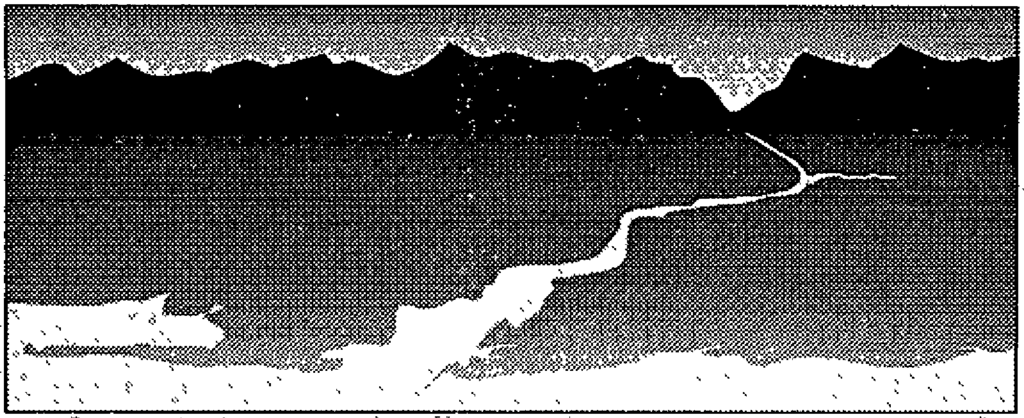
LOWER COLUMBIA RIVER



BI-STATE PROGRAM

RECONNAISSANCE SURVEY OF THE LOWER COLUMBIA RIVER

TASK 1: FINAL SUMMARY REPORT

APRIL 29, 1992

Prepared By:

TETRA TECH

In Association With:

DAVID EVANS & ASSOCIATES
EVS CONSULTANTS

TETRA TECH

TC-8526-01

RECONNAISSANCE SURVEY OF THE LOWER COLUMBIA RIVER

TASK 1:
FINAL SUMMARY REPORT

APRIL 29, 1992

Submitted To:

LOWER COLUMBIA RIVER BI-STATE PROGRAM

Prepared By:

TETRA TECH INC.
11820 NORTHUP WAY, SUITE 100E
SEATTLE, WA 98005

In Association With:

DAVID EVANS & ASSOCIATES
EVS CONSULTANTS

RECEIVED
MAY - 1 1992
WATER QUALITY DIVISION
DEPT ENVIRONMENTAL QUALITY

CONTENTS

FIGURES

TABLES

ACKNOWLEDGEMENTS

This document was prepared by Tetra Tech under the direction of Mr. Gary Braun of Tetra Tech for the Lower Columbia River Bi-State Committee. Ms. Cordelia Shea of Oregon Department of Environmental Quality (ODEQ) and Mr. Neil Aaland of Washington State Department of Ecology (WDOE), served as technical/contract monitors for the Bi-State Program. Funding for the project was provided to the Bi-State Program by WDOE, ODEQ, public ports in Washington and Oregon, and the Northwest Pulp and Paper Association.

The primary authors of this report were Mr. Gary Braun, Mr. Glen St. Amant, Mr. Tad Deshler, and Dr. Mahmood Shivji. Ms. Eva Weaver performed technical editing. Dr. Ted Turk provided final technical review. All graphics were produced by Ms. Kim Shaty. Word processing and report production were provided by Ms. Lisa Fosse and Ms. Rosemary O'Brien. Members of the Bi-State Program Steering Committee provided helpful guidance and comments on an earlier draft.

EXECUTIVE SUMMARY

This report summarizes the findings of a study on the existing water quality data of the lower Columbia River, from the Bonneville Dam to the river mouth. Based on the existing data, with its many limitations and qualifications, the lower Columbia River does not appear to be severely degraded. However, only a small subset of contaminants were measured at most locations. Many unmeasured compounds may exist in the river. Additionally, the geographic coverage for all data types was limited at best. Therefore, an assessment of the overall water quality in the Columbia River based on this data is biased toward those areas where sampling has occurred and does not account for those areas not sampled.

The study—and basis of these conclusions—is one of seven tasks undertaken as part of the Reconnaissance Survey of the lower Columbia River, initiated by the Bi-State Lower Columbia River Water Quality Program. The Bi-State Program was established to assess the overall water quality of the river. The role of this study in the program is to summarize existing data on water, sediment, and biological conditions in the lower Columbia River to identify potential problem areas and data gaps. This information will assist in the design of the reconnaissance survey sampling plan.

To accomplish this task, a wide range of data sources and agency information was researched for the lower river areas. As the data were obtained, each document was catalogued and loaded into a library database. The studies were then separated by data type and evaluated against established criteria, such as appropriate field collection methods, quality assurance procedures, and parameters measured.

The next step in this task was to establish an approach for evaluating the existing data and identifying potential problem areas in the river. This approach, called a technical framework, is presented in a second report. The technical framework is a set of procedures that define the types of data that should be evaluated, the contaminants of concern, and the procedures for establishing reference values against which problem areas were to be identified. Procedures for identifying data gaps were also established and explained in this report.

Data from the water column, sediments, benthic (bottom-dwelling) animals, fish, toxicity test (bioassays), and tissue concentrations of contaminants (bioaccumulation) were evaluated in a third report. Each data type was summarized by examining existing data for each of four major and ten minor divisions of the lower river. Within each segment, potential problem areas and data gaps were identified by applying the technical framework established in the second report

Results of the problem area identification analyses for each data type were presented as a three-tiered ranking scheme as follows:

- High priority (contaminant exceeds the established screening level)

- Medium priority (contaminant is detected, but the concentration does not exceed the screening level)

- Low priority (contaminant is not detected at the location).

Generally, two limitations weakened the analyses for each data type: 1) adequate data were often not available, and 2) data from different studies were difficult to compare because of temporal and spatial differences and the types of parameters studied. Many data types were not useful for identifying problem areas or assessing the general water quality of the study area. Instead, data were most useful for identifying data gaps. Although the sediment data were particularly useful, even the best data were still too limited, however, to make a scientifically valid evaluation of sediment conditions on the river.

Potential high-priority problem areas were identified from fewer than ten sediment locations in the entire lower river. Most of these sites were located in the industrialized areas of Longview and Portland/Vancouver. Fish tissue contaminant concentrations also indicated several high-priority locations, but these spots were located throughout the study area. Dioxins/furans, the pesticide DDE, PCBs, and mercury were the contaminants detected most frequently at these locations.

Results of the existing data summaries and synthesis were used to assist in the design of the sampling plan, which is Task 6 of Bi-State Program's assessment of water quality in the lower Columbia River. Information on problem areas and data gaps were used to design the reconnaissance survey for that sampling plan.

1.0 INTRODUCTION

1.1 THE BI-STATE PROGRAM

The Lower Columbia River Bi-State Program (Bi-State Program) is a four-year study of the water quality of the lower Columbia River. The Bi-State Program was initiated in 1990 in response to growing concerns about the status and ecological health of the river and its associated habitats. Its purpose is to evaluate the water quality within the lower Columbia River, the 146-mile stretch of the river from Bonneville Dam to the Pacific Ocean (Figure 1). The study is a cooperative effort sponsored by the Oregon Department of Environmental Quality, Washington Department of Ecology, Northwest Pulp and Paper Association, and Washington and Oregon ports.

The Bi-State Program has developed the following general goals:

- Identify water quality problems.
- Determine if beneficial or characteristic uses are impaired.
- Develop solutions to the water quality problems identified.
- Recommend a long-term framework for the Bi-State Program.

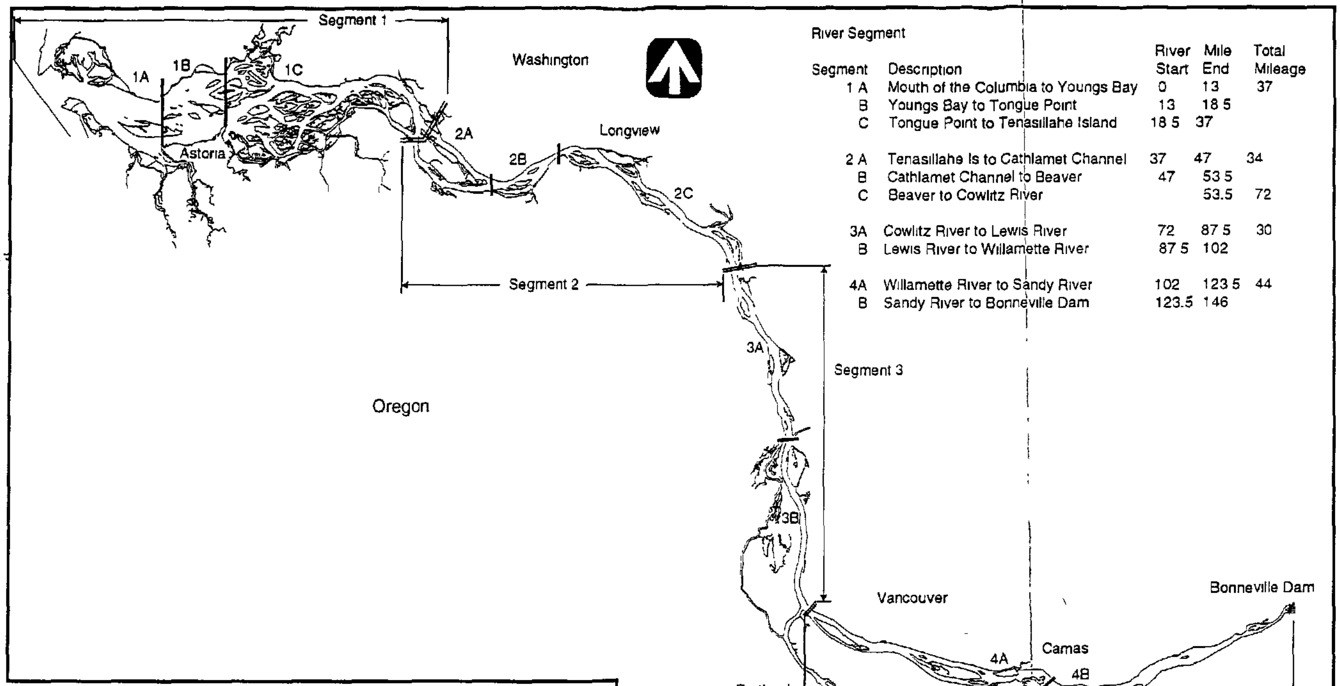
To fulfill these goals, the Bi-State Program developed a series of general tasks:

- Evaluating the existing water quality data on the lower Columbia River.

- Designing and implementing a reconnaissance, baseline survey, and additional advanced field studies.

- Developing recommendations to regulatory agencies based upon the identified problems.

Under the program, these tasks are to be presented in a series of studies the committee will use to identify water quality problem areas and data gaps in the lower Columbia River. The goal of the first-year studies was two-fold. First, existing data were reviewed to establish a technical framework for determining the water quality and ecological health of the lower



River Segment

Segment	Description	River Start	Mile End	Total Mileage
1 A	Mouth of the Columbia to Youngs Bay	0	13	37
B	Youngs Bay to Tongue Point	13	18.5	
C	Tongue Point to Tenasillahe Island	18.5	37	
2 A	Tenasillahe Is to Cathlamet Channel	37	47	34
B	Cathlamet Channel to Beaver	47	53.5	
C	Beaver to Cowlitz River		53.5	72
3A	Cowlitz River to Lewis River	72	87.5	30
B	Lewis River to Willamette River	87.5	102	
4A	Willamette River to Sandy River	102	123.5	44
B	Sandy River to Bonneville Dam	123.5	146	

Figure 1. Vicinity Map of the Lower Columbia River

Columbia. This technical framework will form the basis of the rest of the study. Second, results from the existing data were used to develop and implement an initial field survey (reconnaissance survey) of the river. The purpose of the reconnaissance survey is also two-fold: 1) to evaluate methods for characterizing water quality and 2) to identify potential areas or water, sediment, and aquatic organisms that may be impaired by poor water quality. From the data gathered in this first-year effort, the foundation will be built for directing research in the following three years of the Bi-State Program.

1.2 OBJECTIVES OF TASK 1: INITIAL DATA REVIEW AND SYNTHESIS OF THE RECONNAISSANCE SURVEY

The reconnaissance survey of the lower Columbia River was split into seven separate studies—or tasks—to be completed from May 1991 to June 1992.

- Task 1: Existing Data Review
- Task 2: Pollution Source Inventory and Characterization
- Task 3: Hydrologic and Physical Characterization
- Task 4: Biological Characterization
- Task 5: Beneficial Uses Characterization
- Task 6: Reconnaissance Survey
- Task 7: Technical Framework and Recommendations

Task 1 of the study, Initial Data Review and Synthesis, is a technical review of existing studies and data to determine the water, biological, and sediment quality of the river. Task 1 has five objectives in gathering these data:

1. Compile and review existing studies and relevant data to characterize the current water, biological, and sediment quality status of the lower Columbia River

2. Identify potential problem areas

3. Identify current and ongoing studies in the study area

4. Identify data gaps

5. Use results in the design of the sampling plan for the reconnaissance survey (Task 6).

To complete these studies, the river was broken into several major and minor segments. Major segments represent areas with similar physical features and confluences of major tributaries (Figure 1). Subsegments were generally based on major geographical features along the river and confluences with smaller tributaries. Data examined from various studies in each of these segments are presented in four subtask reports that emphasize the recent data used to identify problem areas and data gaps within the study area:

1. *Reconnaissance Survey of the Lower Columbia River: Task 1, List of Materials to Evaluate.*

2 *Reconnaissance Survey of the Lower Columbia River: Task 1, Problem Area and Data Gap Identification Ranking Framework.*

3. *Reconnaissance Survey of the Lower Columbia River: Task 1, Summary of Existing Data and Preliminary Identification of Problem Areas and Data Gaps.*

4. *Reconnaissance Survey of the Lower Columbia River: Task 1, Summary Report* (This Document).

This summary report is the fourth and final Task 1 report. It briefly explains the major findings of Task 1.

1.3 RELATIONSHIP OF TASK 1 TO OTHER TASKS

Data collected in Task 1 will be used in all seven tasks (Figure 2). Given the importance of Task 1, a library and bibliographic database were established to ease the use of all the literature collected. Results of the initial data summaries in Task 1 greatly influenced the development of the Task 6 sampling plan. The technical framework for assessing problem areas and data gaps developed in Task 1 will also be used in Task 6, with possible modifications, to assign priorities to water quality problems identified by survey data. The results of Task 1 will be combined with the results from the remaining tasks to generate the recommendations for the subsequent study needs of Task 7.

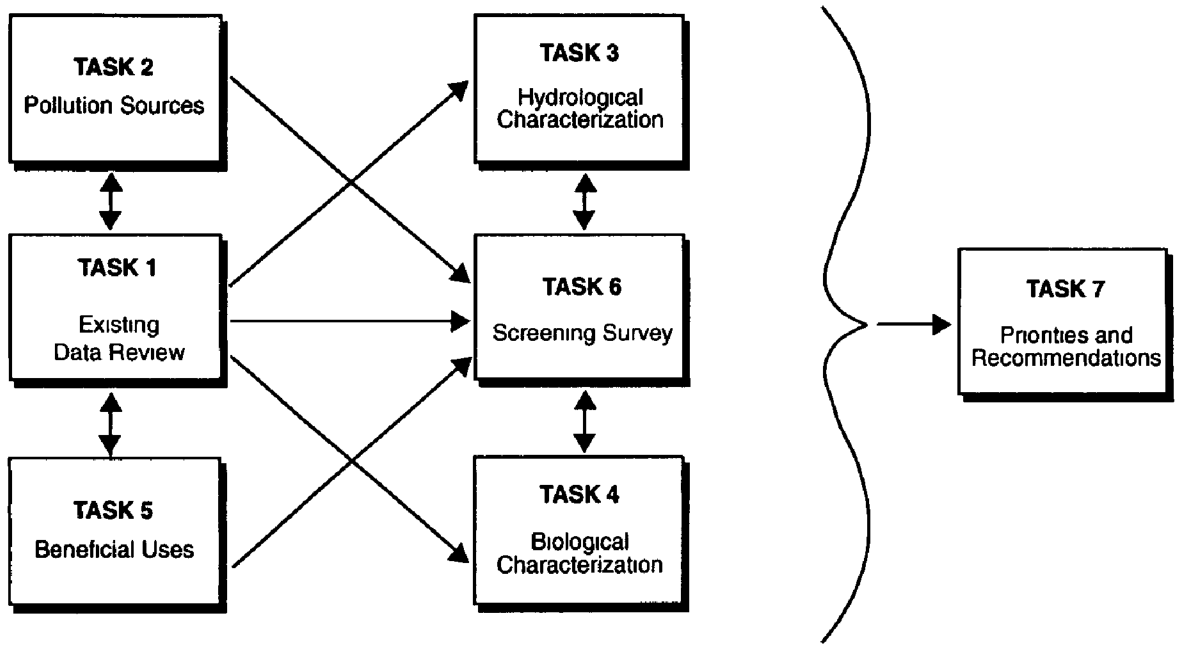


Figure 2. Relationship of Task 1 to other Tasks of the Bi-State Program

2.0 SUMMARY OF TASK 1 REPORTS

This chapter summarizes the findings of the Subtask 1 through 3 reports. As discussed, the Subtask 1 report summarizes the data sources used to characterize water quality in the lower Columbia River. The Subtask 2 report provides a technical framework for using the collected scientific data to highlight potential problem areas and data gaps. Based on the results of these two reports, the Subtask 3 report summarizes and evaluates all the existing data compiled and identifies potential problem areas and data gaps.

2.1 SUBTASK 1: LITERATURE SEARCH AND DATABASE DEVELOPMENT

In this subtask, existing data on water column, sediment, and biota conditions in the lower Columbia River were identified, gathered, and compiled into a bibliographic database. Over 160 reports and documents pertaining to the lower Columbia River were collected and entered into the database. In general, data from 1980 to the present were included, with older studies included where warranted.

2.1.1 Literature Search

During the literature search, existing data on the lower Columbia River were compiled for use in all the tasks. The types of data include the following:

- Water column quality (toxic contaminants, microbial concentrations, and conventional parameters)
- Levels of toxic contaminants in sediments
- Bioaccumulation (contaminant concentration) of toxic substances in fish, shellfish, birds, mammals, and other wildlife
- Benthic macroinvertebrate (bottom-dwelling species) populations and community structure
- Bioassay (toxicity) data from tests conducted with water or sediments

In addition to these, data were identified and collected for use in Tasks 2, 3, and 5. This information includes drainage patterns, land use for the area surrounding and discharging into the river, the pollutant loading data for present sources of conventional pollutants and toxic contaminants, and historical sources of toxic contamination.

2.1.2 Bibliographic Database

From the literature search, a bibliographic database of all literature has been compiled. Part of that database is a list of contacts from the agencies that have provided data. The library database was also developed using software (dBase IV) which allows searches on both citation and keyword information. In addition, copies of references included in the database are coded and stored in a general lower Columbia River Bi-State Program reference library.

2.2 SUBTASK 2: PROBLEM AREA AND DATA GAP IDENTIFICATION RANKING FRAMEWORK

The Subtask 2 report presents the rationale for developing a preliminary framework that uses complex scientific information to identify and rank potential problem areas and data gaps within the lower river system. The ranking framework is designed to characterize existing water quality conditions in the river and to help determine sampling locations for the reconnaissance survey given the financial resources available.

2.2.1 Conceptual Framework

The conceptual framework developed for Subtask 2 used a suite of indices to initially identify and rank problem areas (Figure 3). These indices, also called indicators, are measures of pollution effects. The magnitude of a problem was established by comparing contaminant and biological effects indices with regulatory criteria. If a pollution indicator was not yet regulated, a reference condition was used in the comparison. The geographical distribution and number of indices exceeding screening criteria were additional evidence of ecological effects. Finally, data gaps were identified for each category with little or no data.

The following questions were used to help select indicators and define screening levels:

- What are the contaminants of concern?
- What media (sediment, water, biota) are contaminated?
- Is there evidence of adverse ecological impacts?

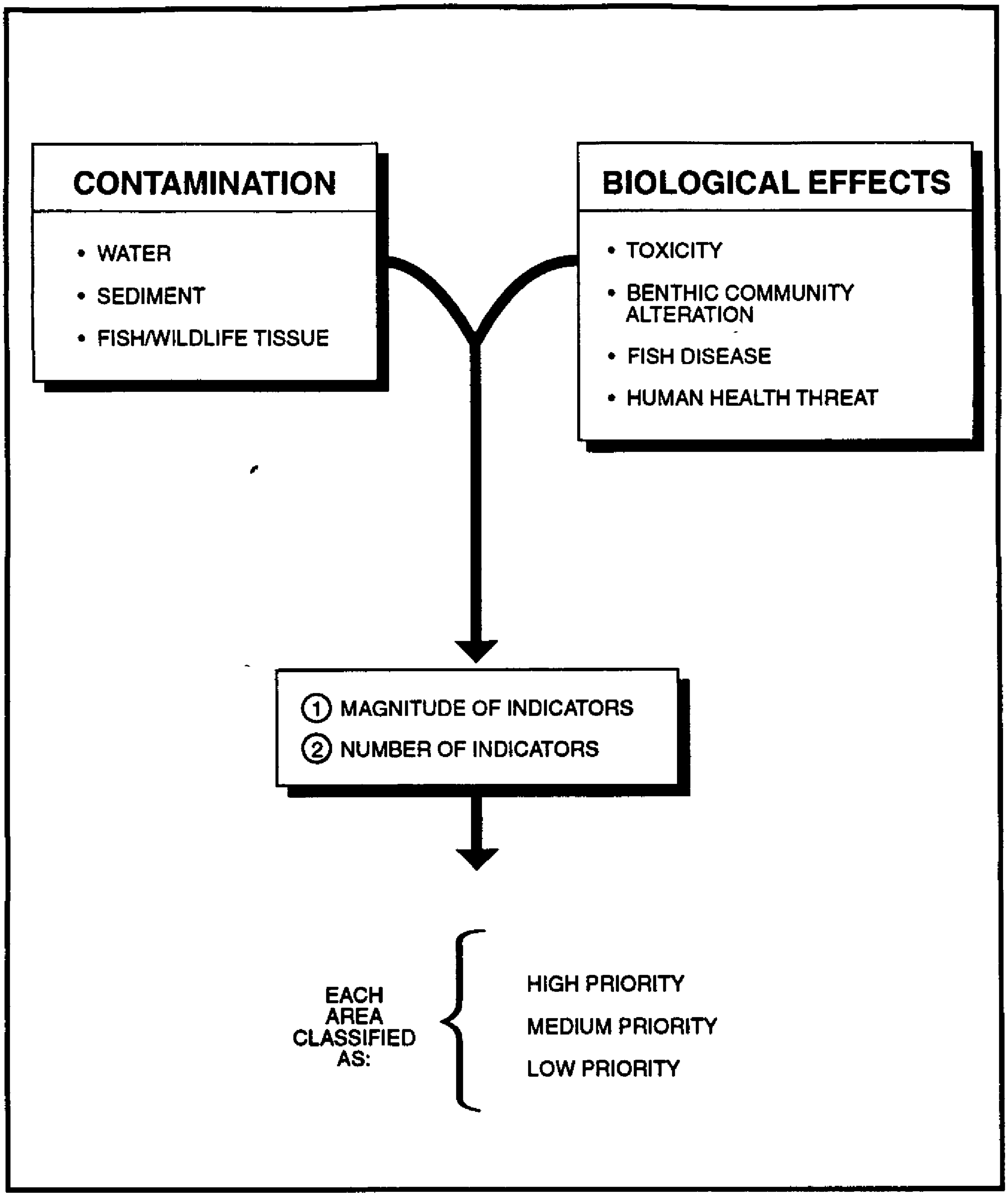


Figure 3. Approach for Evaluating Potential Contamination Problems in the Lower Columbia River

- Does the magnitude of contamination present a threat to environmental or human health?
- Can proximate contaminant sources be identified?

2.2.2 Selection of Indicators

Existing contamination and biological effects data were used to identify problem areas. Several kinds of these data indicate contaminant exposure:

- Contaminant concentrations in sediments and alterations in conventional sediment parameters (the variables measured in scientific studies).

- Contaminant and conventional concentrations and pathogen (disease-carrying bacteria) abundances in water.

- Contaminants in tissues (bioaccumulation) and alterations of liver enzyme activity.

Contaminants of concern were identified based on their widespread distribution, locally elevated concentrations, and high hazard to either biota or human health in the study area. A preliminary list of contaminants is included in the ranking framework report.

Aquatic community alterations such as benthic or fish community diversity depressions and sediment or effluent toxicity tests (bioassays) were used as biological indicators of possible pollution effects from exposure to these contaminants.

2.2.3 Development of Screening Levels

Potential problem areas can also be identified from data that show either a screening level for a contaminant of concern or a biological effects variable has been exceeded. A screening level is the point at which an acceptable concentration of a potential pollutant has been exceeded. For this study, screening levels were developed by comparing site contamination levels with regulatory criteria or reference conditions.

Where possible, existing regulatory criteria were used as screening levels. State and federal water quality criteria were compared, and the lowest value (a number) used for the screening level. Reference conditions were identified by 1) examining the existing studies for sites identified as reference, 2) determining that few contaminants of concern were detected at these sites, and 3) determining that each site showed little indication of a biological response. If no reference sites were identified in the existing studies, then the least contaminated sites (the lowest 20 percent of all available data) were used to establish reference conditions.

In the absence of numerical criteria, screening levels were generated from the identified reference conditions by using the median value (50th percentile) of reference sites.

2.2.4 Comparison with Screening Levels

To establish an index reflecting the degree of contamination, the preliminary ranking framework called for observed values at specific sites to be compared with screening levels. This index was termed Elevation Above Reference (EAR) and was calculated as the ratio of a given variable to a reference value for that variable. These EAR indices were used to reduce large data sets into interpretable numbers reflecting the magnitude of various pollution indicators among areas. The higher the EAR value for a particular contaminant, the more contaminated or affected the site compared to the reference.

2.2.5 Prioritization of Areas and Data Gap Identification

Within the preliminary framework, areas with contaminants or effects exceeding screening levels were ranked for each environmental medium (sediment, water, tissue). Three priority levels—high, medium, and low—were established based on the magnitude of the various indices for each medium. An overall site ranking was established based on the sum of the number of indices in each priority level. This site ranking enabled priorities to be set for potential problem areas.

Data gaps were also identified for each contaminant indicator and each river segment. Areas with few stations or limited numbers of variables were identified as data gaps. Areas with neither data nor ongoing studies were identified as high-priority data gaps; areas with some existing data became medium-priority data gaps.

Finally, the results of this site ranking and the spatial distribution of problem areas were used to design the reconnaissance survey. Through this ranking procedure, project resources were directed to the areas having the highest priority based on either potential contamination or data gaps.

2.3 SUBTASK 3: SUMMARY OF EXISTING DATA AND PRELIMINARY IDENTIFICATION OF PROBLEM AREAS AND DATA GAPS

For Subtask 3, data were summarized on a broad range of water quality measures for the lower Columbia River. These data are organized according to water column, sediment contamination, benthic macroinvertebrate communities, fish communities, bioaccumulation (in fish and wildlife), and sediment toxicity bioassays. From these data, the Subtask 3 report presents rankings for each environmental medium, a combined ranking of problem areas and data gaps (Figures 4–7 and Tables 1–2), and an overall assessment of water quality in the lower Columbia River.

2.3.1 Methods for Data Management and Evaluation

Each document was evaluated to determine its suitability for the study. To focus on the most pertinent data, generally only those studies conducted after 1980 were included. However, older long-term studies—such as the USGS study at Warrendale (RM 141)—were also included to provide historical perspective.

Next, the data were reviewed for quality and for pertinence to the project. Quality was based on appropriate sample collection and handling methods, analytical protocols, and QA procedures. Pertinence was determined by date of record, spatial coverage, variables measured, and apparent trends. If it was determined that quality or pertinence to the project limited the data, the data were dropped from further review.

2.3.2 Data Summaries, Synthesis, and Interpretation

Water Column. Water quality data are limited for the lower Columbia River. Few of the more than 30 studies and reports reviewed contain water chemistry measurements. However, 11 studies, reports, and databases were accepted on the basis of the following criteria:

- Original raw data were included in part of the study.

- Sample collection, sample handling, quality assurance, and analytical methods were adequate to ensure data accuracy and precision.

- Sample stations were located in the Columbia River proper.

- Data were reported for chemical parameters in addition to measurements of pH, temperature, dissolved oxygen, and turbidity.

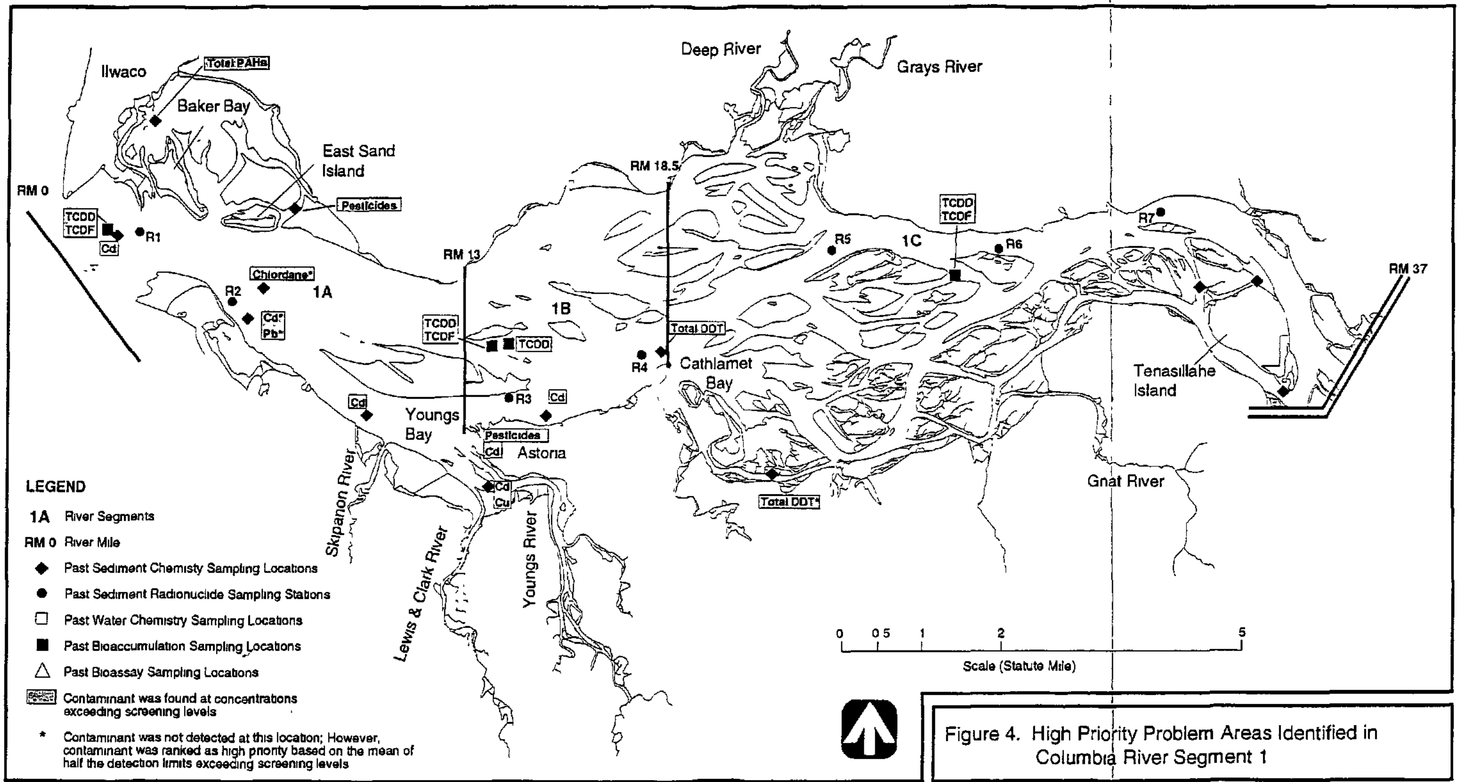


Figure 4. High Priority Problem Areas Identified in Columbia River Segment 1

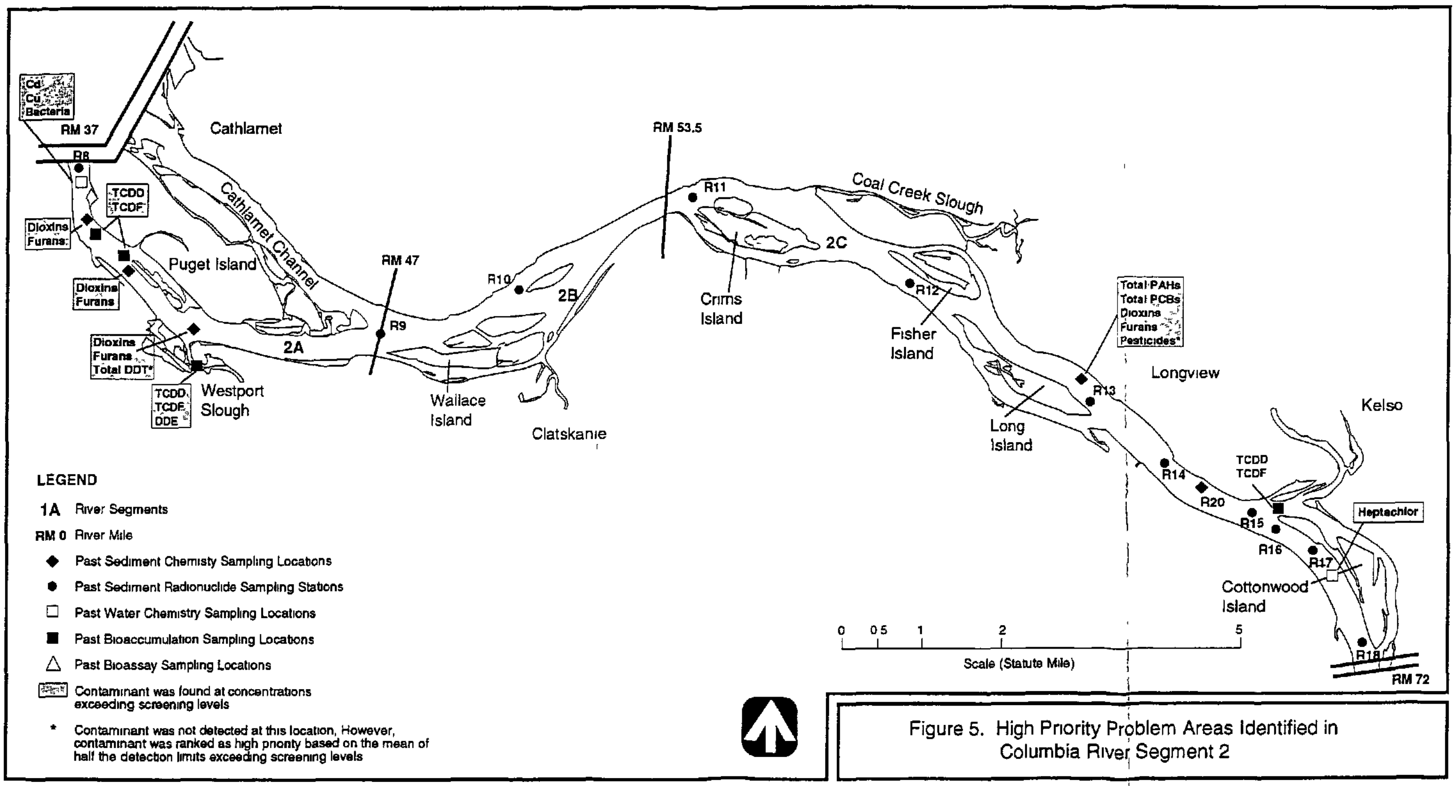


Figure 5. High Priority Problem Areas Identified in Columbia River Segment 2

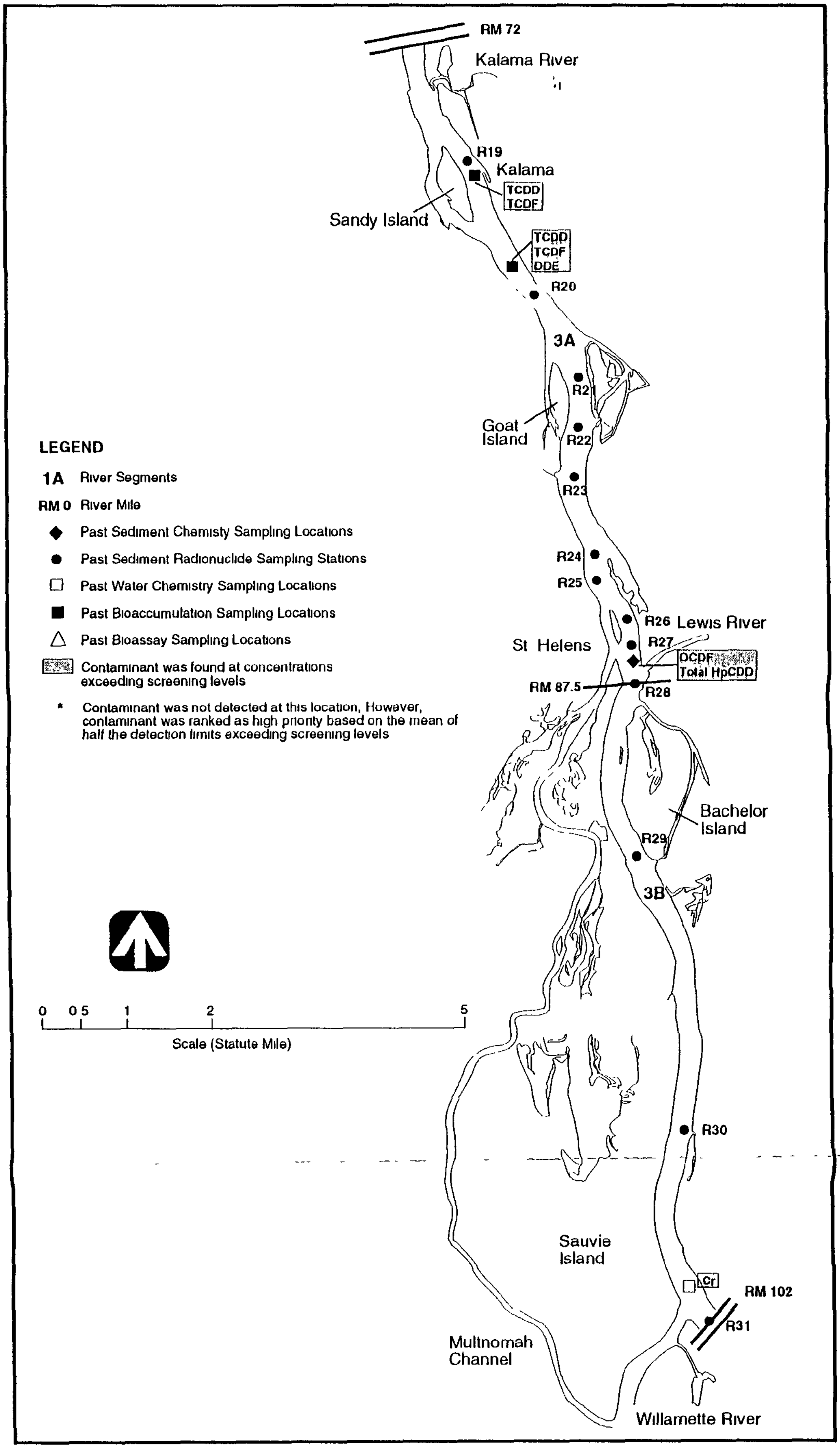


Figure 6. High Priority Problem Areas Identified in Columbia River Segment 3

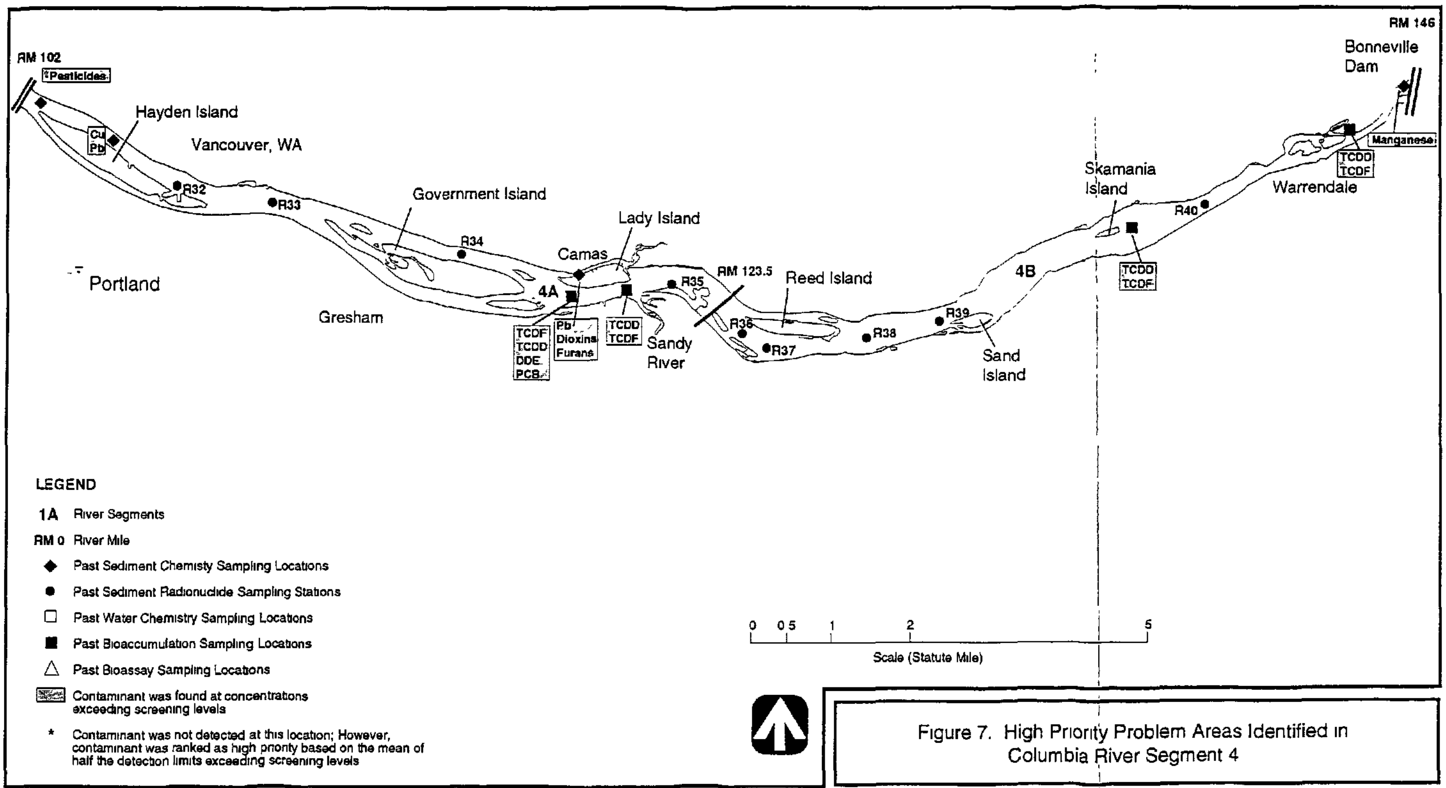


Figure 7. High Priority Problem Areas Identified in Columbia River Segment 4

TABLE 1. HIGH-PRIORITY PROBLEM AREAS IDENTIFIED IN TASK 1 OF THE BI-STATE PROGRAM		
Media	Segment	Compound
Water Quality		
Metals Bacteria	2A	Cadmium, Copper
Pesticides	2C	Heptachlor
Metals	3B	Chromium
Sediment		
Metals[a] Pesticides[b] PAHs	1A	Cadmium, Copper, Lead All pesticides Total PAHs
Metals Pesticides	1B	Cadmium Total DDT, Chlordane, Dieldrin, Other Pesticides
Pesticides	1C	Total DDT
Pesticides Dioxins and Furans	2A	Total DDT All Forms (congeners)
Pesticides PAHs PCBs Dioxins and Furans Resin Acids	2C	All Pesticides Total PAHs Total PCBs All Forms Total Resin Acids
Dioxins and Furans	3A	Total HpCDD and OCDD
Metals Pesticides Dioxins and Furans Resin Acids	4A	Copper, Lead Total DDT, DDD, DOE, DOT Total TCDF, Total HxCDF, Total HxCDD, Total HpCDF, Total HpCDD, OCDF, OCDD Total Resin Acids
Metals	4B	Manganese
Fish Tissue		
Pesticides	1A and 1B 2A and 2B 3A and 3B 4A and 4B	TCDF, TCDD TCDF, TCDD, DDE TCDF, TCDD, DDE TCDF, TCDD, DDE
PCBs	4A	Total PCBs

TABLE 2. DATA GAPS IDENTIFIED BY TASK 1 OF THE BI-STATE PROGRAM	
Media	Segment
Water Quality	General Data Gap
Sediment	
Dioxins and Furans Resin Acids	1A
Dioxins and Furans Resin Acids	1C
Resin Acids	2A
Metals Pesticides PAHs PCBs Dioxins and Furans Resin Acids	2B
Resin Acids	3A
Metals Pesticides PAHs PCBs	3B
Benthic Infauna	General Data Gap
Fish Communities	General Data Gap
Bioaccumulation	Limited Data Gap
Bioassays	General Data Gap

Given the dynamic nature of the Columbia River, long-term measurements of water quality are critical in assessing the river's overall health. Because long-term data for water quality were available only from the USGS stations at Bradwood, Warrendale, and the Beaver Army Terminal in Oregon, we have emphasized these data.

Two of the accepted studies contain data on radionuclide concentrations in the water column of the Columbia River (Haushild et al. 1973, Toombs et al. 1984). Although radionuclides were detected in water samples, in no case did concentrations exceed federal water quality standards (Toombs et al. 1984). Because it has been almost 20 years since the last radionuclide data were collected from the lower Columbia River, radionuclides data were not considered further.

From the accepted studies, 21 sampling stations with water chemistry data were identified. All data from accepted studies were entered into a spreadsheet and sorted by river mile and river segment (see Figures 2-5). Nearly all of the water quality stations were sampled only once.

The water chemistry data from these sampling stations were analyzed for these general categories of pollutants:

- Conventional water quality parameters (CONV), ions, and nutrients (NUTS).
- Bacteria.
- Trace metals (TM) and cyanide (CN).
- Phenols and aliphatic organic halides (AOX).
- Pesticides and PCBs.
- Resin acids.
- Radionuclides.

For many of the chemical compounds measured, federal and state freshwater quality criteria have been established. These values were used as screening levels: any exceedances indicated high-priority areas. The freshwater acute and chronic water quality criteria were used from both Washington and Oregon regulations. When the state regulations differed, the lower of the two values was used as the screening level.

Based on the available water quality data, data are too limited to identify consistent trends for federal and state water quality criteria for the lower Columbia River. None of the data collected since 1980 have exceeded the chronic freshwater criteria, with the exception of one mercury value that slightly exceeded the criteria at a dredged disposal station located in river segment 1A (Fuhrer and Rinella 1983). Two other metals—arsenic and beryllium—had method detection limits (MDL) that exceeded criteria in that river segment. MDLs are those concentrations below which a particular chemical cannot be detected by a particular method. Prior to 1980, cadmium, copper, and bacteria concentrations at Bradwood, concentrations of heptachlor at Cottonwood Island in Segment 2, and chromium concentrations in Segment 3B exceeded the criteria (see Figures 4–7 and Table 1).

Sediment.

<u>General</u>

Several factors hinder assessment of the sediment conditions of the lower Columbia River. Most studies were conducted in different years (from 1980 to 1991) and measured an inconsistent suite of variables. An exception to this is the U. S. Army Corp of Engineers (COE) sampling sites, where specific chemical variables were consistently measured as part of a COE dredging program. Another limiting factor is that detection limits for specific contaminants vary by up to two orders of magnitude from study to study. Adding to these weaknesses in the data, no systematic studies have sampled similar sediment types at different locations to account for the influence of sediment grain size on contaminant binding. Finer sediments generally have higher contaminant concentrations.

Given these overall limits, 46 studies and three databases supplied by the USGS, COE, and the U.S. Environmental Protection Agency (EPA) were reviewed to identify useful sediment chemistry data for the lower Columbia River. Eighteen studies or databases were accepted based on these criteria:

- ☐ Original raw data were included in the study.
- ☐ Sample collection, sample handling, quality assurance, and analytical methods were appropriate to ensure data accuracy and precision.
- ☐ Sample stations were located in the Columbia River proper.
- ☐ Data on conventional parameters, trace metals, and organic compounds were from recently sampled sediments. Studies conducted before 1980 were not included. Data were from the uppermost layer of sediment cores.

- Data were reported for chemical parameters; not limited to sediment texture and grain size.

Over 300 sampling stations with sediment chemistry data were identified from these 18 studies. Each sampling location represents one to several sampling stations. Sampling stations near each other (<0.5 miles) were grouped and identified as a single, numbered location on the maps to aid in the synthesis of contaminant data (see Figures 4-7). Summary statistics (mean, standard deviation, number of samples) were calculated on sediment contamination levels at each location.

Sediment chemistry data from these stations were grouped as follows:

- Conventional parameters (e.g., total organic carbon, grain size, total solids, volatile solids)
- Metals
- Polycyclic aromatic hydrocarbons (PAH)
- Other Base/Neutral/Acid extractable organic compounds
- Volatile organic compounds (VOC)
- Pesticides and PCBs
- Dioxin and Furans
- Resin Acids
- Radionuclides.

The degree and distribution of chemical contaminants in sediments are strongly influenced by the physical and chemical characteristics (grain size and organic content) of the sediments. For example, finer grain sediment generally contains more contaminants than does coarse-grained sediment. To speed interpretation of the sediment chemistry data, data were entered into a series of spreadsheets and sorted by river mile, river segment, and grain size (where available). (See Appendix B of the Subtask 3 report for contaminant raw data.)

Because contaminant levels in freshwater sediments are not yet regulated, screening levels for the various contaminants were developed according to the technical framework developed in the Subtask 2 report. Under that framework, screening levels for contaminants without regulatory criteria were developed by selecting the lowest 20 percent of the contaminant concentrations at reference sites, and taking the 50th percentile of these values as the screening value for each contaminant. We assumed that the contaminant concentrations observed at the reference sites were reasonable measures of background levels of contaminants in the river.

However, the studies reviewed had reference site data for only ten metals: arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, and zinc. Because adequate information on other chemical compounds was not available, sediment screening levels using the EAR approach could be developed only for these metals.

To allow the use of more of the existing data, a second approach was used to develop screening levels for sediment chemistry. This second approach combined MDLs and effects-based contaminant levels. As noted, MDLs are concentrations below which a chemical cannot be detected by an analytical method. Effects-based contaminant levels are those concentrations in which biological impacts have been demonstrated. This combined approach was used to rank all the sediment data. A compound was ranked as a medium priority if any of the values for a location were detected. If the mean value for a contaminant at a station exceeded the mean of all the effects-based screening levels (Long and Morgan 1990 and WDOE 1991), then the contaminant was classified as a high priority. Low priority was assigned to all contaminants that were measured but not detected at each location.

Approximate Assessment of Sediment Quality

Metals. The full suite of ten metals were detected at most locations. However, almost all metal concentrations were below the derived, effects-based reference values and the Washington State sediment quality criteria (WDOE 1991). Detected metal concentrations exceeding the effects-based reference values were ranked as high priority (see Figures 4-7 and Table 1). These exceedances occurred mainly in river segments 1A and 1B at locations 3 (cadmium), 7 (cadmium), 8 (cadmium, copper), 9 (cadmium), and 10 (cadmium). Three locations in river segment 4 also exceeded specific metals values (locations 25 - copper, lead; 27 - lead; 31 - manganese). Locations 15 and 16 in segment 2A were considered high-priority data gaps because no metals data were available (see Table 2).

Polynuclear Aromatic Hydrocarbons (PAHs). PAHs were detected in all major segments of the lower Columbia River. Detected levels of total PAHs were found at locations 1, 4, 11, and 12 in river segment 1; locations 18, 19, and 20 in river segment 2; locations 22 and 23 in river segment 3; and locations 24, 25, 27, and 29 in river segment 4. However, only at location 1 (Ilwaco) and 19 (Longview) did total PAH concentrations exceed the effects-based reference value (see Figures 4-7 and Table 1). No consistent relationship between PAH levels and sediment grain size and organic content was evident in the range of sediment types found at most locations. Location 1 contains mostly silt with relatively high total organic carbon (TOC) values, which is consistent with the observation of high PAH levels at these sites. In contrast, sediments at location 19 consist mainly of sand with low TOC values, but high total PAH levels High levels of total PAH observed at location 19 are the likely result of localized input of these contaminants.

Pesticides. Sediment pesticide residues were detected primarily in river segments 1A and 1B—at locations 1, 4, 9, and 11. Only one other location surveyed in the river (location 24, river segment 4) contained detected levels of pesticides. Locations 4 (Chinook Channel), 9 (Astoria), and 24 (Portland-Vancouver area) contained sediment pesticide levels that exceeded the effects-based reference values (see Figures 4-7; Table 1).

Polychlorinated Biphenyls (PCBs). Of the 31 surveyed locations, 11 sites had no data on sediment PCB concentrations. Contaminants were detected only at locations 1, 4, 9, and 11 in river segment 1; location 19 in river segment 2; and location 24 in river segment 4. Only the sediments at location 19 (Longview) contained total PCB levels exceeding the effects-based reference value (see Figures 4-7; Table 1).

Dioxin and Furan. Data on sediment dioxin and furan concentrations were available only for river segments 2, 3, and 4 (see Figures 2-5). Various forms of dioxin and furan were detected at locations 15, 16, 17, and 19 in river segment 2; location 23 in river segment 3; and location 27 in river segment 4. Because dioxin and furan compounds have no effects-based reference values and are highly toxic, all detected sediment dioxin and furan levels were considered high priority. However, sediment dioxin and furan levels have been measured only at six locations in the lower Columbia River—all near pulp and paper mill operations (see Figures 4-7; Table 1)

Resin Acids. Resin acids were measured and detected at four locations in the lower Columbia River (location 19 in river segment 2; locations 25, 27, and 29 in river segment 4). Because resin acids have no effects-based reference value, detected values were considered medium priorities Two locations [19 (Longview) and 27 (Camas Slough)] had measured values that were ten times higher than those at the other two locations and are considered high priorities (see Figures 4-7; Table 1).

Radionuclides. Comparisons of historical sediment radionuclide levels with derived reference values revealed high radionuclide concentrations at all locations surveyed. With the exception of K-40 (a natural product), the half-lives of the various radionuclides measured in the studies are quite short. This factor—and the absence of cooling water discharge from the former reactors at Hanford—suggests that the radionuclides present in sediments several years ago may no longer pose a problem in the lower Columbia River.

Sediment radionuclides in the lower Columbia River were measured at 40 locations (see Figures 4–7). These locations have been identified separately from other sediment chemistry locations because the data come from studies conducted between 1963 and 1965 (river segments 2, 3, and 4), and in 1973 (river segment 1 and to a limited extent segment 2). In addition, most of the 40 locations were sampled only for radionuclides. The only recent radionuclide data in the lower Columbia River were collected by the Oregon Division of Health (G. Toombs, 18 February 1992, personal communication). While these data have been requested for inclusion in this study, they have not yet been received.

Benthic Infauna. The available benthic infauna data are useful only for describing general trends of density and dominant taxa. Most information on benthic infauna in the lower Columbia River are limited by inadequate reference areas, inconsistent methods, and their design as studies characterizing rather than identifying affected areas.

Over 20 reports describing benthic macrofauna of the lower Columbia River were reviewed. Most studies were focused on river segment 1, primarily as studies conducted for the Columbia River Estuary Data Development Program (CREDDP) in the early 1980s. Several other studies addressed problems associated with the effects of dredged-material disposal on benthic assemblages. Reports were rejected if their methods were inadequate, data were obviously flawed, or if no data beyond species lists were presented. Because of inconsistent methods and analyses, only total macrofaunal densities and the densities of dominant taxa (or major taxonomic groups) were uniformly available among studies.

As a part of CREDDP, the estuary-wide relationships between benthic invertebrate populations and the physical properties of the lower Columbia River were sampled for during September 1981 (Holton et al. 1984). These authors found that faunal assemblages within the study area appeared to be structured by salinity and the degree to which a particular habitat was protected from wind stress and current speed. Within the marine zone, which includes river segments 1A and 1B, the dominant fauna varied among the channel, unprotected flats, and protected flats habitats (Table 3). Dominant fauna included marine species such as the bivalve *Macoma balthica*, the amphipod *Eohaustorius estuarius*, and the polychaetes *Hobsonia florida* and *Pseudopolydora kempi*.

Only one previous study has been conducted in segment 2A, and no data are available for 2B. Although this transition zone was dominated by freshwater taxa (*Corophium salmonis*, oligochaetes, heleid larvae, and *Corbicula manilensis*), estuarine taxa such as *Neanthes limnicola* and *Neomysis mercedis* were locally abundant. These latter species were rare or absent in Segment

TABLE 3. SUMMARY OF RESULTS FROM PREVIOUS BENTHOS STUDIES IN THE LOWER COLUMBIA RIVER

Salinity Zone	River Segment	Habitat	Dominant Species	Total Macrofaunal Abundance
Marine	1A, 1B	Main Channel	Tubellaria Nematodes Oligochaetes Amphipods Copepods	<5,000/m^2
		Unprotected flats	Nematodes Oligochaetes *Corophium salmonis* *Eohaustorius estuarius*	<5,000/m^2
		Protected flats	Oligochates *Hobsonia florida* *Pseudopolydora kemp* *Macoma balthica*	10,000-30,000/m^2[a]
Transition	1C, 2A	Channel	Oligochaetes *Corophium salmonis* Heleid larvae	<5,000/m^2
		Unprotected flats	Oligochaetes *Corophium salmonis* *Corbicula manilensis* *Neanthes limnicola* Ostracods Chironomid larvae	500-12,000/m^2[b]
		Protected flats	Nematodes Oligochaetes *Corophium salmonis*	>10,000-35,000/m^2
Freshwater	2C		Oligochaetes *Corophium salmois* *Corbicula manilensis* Heleid larvae	<5,000/m^2
	3A-4B		Oligochaetes *Corophium salmonis* *Corbicula manilensis* Heleid larvae	<1,000/m^2

[a] Local concentrations of *C. salmonis* up to 80,000/m^2.

[b] Local concentrations of *C. salmonis* up to 90,000/m^2

2C and further upstream. Species diversity appeared to be greater in the unprotected flats habitat than in the channel or protected flats within the transition zone.

The fauna of the 92.5-mile stretch of the lower Columbia River between Beaver, Oregon, and the Bonneville Dam was consistently dominated by oligochaetes, *C. salmonis, C. manilensis*, and heleid larvae.

Fish Communities. Data on fish species in the lower Columbia River are not useful for identifying problems areas because these data are limited by amount and their qualitative nature This lack of information will be treated as a data gap but given a low priority because fish communities are mobile and difficult to use as indicators of impacts (see Table 2).

Approximately 20 studies on fish communities or fish life history were reviewed. As with the benthic infauna, most data are from the estuary-wide CREDDP study of the early 1980s. None of the studies used fish communities to assess impacts. Many of the studies focused on salmonids, while several others examined non-salmonid species. Few studies were found that examined fish communities in the freshwater riverine habitats.

The diversity and abundance of fish in the lower Columbia River are enhanced by the presence of several habitat zones that include near-ocean conditions at the mouth, tidal conditions to about RM 15, a transition zone, and freshwater riverine conditions. Within these zones, the composition and distribution of fish species are also affected by the fish migration cycles and seasonal changes in river flow and salinity.

In the study, area, the most diverse fish communities were found in the estuarine zone because of the large number of subhabitats within the estuary. Over 75 species of anadromous, estuarine, and resident freshwater species have been identified in river segment 1. In more limited studies, less than ten species were identified in river segments 2 and 3. Generally, similar species were collected in segments 2 and 3. Although no studies were conducted in segment 4, given the similarities of segments 3 and 4, similar fish assemblages likely inhabit segment 4.

Bioaccumulation. For fish tissue, two studies provided most of the data. Based on the limited data available on pollutant bioaccumulation in fish and the inconsistencies in contaminants screened, it is difficult to identify problem areas in the lower Columbia River. However, the data suggest that dioxins and furans—also detected in adult anadromous steelhead and salmon—may be detectable in most of the study area. However, because anadromous fish travel in both fresh and saltwater systems, contaminant levels cannot be attributed solely to the Columbia River.

Fish Species—Twenty sampling stations with tissue bioaccumulation data were used in the accepted studies (see Figures 4–7). Generally, analyses for metals, pesticides, dioxins, furans, PCBs, and other organic compounds were conducted on the tissue. The most commonly collected species were coho salmon, chinook, steelhead, sturgeon, carp, suckers, and squawfish.

Based on the raw data, the five most commonly detected pollutants found in these species were: TCDF, TCDD, Mercury, DDE, and PCBs.

Contaminant screening levels for ranking problem areas of pollutant bioaccumulation in fish were obtained from using the lowest value among two sources:

- The reported median value of individual contaminant concentrations observed nationwide in the National Bioaccumulation Study (EPA 1991), or

- The tissue level corresponding to the U.S. EPA chronic freshwater criteria [calculated using the Bioconcentration Factor (BCF)].

Of the 20 bioaccumulation stations, seven were located in river segment 1. TCDF was detected in all species; TCDD was detected in chinook, sturgeon, carp, and suckers. Other contaminants were not analyzed. Only squawfish and suckers were collected at the four segment 2 stations: all had detectable levels of TCDF, TCDD, and mercury. In addition, DDE and PCBs were detected in squawfish from Wauna, OR and suckers from Longview, WA.

Three stations were located in river segment 3, with one station strictly dedicated to analyzing radionuclides near the Trojan Nuclear Power Plant. For the six species analyzed, no detectable levels of radionuclides were found. Among the two other stations located in river segment 3, sturgeon, squawfish, and suckers revealed detectable levels of TCDF and TCDD. Squawfish and suckers from the St. Helens, OR site also revealed detectable quantities of mercury, DDE, and PCBs. At the six stations in river segment 4, all species analyzed except steelhead contained TCDF. Chinook, squawfish, suckers, and carp all revealed detectable levels of TCDD. DDE and PCBs were detected in carp and suckers; mercury was found in squawfish and carp.

Wildlife Species—Although limited, the wildlife tissue data indicate that contamination has occurred in the past and at levels that may cause an impact. Wildlife species that forage along the lower Columbia River are potentially exposed to levels of contaminants from the prey items they consume, yet few wildlife studies have been conducted. Of these, most studies have focused on bald eagles, ospreys, mink, and river otters. Results of these studies have detected concentrations of DDE and PCBs as high as 16.0 ppm and 26.7 ppm in bald eagle and osprey eggs, respectively (Garrett et al. 1988; Henny and Anthony 1989). Studies of mink and river otters from the lower Columbia River conducted in 1978–1979 detected mean PCB concentrations of 9.3 ppm in the livers of river otter and 1.09 ppm in the livers of mink (Henny et al. 1981). The levels detected in mink were similar to levels in experimental mink that experienced total reproductive failure.

Bioassays. A bioassay is test used to evaluate the relative toxicity of a chemical or media by comparing its effect on a living organism with the effect of a standard preparation on the same type of organism. Only a few bioassays have been performed on the lower Columbia River. Most have focused on a variety of organisms—fish, amphipods, crustaceans, and invertebrates. The results of the sediment bioassays indicate that sediment may be toxic near the Weyerhaeuser outfall in Longview. But the data also indicate this toxicity is restricted to a small area. Although bioassays may be a useful indicator of contaminant effects throughout the river, existing data were not adequate to determine sediment toxicity in the lower river (see Table 2).

The three studies reviewed tested locations from Ilwaco (RM 3) to Reed Island (RM 124). At the Ilwaco, WA boat basin, no mortality was found for *Hyalella azteca* and *Daphnia pulex* exposed to these sediments. Amphipods exposed to sediments from a former ship supply and storage site near Tongue Point, OR, showed mortalities ranging from 6–13 percent. A clam and polychaete exposed to the same sediments showed lower mortalities (0–4 percent, respectively). Sediments near Longview, WA were tested and showed mortalities ranging from 8.8 to 22.5 percent. Sediments collected near the Weyerhaeuser outfall in Longview, WA caused 30 percent mortality of *Hyalella* while the upstream control station exhibited no mortality. The Microtox bioassay was also performed on these sediments, but no toxicity was indicated for any of the sediments using this bioassay.

Effluent bioassays were also performed at this facility, but no toxicity was indicated for the final effluent. Bioassays performed on sediment from the Kalama Chemical Pier exhibited 7 and 15 percent mortality; the laboratory control exhibited 6.5 and 0 percent mortality, respectively.

In river segment 4, sediment bioassays were performed in three locations. Near Camas, WA and Reed Island, bioassays had low mortalities for *Hyalella* (0–7 percent) and slightly higher mortalities for *Daphnia* (6.3–27.5) at Camas and Reed Island, respectively. At the Port of Vancouver, WA bulk loading facility, sediments were collected from an area surrounding a copper concentrate spill. Results of the rainbow trout acute bioassays showed that only the location nearest the site was toxic at a concentration of 1000 mg/L.

2.3.3 Identification of Potential Problem Areas and Data Gaps

Water Column. As discussed, water quality data for the lower Columbia River are limited. Many stations sampled were meant only to characterize a potential point source of pollution. Point sources are sources from discrete points, such as pipes or outfalls, that discharge directly into the lower Columbia River. Although priority pollutants were generally not detected in the lower Columbia River water samples, these pollutants may be present in the water column. Because of the dynamic nature of the water body, any water quality "hot spots" have been difficult to document. Many of the pollutants discharged to the main stem of the river are quickly diffused over a relatively large area. Further complicating the matter is that the analytical methods commonly used to measure priority pollutants generally are not sensitive enough to detect pollutants that might be present in the small sample volumes typically tested.

Available data were insufficient to determine if federal and state water quality criteria are consistently met in the lower Columbia River. However, a more informal criterion was used to identify pollutant levels and rank problem areas. This criterion is based on the detected values that were found. Though almost all of these detected values do not exceed the freshwater water quality criteria, their presence in measurable levels in the small volume of a typical water sample can be thought of as a "hot spot" relative to pristine conditions.

An attempt was made to rank potential problem areas based on existing water quality data. Since the areal coverage of historical water quality data from the lower Columbia River was sporadic, each sampling station was considered separately. In the evaluation, data from each measured parameter at a given water quality station were compared against the detection limit and the water quality criteria.

Data from 13 parameters were examined. Ten of these were metals; the others were total PCBs, total pesticides (both taken as sums if individual compounds were analyzed), and fecal coliform bacteria. Only data from the last available year were examined for stations with multiple samplings. If no detected values were available for a given parameter at a given station, that "area" or station was given a low priority for that parameter. If one or more values were above the detection limit but not above the chronic water quality criteria for freshwater, then that station was given a medium priority for that parameter. Finally, if one or more values were above the chronic water quality criteria, then that station was given a high priority for that parameter. If two or more parameters caused a given station to be classified as medium or high priority, then the overall station priority was given as medium or high, respectively. Otherwise, the station was classified as low priority.

Most water quality stations with acceptable data were classified as medium priority. Of the stations classified as medium or high priority, however, most had not been sampled within the last decade (see Figures 4–7; Table 1). Water quality in a dynamic system such as the lower Columbia River depends solely on an active pollutant source, unlike sediment quality, which is also affected by previously deposited pollutant sources. Thus, water quality measurements of ten or more years apply only to present day water quality if the past and present pollutant sources are equivalent. Pollutant sources have changed considerably in character and quantity in the last decade, further limiting the utility of such data.

Given the limitations of the sampling design of most of the water quality surveys described, the entire lower Columbia River could be considered a data gap for water quality (see Table 2). Although a considerable amount of conventional and nutrient data have been collected, the ecological and public health ramifications of these data are still largely unknown.

Sediment. As discussed, sediment contamination in the lower Columbia River can be assessed only very generally because no systematic sediment sampling effort has yet been conducted for the area To date, the most extensive sediment chemistry surveys were done in the estuarine regions of the river, mainly in segments 1A and 1B. Metal contamination was detected at most sampled locations, but at concentrations generally below the effects-based reference levels. Data on organic compounds were limited, with relatively few locations containing detected amounts of these contaminants. Dioxin and furan compounds were generally detected whenever they were measured.

Several locations (Location 4, Chinook Channel; 8, Young's Bay; 9, Astoria; 15, 16, 17 - Wauna; 19, Longview; 24, Vancouver/Portland area; 25, Vancouver; and 27, Camas) were considered priority areas because at least two compounds that exceed the reference criteria were found in those locations (see Figures 4–7; Table 1). Significant data gaps occurred for river segments 2B and 3B, where no sediment data were located. Lack of sediment contaminant data for specific groups of compounds at many of the locations also pointed to data gaps for those locations (see Table 2).

Sediments in river segment 3 were poorly characterized. Only two locations (around Kalama and St. Helens) in segment 3 were sampled for sediment chemistry, despite the occurrence of several municipal and industrial point sources and two landfills in the region.

With the exception of a few locations around heavily industrialized urban areas of Longview and Vancouver/Portland, the historical data suggest that sediment quality is not generally an issue of concern. This evaluation is, however, strongly qualified by the difficulties associated with interpreting the historical data and lack of studies in depositional areas where the most contamination would be expected. A systematic survey of sediments at strategic locations is strongly recommended to derive a scientifically sound assessment of current conditions in the lower Columbia River.

Benthic Infauna. Given the inadequacies of the data, benthic assemblages were not ranked to determine potential problem areas. Instead, lack of data using consistent methods and measuring similar attributes throughout the river was identified as a high-priority data gap (see Table 2).

Future sampling efforts in the lower Columbia River should be concentrated in river segments 2A, 2B, 2C, 4A, and 4B, where little or no information has been collected. More effort should also be made to sample depositional environments, especially in segments 3B and 4A, adjacent to and just downstream from Portland, Oregon, and Vancouver, Washington. River segment 3B contains the Ridgefield National Wildlife Area (Washington) and the State of Oregon's Sauvie Island Wildlife Area, where depositional areas provide feeding habitat for fishes, waterfowl, and shorebirds.

Fish Communities. Because of the mobility, seasonal variability, and anadromous life histories of the fish that reside in the study area, fish assemblages are an inappropriate indicator of problem areas within the lower Columbia River. The physical, biological, and ecological relationships that govern the presence or absence of mobile fish communities are complex and not entirely understood. To separate the effects of pollutants from the effects of other environmental conditions, the input of contaminants would have to be extremely high. The effects of lower, long-term inputs of toxic substances are probably undetectable at the fish community level. The most appropriate use of fish community data would be to identify those individual species in the study area that have ecological linkages to contaminated areas. Those species with a link to a problem area may be appropriate to the study of biological endpoints such as bioaccumulation or liver enzyme activity.

The largest data gap for fish communities are for river segments 2, 3, and 4. Very few studies have been conducted in these freshwater reaches of the river compared with the estuary (see Table 2). Data on species assemblages, seasonal variability, habitat types, major and minor prey, and prey densities are needed to more fully understand the ecological relationships of fish in this area Data should be collected and evaluated geographically and temporally, as was done in the estuary.

Bioaccumulation. Based on the levels of contaminants analyzed in fish tissues from previous studies and the screening levels established for this study, pollutant levels were assigned priorities for fish species within each river segment (see Figures 4–7; Table 1). High, medium, and low priorities were assigned to fish tissue concentrations for individual contaminants based on the following decision criteria:

- High priority was assigned to any detected level or detection limit of a contaminant above the screening level.

- Medium priority was assigned to any detected contaminant that was below the appropriate screening level.

- Low priority was assigned to any non-detected contaminant in a fish species with a detection limit below the appropriate screening level.

This ranking of pollutants allowed problem pollutants to be compared among species and river segments. Dioxins and furans consistently appear as high-priority pollutants in all non-anadromous species in all of the river segments (see Figures 4–7; Table 1). These compounds were also assigned a high ranking for the anadromous chinook salmon, but not for coho or steelhead. The DDT pesticide degradation product, DDE, ranked as a high priority in suckers in river segments 2 through 4 (it was not analyzed in segment 1). DDE and PCBs also ranked as high priorities for carp in river segment 4.

Although data gaps were too numerous to adequately characterize bioaccumulation problems in fish based upon existing data (see Table 2), several trends were noted. First, dioxins and furans appeared throughout species and geographic distributions within the lower Columbia River, and commonly received a high priority status. Second, DDE was also detectable in noticeable quantities in suckers within all river segments analyzed for DDE. Finally, mercury and PCBs were detectable in quantities sufficient to receive a medium, but not high, priority in most species where they were examined.

Bioassays. The bioassay studies reviewed for this subtask encompass only a small range of the potential areas of concern in the study area. Amphipods were used in several sediment bioassays, allowing some comparison of toxicity among sites on the river. For example, sites located near Longview appeared to be more toxic than sediments in Ilwaco. Little or no information is available on the potential toxicity of sediments found away from potential point sources of pollution. Although sediments located in "background" or reference areas are unlikely to be toxic to most bioassay organisms, this phenomena has yet to be demonstrated. Thus, bioassay data were generally classified as a data gap for the river (see Table 2).

3.0 DATA AVAILABILITY AND GAPS

This chapter summarizes and assesses the availability of data and data gaps.

Many studies have been conducted on the lower Columbia River since approximately 1980. Most of those were done in association with CREDDP to investigate and characterize conditions in the estuary. Other studies focus on the maintenance and dredging of the main navigational channel or harbor areas and involve sediment contaminants. The USGS has provided long-term water quality monitoring data from two of sites in the lower river measuring conventionals, nutrients, and metals. Other agencies, firms and educational institutions have done site-specific studies ranging from sediment bioassays to fish tissue bioaccumulation to National Pollution Discharge Elimination System (NPDES) monitoring studies.

However, there is a general lack of studies that survey the entire lower Columbia River. The study closest to this design was conducted by the Washington Department of Ecology (WDOE) to assess conditions--including sediment contaminant concentrations and sediment toxicity at five Columbia River ports (Johnson and Norton 1988). For some segments of the river, sediment contaminant concentrations are completely unstudied. In addition, very little sediment data exist from depositional areas where contaminants would be expected to accumulate.

Likewise no attempt has been made to characterize the water quality over the length of the river. Data for characterizing contaminant concentrations in water are an especially high-priority data gap (see Table 2).

Data on contaminant concentrations in fish and invertebrate tissues are also generally lacking. Bioaccumulation data are currently being collected by several state and federal agencies, and these studies will contribute greatly to the bioaccumulation data. However, systemwide ecological data do not exist either for benthic macrofauna or for fish assemblages (see Table 2).

Further compounding the major problem of lack of data, nearly all the data collection and analysis to date have been inconsistent. Such a lack of consistency greatly limits the comparisons and conclusions that can be made from the existing data.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Over 160 documents were collected, reviewed, and evaluated for existing data on the water column, sediments, and biological quality of the lower Columbia River. These studies were used to characterize the lower river quality and to identify potential problem areas and data gaps. Limitations of the data for all media prevented an integrated analysis of data from location to location. The problem areas, data gaps and existing station locations were recorded and analyzed to fully complement and contribute to the design of the reconnaissance survey sampling plan design.

The following observations were drawn from the existing data:

- **Water Column.** Metals and organic compounds have generally not been detected in water samples. Nutrient data do not indicate problems with over abundances of nutrients. The designation of medium- or high-priority sampling areas was based on pre-1981 data. Among recently sampled locations, neither medium-priority nor high-priority designations were made, except for Warrendale and Beaver Army Terminal stations where metals concentrations were found. Based on the limited data available, however, the entire lower Columbia River is a data gap for water quality (see Table 2).

- **Sediments.** Based on contaminant screening levels, approximately ten potential problem areas were identified from existing sediment data (see Figures 4–7; Table 1). The most prominent areas were Ilwaco, Camas Slough, Longview, and the Portland/Vancouver area. Most data showed contaminant levels either below the screening levels or at undetected values. Data interpretation between studies was difficult because of the inconsistent suite of chemicals analyzed, varying sediment types, differing analytical techniques, and large time spans between surveys.

- **Benthic Invertebrates.** Very limited information on impacts to benthic invertebrate populations was available for the lower Columbia River. For benthic populations in depositional environments, there is some limited data on river segment 1. Benthic invertebrates are a data gap for most of the lower Columbia River (see Table 2).

- **Fish Communities.** No existing studies were found that used fish communities to assess impacts to the aquatic environment of the lower Columbia River. Therefore, this indicator is a data gap (see Table 2).

- **Bioaccumulation.** Based on the relatively few station locations and small suite of chemicals analyzed, dioxins, furans, and DDE exceeded screening levels in most segments of the river (see Figures 4–7; Table 1). Total PCBs were exceeded in carp in river segment 4 (the uppermost segment). However, bioaccumulation data interpretation was very limited given the highly variable suites of chemicals analyzed at most stations.

- **Bioassays.** Based on limited bioassay data, *Hyalella* mortality data suggest a medium-priority problem area near Longview in river segment 2 Kalama and Reed Island, in river segments 3 and 4, respectively, are also classified as medium-priority areas.

Specific recommendations for each medium were presented as part of the earlier Task 1 reports and will not be repeated here. However, two general recommendations are discussed below:

- To characterize the existing health of the lower Columbia River, a much more coordinated effort among state, federal, and local agencies will be required. This coordination should entail standardizing the field and analytical techniques used to collect new data. Lack of consistency was one of the greatest limitations of the existing data for evaluating water quality conditions.

- The existing reference database should be maintained and updated periodically so that there is a central repository for existing studies conducted on the lower Columbia River.

5.0 REFERENCES

Fuhrer, G J , and F.A. Rinella. 1983. Analysis of elutriates, native water, and bottom material in selected rivers and estuaries in western Oregon and Washington. Open File Report 82-922, U.S. Geological Survey, U.S. Army Corps of Engineers. 147 pp.

Garrett, M., R.G. Anthony, J W Watson, and K. McGarigal. 1988. Ecology of bald eagles on the lower Columbia River: Final Report to U.S Army Corps of Engineers, Contract No. DACW57-83-C-0100. Oregon State University, Dept. of Fisheries and Wildlife, Corvallis, OR. 189 pp.

Haushild, H.H., H.H. Stevens, Jr., J.L. Nelson, and G.R. Dempster, Jr. 1973. Radionuclides in transport in the Columbia River from Pasco to Vancouver, Washington. Geological Survey Professional paper 433-N, U.S. Government Printing Office, Washington, DC. 43 pp.

Henny, C.J., and R.G. Anthony. 1989. Bald eagle and osprey. National Wildlife Federation Scientific and Technical Series (12):66-82.

Henny, C.J., L.J. Blus, S.T. Gregory, and C.J. Stafford. 1981. PCBs and organochlorine pesticides in wild mink and river otters from Oregon. In: Worldwide Furbearers Conf. Proc., Aug 3-11, 1980, Frostburg, MO, pp. 1763-1780.

Holton, R.L, D.L. Higley, M.A. Brzezinski, K.K. Jones, and S.L. Wilson. 1984. Final report on the benthic infauna work unit of the Columbia River. College of Oceanography, Oregon State University, Corvallis, OR. 179 pp. + app.

Johnson, A., and D. Norton. 1988. Screening survey for chemical contaminants and toxicity in sediments at five lower Columbia River ports - September 22-24, 1987. Washington State Department of Ecology, Olympia, WA. 20 pp.

Long, E.R., and L.G. Morgan. 1990. The Potential of Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52. Seattle, WA.

Toombs, G. 18 February 1992. Personal Communication (phone by Dr. Mahmood Shivji, Tetra Tech, Inc., Bellevue, WA). Oregon State Health Division, Portland, OR.

Toombs, G.L., S.L. Martin, P.B. Culter, and M.G. Dibblee. 1984. Environmental radiological surveillance report on Oregon surface waters, Volume I, 1961-1983. Oregon State Health Division, Radiation Control Section, Portland, OR. 40 pp. + app.

U.S. Environmental Protection Agency. 1991. Bioaccumulation of Selected Pollutants in Fish, a National Study. Office of Water Regulations and Standards, Washington DC. EPA 506/6-90/001a.

Washington Department of Ecology (WDOE). 1991. Summary Criteria and Guidelines for Contaminated Freshwater Sediments. Compiled by J. Bennett and J. Cubbage, Environmental Investigations and Laboratory Services. WDOE Sediment Management Unit, Washington State Department of Ecology, Olympia, WA.