissance survey of the lower Columbia River. Task 6: Reconnaissance report. Prepared for the Lower Columbia River Bi-State Program. Tetra Tech, Inc., Redmond, WA.
2	Beak Consultants, Inc. 1989. Columbia River fish study: fish collection, fish tissue sampling and age of fish sampled. Prepared for the Northwest Pulp and Paper Association. Beak Consultants, Inc., Portland, OR.
3	Tetra Tech, Inc. 1992. City of St. Helens discharge monitoring report: Accumulation of dioxins and furans in sediment and biota. Prepared for the City of St. Helens. Tetra Tech, Inc., Bellevue, WA.
4	Tetra Tech, Inc. 1994. Backwater reconnaissance survey of the lower Columbia River. Backwater reconnaissance report. Prepared for the Lower Columbia River Bi-State Program. Tetra Tech, Inc., Redmond, WA.
5	Tetra Tech, Inc. 1992. James River Wauna Mill discharge monitoring report: Accumulation of dioxins and furans in sediment and biota. Prepared for the James River Corporation. Tetra Tech, Inc., Bellevue, WA.
6	U.S. Environmental Protection Agency (U.S. EPA). 1992. National Study of Chemical Residues in Fish. Volumes I and II. EPA 823-R-92-008 a,b. Office of Science and Technology, U.S. EPA, Washington, D.C.
7	Oregon Department of Environmental Quality. Unpublished. Investigation of toxins in the Columbia River basin. Data provided by Gene Foster.
8	U.S. Fish and Wildlife Service. Organochlorine contaminants in aquatic resources from the Columbia River. Progress Report, Fiscal Year 1992. U.S. Fish and Wildlife Service, Portland Field Office, Portland, OR.

TABLE 2. SUMMARY OF FISH CONTAMINANT DATA FOR THE LOWER COLUMBIA RIVER (1985-1994)

Reference[a]	Common Name	Sample Portion	Sample Type	Number of Samples	River Mile Range	Contaminant Groups							
						Semivolatiles	Pesticides	PCBs	Metals[b]	Dioxins/ Furans	Mercury	Radionuclides	Buty Tin
1	Carp	Whole body	Composite	11	15-141.5	X	X	X	X	X	X		
1	Crayfish	Whole body	Composite	17		X	X	X	X	X	X		
1	Largescale Sucker	Whole body	Composite	17		X	X	X	X	X	X		
1	Peamouth	Whole body	Composite	9		X	X	X	X	X	X		
1	White Sturgeon	Fillets without skin	Individual	14		X	X	X	X	X	X		
2	Carp	Fillets without skin	Composite	5	24-133					X			
2	Chinook Salmon	Fillets without skin	Composite	2						X			
2	Coho Salmon	Fillets without skin	Composite	2						X			
2	Largescale Sucker	Fillets without skin	Composite	5						X			
2	Steelhead Trout	Fillets without skin	Composite	2						X			
2	White Sturgeon	Fillets without skin	Composite	6						X			
3	Crayfish	Whole body	Composite	6	84-92					X			
4	Carp	Whole body	Composite	2	14-141	X	X	X	X	X	X	X	X
4	Crayfish	Whole body	Composite	13		X	X	X	X	X	X	X	X
4	Largescale Sucker	Whole body	Composite	14		X	X	X	X	X	X	X	X
5	Crayfish	Whole Body	Composite	5	35-50					X			
6	Carp	Whole body	Composite	17	6-120					X			
6	Bridgelip Sucker	Whole body	Composite	12						X			
6	Crayfish	Whole body	Individual	2			X			X			
6	Dungeness Crab	Whole body	Composite	2			X	X		X	X		
6	Northern Squawfish	Fillet	Composite	50			X	X		X	X		
6	White Sturgeon	Whole body	Composite	50		X	X	X		X	X		
7	Carp	Whole body	Individual	1	95-132		X	X		c	X		
7	Northern Squawfish	Whole body	Individual	1		X	X	X		c	X		
7	Sturgeon	Steak	Individual	3		X	X	X		c	X		
8	Carp	Whole body	Composite	1	20-118.5								
8	Carp	Whole body	Individual	1			X	X					
8	Peamouth	Whole body	Composite	1			X	X					
8	Peamouth	Whole body	Individual	1			X	X		X	X		
8	Sucker	Whole body	Individual	1			X	X		X	X		

[a] Numbers refer to the List of Fish Tissue Contaminant Documents for the Lower Columbia River references.

[b] Reference 1 and 4 have the following metals (except reference 4 also has chromium): antimony, arsenic, cadmium, copper, lead, nickel, selenium, silver, and zinc.

[c] Data have been collected but are still undergoing internal review.

Table 3. Additional References on Chemical Concentrations in Fish from the Lower Columbia River	
	Citation
	Anthony, R.G., M.G. Garrett, and C.A. Schuler. 1993. Environmental contaminants in bald eagles in the Columbia River estuary. Journal of Wildlife Management 57:10-19.
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	ChemRisk. 1990. Assessment of the human health risks related to the presence of dioxins in Columbia River Fish. ChemRisk, Portland, ME.
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	U.S. Environmental Protection Agency (U.S. EPA). 1991. Bioaccumulation of selected pollutants in fish. A national study. Volumes I and II. EPA/506/6-90/001/a,b. Assessment and Watershed Protection Division. Office of Water regulations and Standards, U.S. EPA, Washington, D.C.

APPENDIX A

LIST OF INDIVIDUALS CONTACTED TO OBTAIN TISSUE CONTAMINANT DATA FOR THE LOWER COLUMBIA RIVER

List of Individuals Contacted to Obtain Tissue Contaminant Data for the Lower Columbia River (Page 1 of 2)	
Federal	
USGS	
Stuart McKenzie Portland, OR (503) 251-3201	Does not have any tissue contaminant data for lower Columbia River.
Frank Rinella Portland, OR (503) 251-3277	Has collected data for dioxins/furans in sediments on lower Columbia recently, but is not able to release them before QA/QC has been completed. Does not have any tissue contaminant data for lower Columbia River.
Walter Lowe Boise, ID (208) 387-1385	Has tissue data for Snake River collected in 1992-93, but is not able to release them before QA/QC has been completed. Does not have any tissue contaminant data for lower Columbia River.
Sandy Williamson Tacoma, WA (206) 593-6530	Analyzed carp, bottom feeders, and snails on the Deschutes River and metals from fish livers on Columbia River tributaries and Snake River. These data are not available until internal review has been completed.
USFWS	
Dr. Charles Henny Corvallis, OR (503) 757-4840	Has collected pesticide/PCB and dioxin/furan data for mink and otter on lower Columbia River. These data will be available in approximately six months. Does not have any fish tissue contaminant data for lower Columbia River.
Carol Schuler Portland, OR (503) 231-6179	Has collected pesticide/PCB and dioxin/furan data for invertebrates and fish on lower Columbia River. Received invertebrate data on 2/04/94. Requests made for fish data on 2/23/94 and 3/22/94. At last contact, data were still being entered into the computer.
Lawrence Blus Corvallis, OR (503) 757-4840	Analyzed bird eggs from TriCities for pesticides/PCBs and dioxins/ furans; data available next month. Does not have any tissue contaminant data for lower Columbia River.
Liz Block Moses Lake, WA (509) 765-6125	Has data from mid 1970s for sturgeon in Lake Roosevelt. Does not have any tissue contaminant data for lower Columbia River.
NMFS	
Bob Emmett Hammond, OR (503) 861-1818	Does not have any tissue contaminant data for lower Columbia River.
USACOE	
Geoff Dorsey Portland, OR (503) 326-6481	Does not have any tissue contaminant data for lower Columbia River.

List of Individuals Contacted to Obtain Tissue Contaminant Data for the Lower Columbia River

Oregon	
Dept. of Fish and Wildlife	
Don Bennett Clackamas, OR (503) 657-2030	Does not have any tissue contaminant data for lower Columbia River.
Dept. of Environmental Quality	
Gary Arnold Portland, OR (503) 229-5983	A list of major NPDES permittees that are required to sample biota and sediments on the lower Columbia River on 3/2/94 was requested. No information has been received. As of 4/29/94, Gary Arnold has been transferred to DEQ's Medford Office and no longer is responsible for data pertaining to the Columbia River.
Don Yon Portland, OR (503) 229-5995	Requested monitoring data from Washington NPDES files on chemical levels in sediment and tissue in the lower Columbia River. Request was made on 4/29/94.
Gene Foster Corvallis, OR (503) 737-2896	The dioxin data for samples collected as part of the Bi-State Program during 1990 and 1991 are incomplete. Gene Foster indicated that he had sent all of the data to Don Yon of DEQ. A letter requesting the missing data was sent to Don Yon and Brian Offord on 3/15/94. The missing data has not been received.
Dept. of Health	
Cathy Neumann Portland, OR (503) 731-4015	Left a message on 4/29/94 inquiring about the availability of any data collected by the Oregon Department of Health.
Washington	
Dept. of Ecology	
Art Johnson Olympia, WA (206) 586-6828	Does not have any tissue contaminant data for lower Columbia River.
Brian Offord Olympia, WA (206) 407-6479	Requested monitoring data from Washington NPDES files on chemical levels in sediment and tissue in the lower Columbia River. Request was made on 4/29/94.
Dept. of Fisheries	
Carl Samuelson Olympia, WA (206) 902-2563	Does not have any tissue contaminant data for lower Columbia River.
Dept. of Health	
Harriet Ammann Olympia, WA (206) 586-5405	Does not have any tissue contaminant data for lower Columbia River.

Note: Individuals in bold have data that may be relevant to human health risk assessment on the lower Columbia River.