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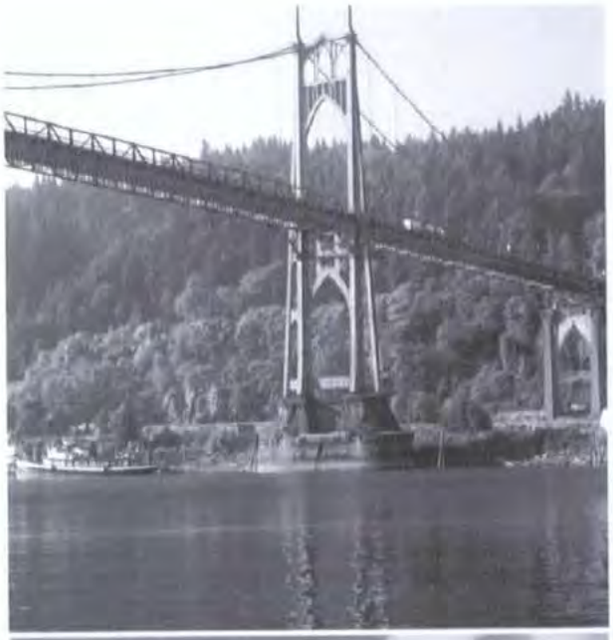

Portland Harbor RI/FS

Revised Draft Final Programmatic Work Plan

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Appendix A

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PORTLAND HARBOR RI/FS PROGRAMMATIC WORK PLAN

APPENDIX A: FEASIBILITY STUDY WORK PLAN

REVISED DRAFT FINAL
November 13, 2003

Prepared for:
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TABLE OF CONTENTS

1.0 INTRODUCTION 1
2.0 PRELIMINARY FS PLANNING TASKS 1
2.1 RAO Technical Memorandum 2
2.2 Disposal Facility Siting Evaluation 3
2.3 Summary of Capping Material Sources and Testing 3
2.4 Natural Attenuation Data Needs 4
3.0 TREATABILITY STUDIES 5
3.1 Literature Survey and Determine Need for Treatability Studies 6
3.2 Evaluation of Treatability Studies and Subsequent Tasks 6
4.0 USE OF COLLECTED DATA IN FEASIBILITY STUDY 8
4.1 Existing Information and PRE-AOC Tasks 8
4.2 Round 1 Sampling 8
4.3 Round 2 Sampling 9
4.4 Round 3 Sampling 9
4.5 RECONTAMINATION EVALUATION 10
5.0 DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES 12
5.1 Refine Remedial Action Objectives 12
5.2 Identify Sediment management Areas and Volumes 12
5.2.1 Data Needs to Develop SMAs and Volumes 13
5.2.2 Preliminary SMA Definition 14
5.3 Refine General Response Actions (GRAs) 15
5.4 Identify and Screen Applicable Technologies and Process Options 15
5.5 Assemble Alternatives 16
5.6 Refine Alternatives 18
5.7 Screen Alternatives 18
5.8 Alternatives Development and Screening Summary Report 19
6.0 DETAILED EVALUATION OF ALTERNATIVES 20
6.1 Evaluate Each Alternative Against CERCLA Evaluation Criteria 20
6.2 Comparison of Alternatives 20
7.0 SUBMIT FEASIBILITY STUDY 22
8.0 REFERENCES 23

Figure 1. Flow Chart – Feasibility Study Tasks
Figure 2. Data Uses and Evaluations Diagram for RI/RA/FS

Attachment A1: Revised Remedial Action Objectives Technical Memorandum
Attachment A2: Draft Disposal Facility Siting Technical Memorandum
Attachment A3: Draft Capping Material Evaluation Technical Memorandum
Attachment A4: Revised Natural Attenuation Data Gaps Technical Memorandum

1.0 INTRODUCTION

This Appendix describes the tasks that will be performed to develop the recommended remedy for the Portland Harbor Superfund Site (Site). This includes an upfront preliminary planning process, potential treatability studies, development and screening of remedial alternatives, a detailed evaluation of the alternatives, and selection of a recommended remedy. A flow chart of the overall FS process is shown in Figure 1. This process is consistent with the project SOW, AOC, EPA guidance on conducing CERCLA Feasibility Studies (EPA 1988), CERCLA regulations in general, and the National Contingency Plan (NCP).

The overall remedy will likely include integration with habitat restoration activities at locations with available and appropriate opportunities. However, it should be noted that habitat restoration is not a primary goal of the RI or the FS process. Thus, there are no DQOs developed in the main Work Plan for restoration. Rather, the intent of this FS process is to define cleanup remedies that allow for cost effective and efficient integration with any restoration activities that may be proposed through other efforts not detailed in this Work Plan (e.g., Natural Resource Damage Assessment process) during the course of the RI/FS process.

2.0 PRELIMINARY FS PLANNING TASKS

Typically, most elements of an FS are conducted after the RI is complete or mostly complete. However, there is a need for some elements of the FS to be developed early in the project so that the RI can be coordinated with the eventual goals of the FS (e.g., remedy selection). In addition, some FS related tasks will take substantial time to complete and can be conducted in parallel with the RI process. The SOW requires four preliminary FS planning documents to be prepared and submitted at the time of this overall Work Plan:

- Remedial Action Objectives (RAO) Technical Memorandum (Attachment A1)
- Facility Siting Technical Memorandum (Attachment A2); originally submitted in March 2002)
- Capping Material Evaluation Technical Memorandum (Attachment A3); originally submitted in February 2002)
- Natural Attenuation Data Gaps analysis (Attachment A4).

These tasks are depicted at the start of the FS process at the top of Figure 1. The attachments cited above contain the draft documents required by the SOW. Each of these documents details the purpose of the planning task and presents recommendations on how to proceed throughout the remainder of the FS process. These documents, and particularly how their contents relate to and will be integrated with the rest of the FS, are summarized below.

2.1 RAO TECHNICAL MEMORANDUM

Section 4.6.1 of the SOW calls for a technical memorandum regarding RAOs that describes:

- "...a range of broadly defined potential RAOs and associated technologies..."
- "...a range of potential [remedial] alternatives..."
- "...[a summary of] previously identified RI/FS data gaps associated with each potential remedial action..."
- "...potential State and Federal [Applicable or Relevant and Appropriate Requirements] ARARs...[and] 'to be considered initiatives'..."

The Remedial Action Objectives Technical Memorandum in Attachment A1 defines the proposed RAOs for the project. These RAOs address objectives that apply to each of the matrices (e.g., sediment) of concern and operable units of the Site[1]. The RAOs consider chemicals of likely interest, exposure pathways and receptors, ranges of acceptable chemical levels[2], and other considerations such as the commercial/industrial nature of the Site, the river physical system, and integration with restoration activities (where appropriate).

A range of General Response Actions (GRAs) that could potentially fulfill the RAOs is presented including such alternatives as: no action, institutional controls, natural attenuation, in-situ containment, in-situ treatment, removal and disposal, monitored natural attenuation, and removal and treatment. Existing data gaps that can be identified at this time are summarized for each of these GRAs. In addition, a preliminary list of ARARs is presented.

RAOs will be refined and made more detailed (as necessary) after the RI and associated risk assessments are completed. Any updates to RAOs will be presented in the Refined RAOs Technical Memorandum (Figure 1; see Section 5.1). This will include development of Preliminary Remediation Goals (PRGs) as required under Section 7.3.1 of the SOW. As required by the SOW general types of PRGs (e.g., national or regional numeric sediment guidelines) will be considered when developing PRGs. However, PRG development will primarily rely on the results of the risk assessment conducted specifically for this RI/FS.

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[1] There is only one operable unit to the Site at this time.

[2] Chemical levels are defined in terms of acceptable risks that will be defined during the Project Risk Assessment.

2.2 DISPOSAL FACILITY SITING EVALUATION

Section 4.6.2 of the SOW calls for a technical memorandum that describes, "...the process needed to identify and obtain disposal site options for contaminated sediment." The proposed process is described in the Facility Siting Technical Memorandum in Attachment A2. It should be noted that this document considers only those GRAs that are related to dredging and disposal of sediments. As noted above, several other GRAs will be considered in the overall FS process. In summary, the proposed facility siting process includes the following steps:

1. Define the geographic limits of the study area to be considered for facility siting.
2. Estimate volumes of sediments to be disposed based on information after Round 2 data collection.
3. Evaluate the study area for sites of appropriate size (given Step 2 volume assumptions) and use preliminary screening criteria to create a preliminary inventory of sites.
4. Determine the specific volume, and the chemical, physical, and geotechnical characteristics of the sediments to be disposed (information from the RI/FS process).
5. Optional step that rescreens sites from Step 3 to create a refined site list, based on the information from Step 4 and any additional useful criteria that become evident from the information gathered in Step 4. (If Step 4 information is insufficient to further refine the site list we will skip this step and go directly to Step 6.)
6. Conduct a brief evaluation of each site on the refined list using CERCLA-based criteria to arrive at a final ranked list of potential sites.

The steps of the Facility Siting evaluation, and how they fit into the overall FS process, are shown in Figure 1. Step 3 can be conducted during the RI. Steps 4 and 5 will use RI/FS information on areas and volumes of sediments to be remediated to refine the list of potential sites. The results of Step 6 (final ranked site list) will be input into the Assembled Alternatives Technical Memorandum (see Section 5.5). Top ranked facility sites will be assessed in the assembled alternatives to determine the most appropriate combinations of disposal sites and other remedial technologies.

2.3 SUMMARY OF CAPPING MATERIAL SOURCES AND TESTING

Section 4.6.3 of the SOW requires a technical memorandum that "...identifies potential sources of sediment capping materials and outlines testing requirements needed to evaluate the acceptability of the material." The Capping Material Evaluation Technical Memorandum is contained in Attachment A3.

The memorandum reviews a number of potential sources of capping material. From this review it was concluded that large quantities of capping material are available from both likely future dredge projects and commercial sand/gravel operations in any grain size distribution required. The memorandum proposes that the testing requirements to determine the suitability of these materials be consistent with "Dredged Material Evaluation Framework, Lower Columbia Management Area" (USACE et al. 1998).

As GRAs are refined (Section 5.3) in the FS Process and appropriate remedial technologies are screened (Section 5.4), the information from this memorandum will be used to select and pursue specific sources of capping material that are appropriate for those areas that might be capped. Volumes of capping material needed and appropriate grain sizes (to withstand river erosion for example) will be determinable from RI information available at that time.

2.4 NATURAL ATTENUATION DATA NEEDS

Section 4.6.4 of the SOW requires identification of "...the data needed to evaluate natural attenuation options and include collection of this data in a RI planning task so that it is available when needed." A description of these data needs and proposed data collection efforts to fill these needs are contained in Attachment A4.

In order for the data needs to be defined, the overall approach to evaluating natural attenuation in the river must be developed. A three-step process is proposed:

- **Step 1:** Identify areas that have basic processes that are potentially suitable for natural attenuation based on general information about the river system.
- **Step 2:** Conduct select sampling (in Round 2) and simple probabilistic modeling for representative areas with potential natural attenuation processes and eliminate from further evaluations the types of areas that have a low probability processes sufficient to support natural attenuation.
- **Step 3:** Conduct detailed sampling (in Round 3) and modeling in areas that appear to have suitable processes for natural attenuation to determine viability and rate of natural attenuation.

Existing information is sufficient for Step 1. Additional area specific data will likely be needed to complete Steps 2 and 3 and could include additional surface sediment chemistry and physical characteristics, hydrodynamic modeling, sedimentation rate estimates, chemistry of sediments settling from the water column, mixed layer depth, and mixing rate. Some of these efforts (e.g., surface sediment chemistry and hydrodynamic modeling) are already proposed in this work plan to fulfill other information requirements. Some additional types of sampling specific to sedimentation rates, suspended sediment chemistry, and sediment mixing dynamics

may be needed specifically to fill natural attenuation data gaps. A review of historical sediment information will also be conducted to determine whether there is any evidence of ongoing natural attenuation.

The results of the Step 1 evaluation based on existing information as well as a Modeling Technical Memorandum presenting the details of the proposed Step 2 model will be presented in one document, which will be submitted to EPA prior to or concurrent with submittal of the Round 2 FSP. The Round 2 FSP will contain the sampling types, locations, and methods needed to collect data to conduct Step 2 of the natural attenuation approach. The results of the Step 2 modeling and a Modeling Technical Memorandum presenting the details of the proposed Step 3 model will presented in one document, which will be submitted to EPA prior to or concurrent with submittal of the Round 3 FSP. The Round 3 FSP will contain the sampling methods needed to collect data to conduct Step 3 of the natural attenuation approach.

As shown in Figure 1, overall natural attenuation data collection and modeling will take place at the same time as the RI and risk assessment work. Results of natural attenuation modeling from Step 3 will be input to the Refinement of GRAs portion of the FS process (see Section 5.3).

3.0 TREATABILITY STUDIES

Treatability Studies are called for in Section 8 of the SOW, but only where it is demonstrated that this information is needed to understand how various treatment technologies may or may not be viable for this specific Site. Consistent with the SOW, a literature survey will be conducted during the RI (early in the RI/FS process) and existing information on treatment technologies will be evaluated to determine:

- Which treatment technologies are effective and cost competitive (potentially suitable) as compared to other GRAs, and
- For those potentially suitable technologies, whether treatability studies would be needed to determine the appropriateness of the technologies for this specific Site.

If existing information is sufficient to determine suitable technologies and/or judge their appropriateness without treatability studies, no treatability studies will be conducted. In this case, Sections 8.1.2 through 8.2.4 of the SOW (or Section 3.2 below) would not be required to complete the RI/FS (Figure 1).

It should be noted that other types of sediment investigations to understand engineering properties of materials will be conducted (see Section 5.4). Strictly speaking, these are not treatability studies, but they do gather information on the properties of the sediments that may be valuable to all remedial alternatives being considered including treatment.

3.1 LITERATURE SURVEY AND DETERMINE NEED FOR TREATABILITY STUDIES

Per Section 8.1.1 of the SOW, the Lower Willamette Group will conduct a literature survey on existing sediment treatment methods. Information on performance, relative costs, applicability, removal efficiencies, operation and maintenance (O&M) requirements, and implementability of candidate technologies will be compiled and evaluated. Information gathered during the course of the RI (e.g., sediment volumes, chemicals of concern, physical characteristics) will be used to determine the appropriateness of various sediment treatment technologies for this specific Site.

Based on this review and data evaluation, the Lower Willamette Group will recommend to EPA in a technical memorandum (***Treatability Study Literature Survey Technical Memorandum***) whether treatment is a feasible and cost-effective GRA for sediments. If so, the specific types of treatment technologies likely to be feasible and cost-effective (and why) will be presented and discussed in a technical memorandum. Where treatment appears viable, the Treatability Study Literature Survey Technical Memorandum will also provide a recommendation to EPA on whether site-specific treatability studies are needed for any of the viable technologies. In this case, the technical memorandum will include a brief description (statement of work) outlining the basic steps to conducting such treatability studies.

Note that the SOW language could be construed to require as many as three separate deliverables in Sections 8.1 through 8.1.1. However, one deliverable (Treatability Study Literature Survey Technical Memorandum) that contains information required in these Sections of the SOW will be submitted for this task. The AOC indicates that the first memorandum regarding treatability studies is due to EPA within 60 days after EPA's notification that treatability studies are required. However, this would be impossible since the first memorandum will address whether treatability studies are indeed necessary.

Consequently, we propose that the Treatability Study Literature Survey Technical Memorandum be developed and submitted during the course of the RI and prior to the refinement of RAOs, which is the start of the formal FS process (Figure 1). This will give EPA sufficient time to review the memorandum and determine the need for treatability studies. A decision on the need for treatability studies will be needed from EPA before GRAs can be refined (see Section 5.3). It should be noted that estimates on the volumes of sediment, chemicals of concern, and physical characteristics must be available from the RI before the literature survey on treatment can be completed.

3.2 EVALUATION OF TREATABILITY STUDIES AND SUBSEQUENT TASKS

This section of the Work Plan will only be conducted if it is determined in the Treatability Study Literature Survey Technical Memorandum above that treatability testing is needed. This section covers sections 8.1.2 through 8.2.4 of the SOW.

Once a decision has been made to perform treatability studies, the Lower Willamette Group will decide in conjunction with EPA on the type of treatability testing to use (e.g., bench vs. pilot). A brief technical memorandum (called a statement of work in the AOC and defined as the ***Evaluation of Treatability Studies Technical Memorandum*** here) will be prepared by Lower Willamette Group that lists the candidate technologies, identifies the scale at which they will be tested (pilot vs. bench), and lists available facilities/sites at which the testing can occur. The Lower Willamette Group would begin the process of finding appropriate sites at this point in the process (not during the literature survey technical memorandum development as implied by the SOW). Candidate sites and the process for obtaining their use would be presented in the technical memorandum.

The Evaluation of Treatability Studies Technical Memorandum will also consider such issues as process sizing and other logistical requirements for the adequate evaluation of the technology. The goal will be to provide sufficient information for the remedial action alternative development and selection. Where smaller-scale studies can provide sufficient information, they will be selected instead of larger-scale pilot studies wherever possible.

Per the AOC, the Evaluation of Treatability Studies Technical Memorandum is due to EPA 90 days after EPA's notification that treatability studies are required.

Once EPA approves the general approach to treatability testing as outlined in the above technical memorandum, specific deliverables required in SOW Sections 8.2.1 through 8.2.4 will be developed and provided to EPA. In order of submittal, these include: ***Treatability Studies Work Plan, Treatability Studies SAP and HSP, and a Treatability Studies Evaluation Report*** (after studies are completed).

The nature and content of these subsequent deliverables is highly dependent on the treatment technologies and scale of testing proposed. These deliverables will meet or exceed all requirements set forth in Sections 8.2.1 through 8.2.4 of the SOW and be submitted on a time-scale consistent with AOC requirements.

4.0 USE OF COLLECTED DATA IN FEASIBILITY STUDY

As noted in the main body of the Work Plan, several rounds of sampling will take place. Most of this information will be used in some form in the FS. This section briefly outlines how these data will be used in the detailed FS to identify and select remedial alternatives (a process which is described further in Sections 5 through 8 below.)

The information collected for this RI/FS is summarized in Figure 2. In general, some data collected is intended mostly or solely for FS purposes. However, in most cases, collected information will be evaluated and assessed during the RI and Risk Assessment (RA) steps of the overall project. Most often the data used in the FS will be in a highly processed form yielded by the RI and RA. For example, instead of using sediment chemistry directly to delineate areas requiring remediation, the FS will use the risk assessment, which will indicate areas of unacceptable sediment risks for various receptors of concern. With this general approach to data use in mind, the following subsections outline how data collected will be used in various FS tasks.

4.1 EXISTING INFORMATION AND PRE-AOC TASKS

As shown in Figure 2, considerable general knowledge is already available on the physical and chemical conditions within the site. This information will be input into numerous evaluations in the RI and RA steps, and will generally be used to develop a conceptual site model (CSM). Both the CSM and the individual types of information will be important throughout the FS process. For example, information on sediment transport and hydrology will be invaluable to making preliminary engineering calculations for remedial alternatives (such as capping) to determine whether they are feasible.

4.2 ROUND 1 SAMPLING

With the exception of sediment stake and bathymetry work, most of the Round 1 information will be used for the RI and RA. Eventually, this information will be used in the FS in the form of risk estimates provided by the RA. Bathymetry and sediment stake data provide information on sediment transport and sediment bed stability, when compared to earlier similar investigations. Sediment stability and transport regimes will be very important in the determination of Sediment Management Areas (SMAs; discussed below), which will be defined after Round 2 sampling. SMAs are areas of similar physical and chemical characteristics that can be viewed as units for the purposes of developing remedial alternatives. An example of the use of sediment stability information would be to define erosive areas that may require more robust designs for caps than caps designed for areas that are primarily depositional.

4.3 ROUND 2 SAMPLING

For planning purposes, two sub-rounds to Round 2 sampling are assumed (Round 2 and 2B; see main body of Work Plan for more information). These rounds will focus on collection of chemistry and toxicity information that will be used directly in the RI and RA. At the end of Round 2, a Baseline RA (BLRA) will be produced that will delineate areas of unacceptable risk to various receptors. This information and physical information from previous rounds of sampling will be used to define SMAs. In addition, subsurface sediment sample results will be used to make estimates of the volumes of contaminated sediments in various SMAs. Volume information is important when evaluating dredging, disposal, and/or treatment options. Volume estimates will be made using RA established levels that apply to surface sediments. This is a conservative approach that allows identification of all sediments that, if ever exposed to the surface, would potentially pose risks. Use of such volume estimates should not be assumed to be synonymous with baseline risks, which focus only on those contaminants that receptors may be exposed to under existing conditions.

Round 2 sampling will also provide information on natural attenuation processes that may be ongoing at the site. Attachment A4 describes the approach to assessing natural attenuation in detail. In summary, preliminary natural attenuation information from Round 2 will be used to determine whether in fact the natural processes are present that would likely support attenuation of chemicals in surface sediments in any areas of the site. If these processes do appear to be present, more detailed study would be conducted in Round 3 to determine the actual areas and rates of natural attenuation.

4.4 ROUND 3 SAMPLING

Round 3 sampling is primarily concerned with gathering any remaining information that is needed to conduct the FS. In addition, some data gap sampling for RA purposes may be conducted, as necessary. Round 3 will provide detailed information on natural attenuation areas and rates, sample disposal sites or facilities that have been identified through the facility siting process, determine the volume of contaminated sediments in any candidate dredging or erosive areas, and collect physical and engineering parameters on sediments in remediation and disposal areas (e.g., consolidation tests, sheer stress tests, Atterberg limits).

This information may be used to refine SMAs (where needed) and sediment volumes defined earlier, define natural attenuation areas (if any), conduct preliminary feasibility level design work on various remedial options and disposal sites, and understand the potential for recontamination of various remedial alternatives. Subsurface coring in Round 3 will be conducted to specifically determine the depth of contamination in SMAs that appear to be potential candidates for dredging (either through remedial design or for navigational purposes) or in areas that have a potential to erode over time. This information may also be gathered for Principal Threat areas,

regardless of the erosion potential. As noted above, chemical levels in subsurface sediments would be compared to risk-based levels established in the BLRA.

All this information will be used to develop remedial alternatives for each SMA in question. It should be noted that specific data collection in Round 3 to refine SMAs will only be conducted where it is necessary for the development of remedial alternatives. In many cases, refinement of SMAs could be conducted as a part of the RD/RA process after the ROD. Development and screening of remedial alternatives is discussed in the remaining sections of this document.

4.5 RECONTAMINATION EVALUATION

Recontamination potential will be assessed using information available through Round 3 sampling on natural attenuation processes such as sediment trap data, water column sampling, subsurface core information, and sediment physical parameters. General information on the physical and chemical make up of sediments and waters (including groundwater and porewater) in various areas of the site will also be used. Natural attenuation models predict changes in surface sediment chemistry given present understanding of water column and groundwater sources. These models can also be used to predict changes in sediment chemistry that will occur after, for example, dredging or capping.

Because recontamination potential cannot be predicted from direct water or sediment measurements, we propose that the same natural attenuation model discussed in Attachment A4 would also be used to assess the potential for recontamination. Natural attenuation models predict changes in surface sediment chemistry given present understanding of water column, subsurface sediment, and groundwater sources. These models can also be used to predict changes in sediment chemistry that will occur after, for example, dredging or capping.

The data collected for natural attenuation in Round 3 will provide the basic inputs for the recontamination model including:

- Grain size
- Surface chemical concentrations, water content, specific gravity
- Hydrodynamic modeling results
- Sedimentation rates from radioisotope cores and/or sediment traps
- Settling sediment chemical concentrations from water column samples or sediment traps
- Mixed layer depth and mixing rate

In addition, where groundwater is a known or suspected source (and/or flow of clean groundwater through contaminated subsurface sediments is suspected) information on these sources and subsurface concentrations would be needed. This information may

be available through LWG efforts, DEQ-directed efforts at individual upland sites, or a combination of both.

Where to model, and at what density, will be determined by available source effect information, which by Round 3 will likely include:

- LWG efforts to understand source effects to river waters and sediments
- DEQ efforts to identify and control sources at individual sites
- EPA efforts regarding upstream sources

It is difficult to predict the state of knowledge on all these sources at the time that Round 3 starts. Consequently, an exact program of sampling and analysis cannot be described at this time. However, the concept is to review the status and amount of source effect information and fill in data gaps as needed to provide sufficient information for recontamination modeling. This might include such studies as sediment traps near outfalls, water column samples near suspected sources, subsurface chemistry near sources, and sampling pore water near known or suspected groundwater sources. Again, we anticipate any such data gaps to be filled in Round 3.

5.0 DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES

The alternatives development process may be viewed as consisting of a series of analytical steps that involves making successively more specific definitions of potential remedial activities. This section contains the core of the formal FS process and leads to the overall FS Report. The specific steps in this process are described in the following sections.

5.1 REFINE REMEDIAL ACTION OBJECTIVES

Per Section 9.1.1 of the SOW, a technical memorandum (***Refined RAOs Technical Memorandum***) is required that reviews, and if necessary, refines the RAOs developed prior to the RI (see Section 1.1). Per the AOC, this technical memorandum is due to EPA 90 days after receipt of EPA's comment on the RI. If the Site risk assessments have not been completed and/or accepted by EPA at that time, a draft Refined RAOs Technical Memorandum will be submitted to EPA based on the risk assessment information available 90 days after EPA comment on the RI. In this case, an additional revision to the Refined RAOs Technical Memorandum will be due to EPA 30 days after EPA acceptance of the Site RA.

The Refined RAOs Technical Memorandum will include updated RAOs and PRGs. As required by the SOW, general types of PRGs (e.g., national or regional numeric sediment guidelines) will be considered when refining PRGs. However, refined PRGs will be primarily based on the results of the RA conducted during the RI. As with the preliminary RAOs, the refined RAOs will specify the chemicals and media of interest, exposure pathways and receptors, and an acceptable chemical level or range of levels (i.e., a PRG). PRGs will be location-specific within the project study area where risks estimates vary across the study area due to differences in exposure levels/routes or other site-specific risk parameters. Once RAOs and PRGs are refined, this information will be used to identify areas and volumes of sediment that require remediation.

Consistent with the goal of integrating cleanup remedies and restoration, the refined RAOs will also include any additional information that is available regarding potential restoration opportunities. This may result in a more specific RAO on restoration integration than the RAOs currently proposed in Attachment A1. This could include such factors as when and where to search for remedy/restoration combinations at particular sites and when and where to avoid remedial activities to preserve and improve existing habitats of value.

5.2 IDENTIFY SEDIMENT MANAGEMENT AREAS AND VOLUMES

The next step in developing remedial alternatives is to make an initial determination of areas and/or volumes of sediment that might require remediation. The first part of this process is defining SMAs.

The primary objective of the FS is to identify a menu of remedial options for SMA within the Site. Rarely if ever, will one remedial alternative be applicable to all parts of an extensive Superfund site such as Portland Harbor. Consequently, the Site must be broken down into a "mosaic" of discreet areas (i.e., SMAs) where remedial alternatives can be evaluated and applied.

5.2.1 Data Needs to Develop SMAs and Volumes

SMAs will be developed using the following information from the RI and RA tasks:

- A delineation of areas posing unacceptable risks ecological and human health receptors
- A categorization of risks within areas that pose unacceptable risks (e.g., areas that pose a principal threat or so-called "hotspots" versus relatively low risk areas)
- A delineation of sediment volumes (vertical and horizontal extent) that unacceptable pose risks, where deeper sediments may pose potential future risks
- Delineation of sediment volumes sufficient for evaluation of remedial alternatives in the FS (particularly for areas where dredging is likely due to navigation, water dependent, or other similar uses)
- Identification of physical environments (e.g., erosive areas, deposition areas, nearshore benches, navigation channels, depressions)
- Identification of river uses that effect remedial alternatives (e.g., navigation channels, current and future marine facilities, proposed shoreline developments)
- Identification of areas that may be impacted by ongoing sources (upstream and/or upland).

The primary additional tasks that are not part of other efforts and have been identified to help define SMAs are:

- Obtain periodic updates of DEQ gathered information on sources through the course of Round 2 so that these can be input into the preliminary SMAs
- Obtain information from land owners about potential future uses of shorelines and waterways.

This second task will be conducted by interviewing major landowners along the shoreline, reviewing both dredging records and existing maintenance dredging permits, reviewing City of Portland Comprehensive Plan, and Port of Portland marine master plan, to determine areas that are or will be routinely maintained for navigation. It must be realized that in many cases landowners may either be uncertain about

potential future uses and/or unwilling to provide this information for commercial reasons. Consequently, where information gaps exist, we will assume for SMA definition that existing uses would be maintained at shoreline sites.

It is anticipated that after Round 3 data collection, the SMAs may be refined. The following information will likely be available at that time:

- Additional natural attenuation sampling (water samples, sediment traps, radioisotope cores) and modeling results
- Additional subsurface sediment cores intended to define volume of sediment posing risks.

The potential refinement of SMAs after Round 3 is discussed more below.

5.2.2 Preliminary SMA Definition

There is no well-defined guidance or process for defining SMAs that applies to all situations. SMA development will be an iterative process that considers how areas of risks, volumes of sediments, physical environments, biological environments, and site uses overlap. It will primarily be a mapping exercise. Sediment areas that define unacceptable ecological risks, unacceptable human health risks, physical environments (e.g., erosive, depositional, benches, depressions, and landforms), and site uses will be separately mapped. Where possible, the individual locations (such as surface sediment stations) that are used to define the areas, will also be shown on the maps. These separate layers and sampling locations will be overlaid to see how they interact and group. Generally, SMAs will be defined to minimize the number of risk, physical, and site use boundaries that are crossed by each SMA while keeping the SMAs at sizes that are reasonable to evaluate from an engineering perspective. Areas of relatively high risk (i.e., principal threat areas or so called "hot spots") will also be considered in developing SMAs. Principal threat areas may either be parts of SMAs or unique separate SMAs. The identification of principal threat areas will assist in the evaluation of remedial alternatives that may better address areas of particularly concentrated or toxic chemicals that differ in character from other SMAs or the site in general.

It should be noted that risks may be defined either on an area basis or an extrapolation of areas from one or more point samples. Where risks are based on point samples that are extrapolated to areas, spatial or statistical procedures (e.g., Theissen polygons, Kriging, inverse distance weighting) may be used to define the areas of risks. Where risks are available on area-weighted average basis (e.g., over a home range or a swimming beach), these areas will be used to define the risk area component of the overlay.

Once a preliminary SMA map is defined, it will be examined to determine where SMA boundaries are based on relatively limited data sets. If it appears that further definition of these boundaries is needed in order to develop a reasonable set of remedial alternatives for evaluation in the FS, then these areas may be targeted for

additional sampling in Round 3. If this information is not critical to the FS, refinement of SMA boundaries may be left to the RD/RA phase after the ROD.

Subsurface coring in Round 3 will be conducted to specifically determine the depth of contamination in SMAs that appear to be potential candidates for dredging (either through remedial design or for navigational purposes) or in areas that have a potential to erode over time. This information may also be gathered for principal threat areas. Chemical levels in subsurface sediments would be compared to risk-based levels established in the BLRA to determine volumes of contaminated sediments.

As shown in Figure 1, SMA and volume development is a critical step in the process, which relies on information from RAO development, the RI, and natural attenuation modeling. In turn, this information is necessary to refine GRAs and complete the Disposal Facility Ranking process (Attachment A2). Standard EPA guidance (EPA 1988) shows this step conducted after GRAs are developed, but we have reversed these steps for this Work Plan. This is because very basic GRAs have already been developed for the project and are described in Attachment A1 and provide more than sufficient context for identification of areas and volumes of sediments.

There is no EPA required deliverable for this task. However, the results of the SMA development will be provided as part of the ***Identification and Screening of Remedial Technologies Technical Memorandum*** (see Section 5.4).

5.3 REFINE GENERAL RESPONSE ACTIONS (GRAS)

Commonly, the development of remedial alternatives starts with developing GRAs. This step has already been conducted for the RAOs Technical Memorandum (see Attachment A1). Consequently, this step will refine those GRAs given the information available from all the previous activities shown in Figure 1. This process will include removing GRAs that no longer appear viable and adding GRAs that may not have been previously considered. Any GRAs that provide opportunities to include or improve restoration activities will be identified. The inclusion of treatment as a GRA will be determined based on the results of the Treatability Study Literature Survey Technical Memorandum (Figure 1). If included, the treatment GRA will describe those treatment technologies that appear potentially viable. This task is described in Section 9.1.2 of the SOW.

There is no EPA required deliverable for this task.

5.4 IDENTIFY AND SCREEN APPLICABLE TECHNOLOGIES AND PROCESS OPTIONS

GRAs are overall types of remediation techniques, while technologies are more specific categories within each GRA. Process options are even more specific categories within each technology. The relationship between GRAs, technology

types, and process options are discussed with examples applicable to this project in Attachment A. One applicable example is:

- GRA – Removal and disposal
- Technology Types – Dredging, unconfined aquatic disposal, confined aquatic disposal, nearshore disposal, unconfined upland disposal, new upland confined disposal, existing upland confined disposal
- Process Options for Confined Aquatic Disposal – clamshell dredging, hydraulic dredging, split hull barge placement, barge wash off placement, clamshell placement, hydraulic pipeline placement (and similar options for cap dredging and placement)

There are even more detailed process options that may be considered (e.g., type of diffuser on a hydraulic pipeline). However, remedial technologies and process options will be developed to sufficient detail that they can be screened for inclusion in the remainder of the FS process. The primary screening criteria for including technology types and/or process options will be that of technical implementability. However, as specified in Section 9.1.4 of the SOW, cost and effectiveness criteria will also be generally considered. Information on capping material availability (Section 1.3) will be used to determine reasonable likely sources of capping material for technology types involving capping (e.g., in-situ capping, confined aquatic disposal, and nearshore disposal).

The results of the above review will be presented in the ***Identification and Screening of Remedial Technologies Technical Memorandum***. There is no AOC specified deliverable timeline for this memorandum. The Alternatives Development and Screening Summary Report is due to EPA within 90 days after EPA comment on Refine RAOs Technical Memorandum. Consequently, the Identification and Screening of Remedial Technologies Technical Memorandum will be submitted as a section or appendix to the Alternatives Development and Screening Summary Report.

5.5 ASSEMBLE ALTERNATIVES

Once a set of viable technology types and process options has been defined, these can be combined into sets of remedial alternatives for the Site. The Site will be broken down into a mosaic of sub-areas based on site-specific information obtained through the RI process. Sub-areas will be defined on the basis of:

- Physical factors such as waterway shapes (e.g., slips, inlets) and shoreline/river structures (e.g., docks, bulkheads, bridges)
- Natural physical parameters (e.g., bathymetry, current velocities, groundwater flows, stormwater inputs)
- Existing and future waterway and shoreline uses
- Existing habitats and value of those habitats

- Restoration activities under consideration for NRDA or other programs
- Depth of contamination
- Variations in chemicals of concern
- PRGs (and related RAOs)
- Exposure pathways defined in the risk assessment (e.g., where a pathway does not exist, a PRG may not apply)
- Matrices at risk (e.g., sediments, tissues, water)
- Potential or poorly defined sources.

All technologies that are reasonably applicable to each sub-area will be listed for that sub-area in a matrix format (e.g., sub-areas by technology types). Thus, some technologies would be eliminated for some sub-areas (e.g., capping in a sub-area that is an active berthing area that requires frequent dredging). Where the same technology or list of technologies is applicable to continuous sub-areas, the sub-areas may be grouped to make larger areas. If specific areas exist that have clearly unique issues or poorly understood sources, additional operable units may be defined and proposed at this time. This will allow the RI/FS to proceed for those portions of the site where contamination, risks, and sources are well understood and can be controlled.

Based on the matrix of technologies across sub-areas, a list of alternatives will be developed. A simplified example of such a list might be:

Alternative 1

- Sub-area A – Capping with restoration components on cap surface
- Sub-area B – Natural Attenuation
- Sub-area C – Dredging and Confined Aquatic Disposal in Area D
- Sub-area D – Capping via Sub-Area C material disposal
- Sub-area E – Principal Threat area removal and upland treatment

Alternative 2

- Sub-area A – Dredge and Nearshore Disposal in Area E with new shallow restoration habitat
- Sub-area B – Thin-Layer Capping
- Sub-area C – Dredge and Nearshore Disposal in Area E with restoration
- Sub-area D – Dredge and Nearshore Disposal in Area E with restoration
- Sub-Area E – Containment via nearshore disposal facility development.

The goal of the assembled alternatives will be to have a comprehensive list of potential alternatives that are integrated with restoration opportunities and consider all applicable technologies that are most likely to be viable within each sub-area. The rationale for the list of assembled alternatives will be clearly presented in the ***Assembled Alternatives Technical Memorandum*** that will be the deliverable for this task. The memorandum will also revisit the action-specific ARARs developed for the RAOs Technical Memorandum (Attachment A1), to ensure that this list of ARARs is appropriate for the alternatives assembled.

The Assembled Alternatives Technical Memorandum does not have a required timeline in the AOC. As with the previous task, the Assembled Alternatives Technical Memorandum will be submitted as an appendix or section of the Alternatives Development and Screening Summary Report, which is due to EPA 90 days after EPA's comments on the Refine RAOs Technical Memorandum.

5.6 REFINE ALTERNATIVES

The Lower Willamette Group will refine the remedial alternatives as necessary as new information becomes available in the period between assembly of alternatives (previous task) and the Alternatives Development and Screening Summary Report. This may include but is not limited to updated information from the EPA approved version of the RA, further refinements of sediment areas/volumes, refinements of ARARs, and refinements of restoration activities.

In addition, if treatability studies are completed by the time this task is underway, the information from these studies will be used in the refinement of alternatives (Figure 1). Per Section 3.1, completion of the Treatability Studies Literature Survey Technical Memorandum will require information from the RI activities. There is no SOW deliverable associated with this task.

5.7 SCREEN ALTERNATIVES

At this point in the FS process, assembled potential alternatives across all sub-areas of the Site will be available. The screening of alternatives is intended to reduce that comprehensive list to a manageable list of reasonable alternatives to be used in further evaluations. To some extent this screening will rely on best professional judgment so that a full range of reasonably viable remedial technologies are preserved for each sub-area. The goal of the screening will be to eliminate alternatives that are largely redundant or similar in terms of cost, effectiveness, and implementability.

The alternatives will be compared on an equivalent basis (i.e., definitions of alternatives are approximately at the same level of detail to allow preparation). A technical memorandum (***Screening Evaluation of Alternatives Technical Memorandum***) summarizing the results and reasoning employed in screening,

presenting alternatives that remain after screening, and identifying the action-specific ARARs for the alternatives that remain after screening will be prepared.

As with some previous tasks, there is no AOC timeline associated with the Screening Evaluation of Alternatives Technical Memorandum. It will be submitted as a section or appendix to the Alternatives Development and Screening Summary Report.

5.8 ALTERNATIVES DEVELOPMENT AND SCREENING SUMMARY REPORT

Per Section 9.2 of the SOW this task is primarily a summarization of the results of the identification, assembly, refinement, and screening of remedial alternatives. It will contain the results of the previous evaluations and summarize the overall outcome of these steps and resulting recommendations to EPA.

6.0 DETAILED EVALUATION OF ALTERNATIVES

6.1 EVALUATE EACH ALTERNATIVE AGAINST CERCLA EVALUATION CRITERIA

After EPA has reviewed and approved the alternatives developed, screened, and presented in the Section 5.8 deliverable, a detailed evaluation of the surviving alternatives can be performed. This task is covered under Section 10.1.1 of the SOW.

The Lower Willamette Group will compare each of the alternatives against the nine CERCLA evaluation criteria. The evaluation criteria include:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction in toxicity, mobility, or volume
- Short-term effectiveness
- Implementability
- Costs
- State and agency acceptance
- Community acceptance

The last two criteria are not possible to evaluate initially, as they require the draft document to have been circulated to those parties. Those criteria will be evaluated and addressed either by the Lower Willamette Group between the draft and final FS or by EPA. The cost criteria will consider any cost savings achieved from restoration integration.

There are no SOW required deliverables associated with this task.

6.2 COMPARISON OF ALTERNATIVES

Once the alternatives have been described and individually assessed against the criteria, a comparative analysis will be conducted to evaluate the relative performance of each alternative in relation to each specific evaluation criterion. Per Section 10.1.2 of the SOW, the results of this comparison will be presented in the ***Comparison of Alternatives Technical Memorandum***. Unlike the preceding analysis in which each alternative was analyzed independently without a consideration of other alternatives, the purpose of this comparative analysis is to identify the advantages and disadvantages of each alternative relative to one another so that the key tradeoffs can be identified.

As required by the AOC, the technical memorandum will be submitted within 120 days of EPA comment on the Alternatives Development and Screening Summary Report (Section 5.8).

7.0 SUBMIT FEASIBILITY STUDY

The Lower Willamette Group will complete the detailed analysis of remedial alternatives by recommending remedial alternative(s) that meets the Refined RAOs and include any appropriate restoration components. A justification for the selection of this recommendation will also be included. This recommendation along with all the supporting analysis and information developed in Sections 3, 4 and 5 will be submitted in a ***Draft Feasibility Study Report*** to EPA within 90 days after EPA's comments on the Comparison of Alternatives Technical Memorandum (Section 6.2). As indicated in 6.1, evaluation of agency and community acceptance criteria will take place between the draft and final FS Reports.

8.0 REFERENCES

EPA, U.S. 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA. Interim Final. OWSER Directive 9355.3-01, Office of Emergency and Remedial Response. Washington, D.C. EPA 540 G-89 004.

(USACE) US Army Corps of Engineers Northwestern Division (with EPA Region 10, Washington Department of Ecology, and Oregon Department of Natural Resources). 1998a. Dredged Material Evaluation Framework, Lower Columbia River Management Area, Draft. Portland, Oregon.

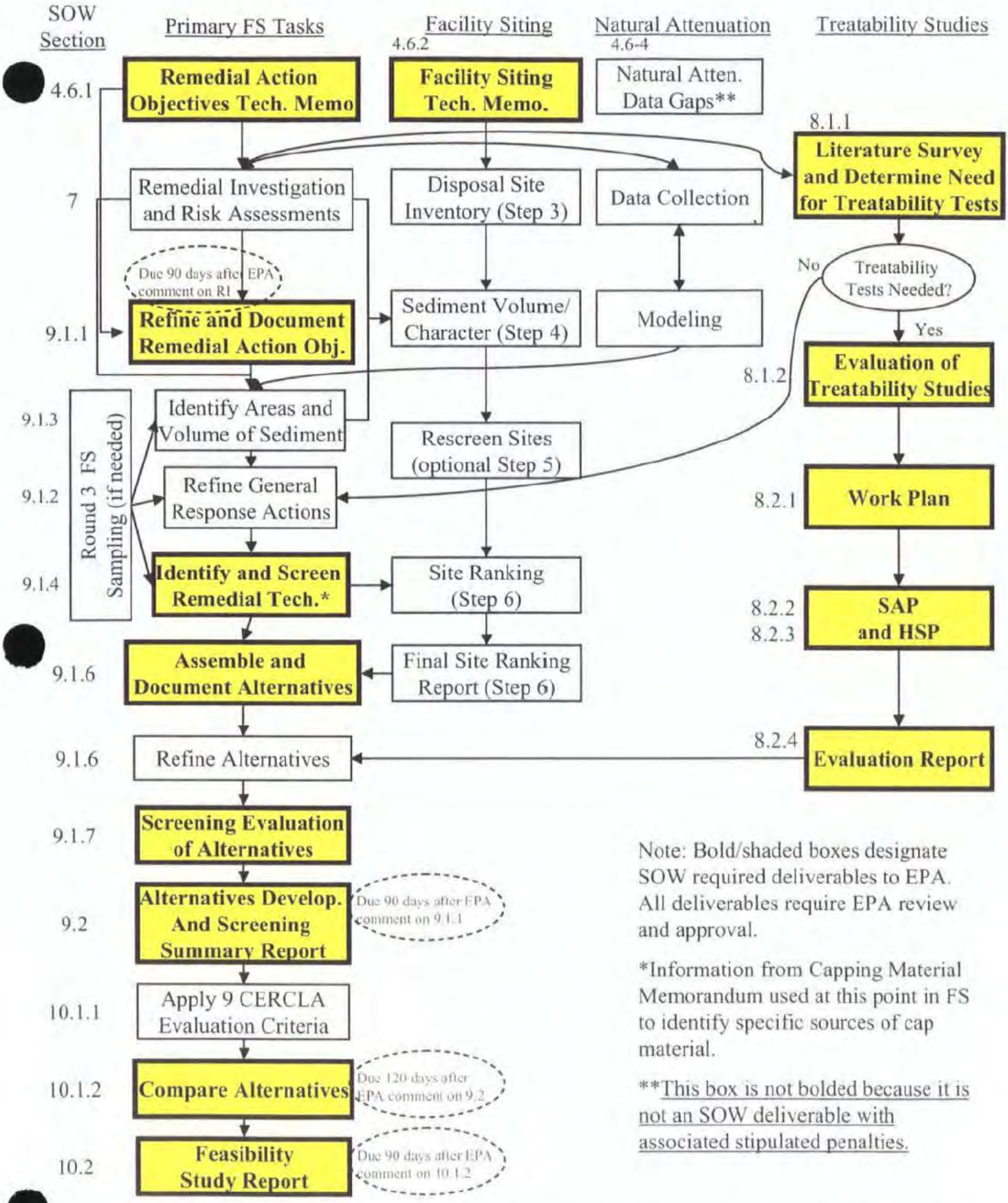
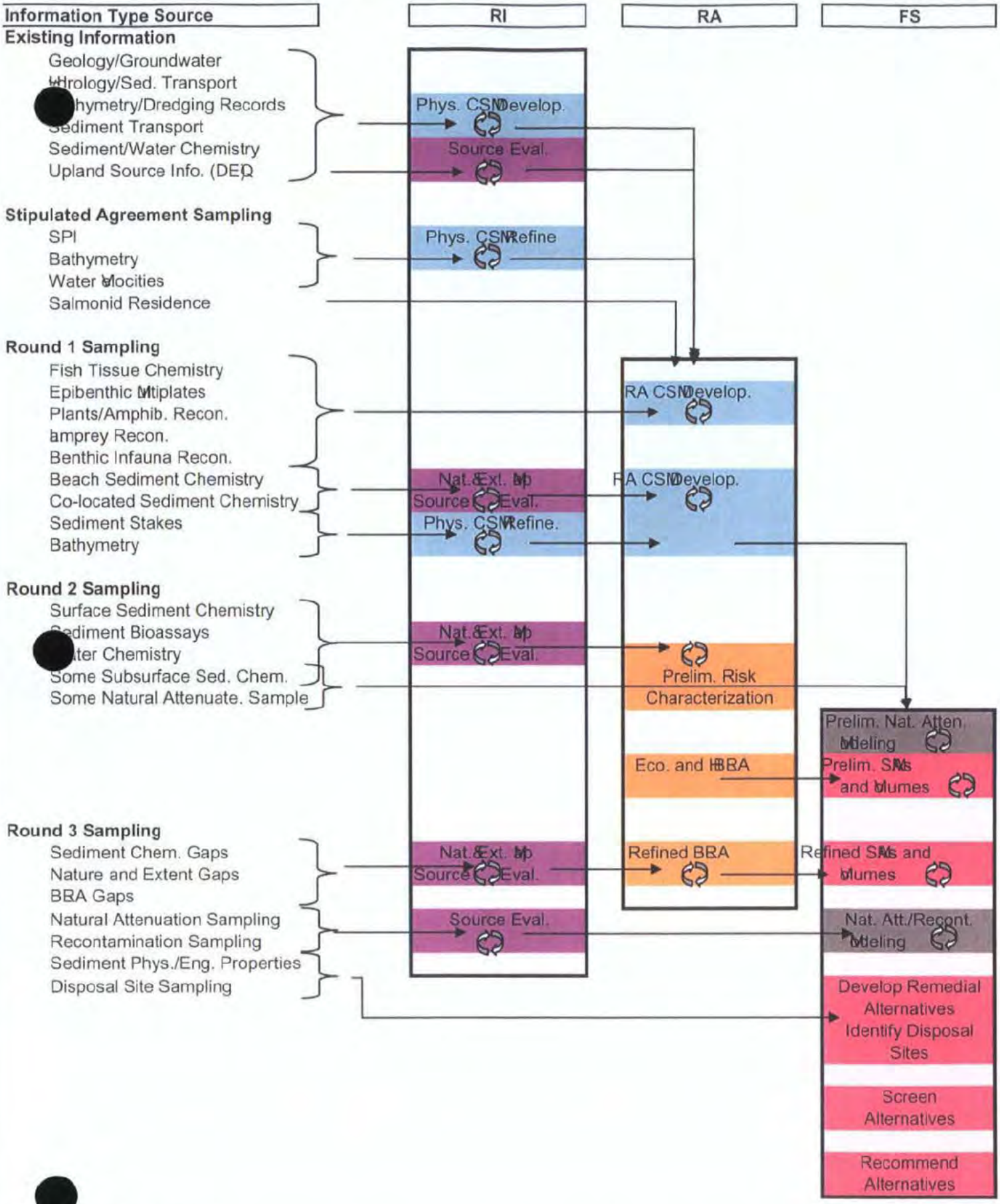


Figure 1. Flow Chart – Feasibility Study Tasks

Figure 2. Data Uses and Evaluations Diagram for RI/RA/FS.



= data evaluation step

Note: Colors denote tasks that rely on feedback and refinement based on all previous tasks of the same color.

ATTACHMENT A1
REMEDIAL ACTION OBJECTIVES
TECHNICAL MEMORANDUM

PORTLAND HARBOR SUPERFUND SITE

Prepared for

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Table of Contents

1 INTRODUCTION 1

2 PRELIMINARY REMEDIAL ACTION OBJECTIVES 2
- 2.1 Overall RAO Approach 2
- 2.2 Relevant Operable Units and Matrices 2
- 2.3 RAO Components 3
  - 2.3.1 Chemicals of Interest 3
  - 2.3.2 Exposure Pathways and Receptors 4
  - 2.3.3 Ranges of Acceptable Chemical Levels 4
- 2.4 Other Considerations 5
- 2.5 Summary of Proposed Preliminary RAOs 6

3 GENERAL RESPONSE ACTIONS (GRA) AND REMEDIAL TECHNOLOGIES 7
- 3.1 No Action 10
- 3.2 Institutional Controls 10
- 3.3 Natural Attenuation 10
- 3.4 In-situ Containment 11
- 3.5 In-situ Treatment 11
- 3.6 Removal and Disposal 11
- 3.7 Removal and Treatment 12

4 DATA GAPS SUMMARY FOR GENERAL RESPONSE ACTIONS 13
- 4.1 No Action 13
- 4.2 Institutional Controls 13
- 4.3 Natural Attenuation 14
- 4.4 In-situ Containment 14
- 4.5 In-situ Treatment 15
- 4.6 Removal and Disposal 15
- 4.7 Removal and Treatment 16

5 POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS 17

6 REFERENCES 27

List of Tables

Table 1. General Response Actions (GRA) and Remedial Technologies. 9

Table 2. Potentially Applicable or Relevant and Appropriate Requirements and To Be Considered Initiatives for the Portland Harbor Superfund Site RI/FS. 18

1 INTRODUCTION

This Preliminary Draft Remedial Action Objectives (RAO) Technical Memorandum proposes preliminary RAOs for the Remedial Investigation and Feasibility Study (RI/FS) currently underway at the Portland Harbor Superfund Site (Site) administered by the U.S. Environmental Protection Agency (EPA). This memorandum has been prepared to fulfill specific requirements of the Administrative Order on Consent (AOC; Docket No. CERCLA – 10-2001-02040) and the attached Statement of Work (SOW) between the members of the Lower Willamette Group (LWG) and EPA. This memorandum is one element in the overall RI/FS for the Site.

Section 4.6.1 of the SOW calls for a technical memorandum regarding RAOs that describes:

- "...a range of broadly defined potential RAOs and associated technologies..."
- "...a range of potential [remedial] alternatives..."
- "...[a summary of] previously identified RI/FS data gaps associated with each potential remedial action..."
- "...potential State and Federal [Applicable or Relevant and Appropriate Requirements] ARARs...[and] 'to be considered initiatives'..."

Each of these elements is described in the following sections (2 through 5) of this memorandum. Consistent with EPA guidance (EPA 1988) the range of potential remedial alternatives is discussed in terms of General Response Actions (GRAs) and Remedial Technology Types in Section 3.

2 PRELIMINARY REMEDIAL ACTION OBJECTIVES

Superfund Guidance (EPA 1988) states that RAOs consist of medium- and/or operable-unit-specific goals for protecting human health and the environment. At the end of the RI/FS process the selected remedial alternative or combination of alternatives should meet or exceed the RAOs.

2.1 Overall RAO Approach

Preliminary (or potential) RAOs are developed early in the RI/FS process prior to any remedial RI work or risk assessments (EPA 1988). Because they are developed early in the process, preliminary RAOs must be relatively broad statements of goals. In some cases, as more information is gathered about the Site during the RI/FS, and particularly the risk assessment, RAOs can be revised or become more specific to the Site. Thus, preliminary RAOs should not be viewed as immutable standards that cannot be changed or updated as the RI/FS proceeds. Conversely, many RI/FS projects have been effectively completed using relatively broad statements of goals all the way through the Final FS process.

The proposed approach for RAOs for the Portland Harbor Superfund Site, is to start with broadly defined preliminary RAOs and refine these RAOs where (and when) necessary to clarify the overall goal for the eventually chosen remedial alternative(s). It is anticipated that the final RAOs will continue to be broadly defined statements of goals for the overall remediation, but that these final statements may be refinements of the preliminary RAOs proposed in this document.

This RAO approach does not preclude the use of numeric guidelines or standards that may be developed to determine the extent and volume of sediments to be remediated. Such numeric guidelines will be developed as Preliminary Remedial Goals (PRGs) as required by Section 7.3.1 of the SOW (not the RAOs). PRGs are anticipated to be developed after the risk assessment task of the RI/FS is completed.

2.2 Relevant Operable Units and Matrices

As stated above, RAOs need to be operable unit and matrix specific. There is only one operable unit for the Site at this time, so all RAOs proposed apply to this operable unit. The relevant matrices are primarily sediment, aquatic organism tissues (e.g., fish tissue), and river water.

As stated in the AOC, RI/FS work for upland facilities is not covered by the AOC, which is for the in-water portion of the Site. Thus, upland matrices (e.g., soils, groundwater, and upland storm/surface water) are not the subject of the preliminary RAOs proposed in this document.

River water is included as relevant matrix for the purposes of developing preliminary RAOs. If through the risk assessment process it can be established that this matrix is not relevant to potential risks, then river water may be removed as a matrix of relevance to RAOs.

It is anticipated that source control efforts led by DEQ on a facility-specific basis will include and require RAOs (or equivalents) that protect human health and the environment from chemicals in soils, upland surface/stormwaters, and groundwaters both in the upland and where these matrices enter river water.

2.3 RAO Components

EPA Guidance (EPA 1988) states that RAOs should contain the chemicals of interest, exposure pathways and receptors, and a range of potentially acceptable chemical levels. Each of these RAO components for this RI/FS is described below.

2.3.1 Chemicals of Interest

Preliminary RAOs apply to all chemicals of interest in the RI/FS. The term "chemicals of concern" is sometimes used in reference to RAOs (EPA 1988). However, because these are preliminary RAOs, prior to any RI work, it cannot be confirmed at this time whether any potential chemical is of actual concern. The initial chemicals of interest are detailed in the Draft Analytical Concentration Goals for Target Analytes in Sediments, Tissues, and Water Samples Report to EPA (Windward and Kennedy/Jenks 2002) and include metals, polycyclic aromatic hydrocarbons, pesticides, PCBs, butyltins, and dioxin/furans as well as several miscellaneous semi-volatile and volatile organic compounds.

2.3.2 Exposure Pathways and Receptors

Preliminary RAOs apply to all complete and significant evaluated exposure pathways and receptors potentially at risk from the chemicals of interest (as defined in main Work Plan). The Ecological and Human Health Risk Assessment Work Plans (Appendices to main Work Plan) describe the preliminarily identified complete and significant evaluated exposure pathways and receptors for both Site ecology and human health in detail. In summary, the RAOs apply to the following receptors and exposure pathways:

- Plants (water and sediment contact)
- Invertebrates (water contact, water ingestion, biota ingestion, sediment ingestion, and sediment contact)
- Fish (water ingestion, water contact, biota ingestion, and for some species, sediment ingestion and sediment contact)
- Amphibians/Reptiles (biota ingestion)
- Birds (biota ingestion, and for some species, sediment ingestion)
- Mammals (biota ingestion)
- Human occupational (sediment ingestion and sediment dermal contact)
- Human transient residential (sediment ingestion and sediment dermal contact)
- Human recreational beach users (sediment ingestion and sediment dermal contact)
- Recreational fishers (fish ingestion)
- Native American consumption fishers (fish ingestion)
- Non-tribal consumption fishers (fish ingestion)

It should be noted that several representative species are selected for fish and bird receptors in the Ecological Risk Assessment Work Plan where species- or guild-specific exposure pathways are also described. As a result, some exposure pathways detailed above may apply to only one or some of the representative species assessed. Similarly, not all exposure pathways apply to all types of human river users discussed in the Human Health Risk Assessment Work Plan.

2.3.3 Ranges of Acceptable Chemical Levels

In EPA guidance (EPA 1988) this component of the RAO is defined as a PRG. As described above in the overall approach, we do not anticipate developing specific PRGs

(i.e., numeric guidelines or standards) until after the risk assessment is complete. At that time, PRG development will follow Section 7.3.1 of the SOW.

PRGs are also sometimes used to identify preliminary analytical concentration goals for sampling and analysis purposes. However, for this RI/FS preliminary analytical concentration goals were developed using preliminary risk-based estimates for each matrix of interest. These methods and the resulting analytical goals are described in Windward and Kennedy/Jenks (2002).

Regardless of the eventual content of specific PRGs later in the process, preliminary RAOs should make reference to acceptable chemical levels. For this document, acceptable chemical levels are defined as those levels that do not cause unacceptable adverse risks to either the ecological or human health receptors identified above. For human health receptors this includes both cancer and non-cancer risks. For ecological receptors this includes those measurement endpoints defined in the Ecological Risk Assessment Work Plan.

2.4 Other Considerations

RAOs must be developed within the context of the physical site conditions and regulatory environment of Superfund so that they are logical for the site-specific situation being addressed. The RAOs must be developed consistent with Natural Resource Damage Assessment (NRDA) issues. The Lower Willamette Group hopes that the Superfund process will take place in conjunction with the NRDA process. A cooperative NRDA process will help determine the extent of restoration needed to restore services adversely affected by chemicals. RAOs must allow for the integration of Superfund remediation and NRDA primary or site-specific restoration wherever possible because this will likely be the most cost effective means of addressing both Superfund and NRDA requirements. Note that the purpose of the RI/FS is not to investigate or determine restoration needs, but it should be recognized that such needs will be identified through other processes, and should be integrated into the FS where possible.

2.5 Summary of Proposed Preliminary RAOs

Based on the discussion of each component above, the Preliminary RAOs for the RI/FS are summarized below. It is important to note the following specific definitions of terms used in the preliminary RAOs:

Reduce Risks – Lessening the unacceptable risks from chemicals by lowering their concentrations, mobility, bioavailability, toxicity and/or exposure to receptors. The assessment endpoints used to define unacceptable risks are presented in detail in the Ecological and Human Health Work Plans. In summary, the ecological risk assessment endpoints are the survival, growth, and reproduction of relevant ecological receptors. For human health, the endpoints are carcinogenic and non-carcinogenic effects to people. Use of the word "reduce" is not intended to imply that the risk reduction must occur through a decrease in chemical concentration in the matrix of interest, although this is one potential method to obtain such reductions.

Acceptable Levels – Risks posed by chemicals that are below unacceptable adverse risk or harm to either the ecological or human health receptors identified above using the assessment endpoints defined in the Ecological and Human Health Work Plans (Appendices C and D, respectively). These risk levels will be eventually quantified through the Baseline Risk Assessment.

The proposed Preliminary RAOs are:

1. Reduce human health risks from direct contact with and incidental ingestion of chemicals of concern (COCs) in sediments in the Site to acceptable (or background) levels.
2. Reduce COC concentrations in sediments in the Site to levels that will result in acceptable (or background) risks to humans that eat fish and shellfish from the Site.
3. Reduce human health risks from direct contact with and incidental ingestion of COCs in water in the Site to acceptable (or background) levels.
4. Reduce ecological risks from contact with and ingestion of COCs in sediments or prey in the Site to acceptable (or background) levels.
5. Reduce ecological risks from contact with and ingestion of COCs in water in the Site to acceptable (or background) levels.

These preliminary RAOs all follow the specific requirements of RAOs in EPA guidance (EPA 1988). It should be noted that the use of the term "background" specifically follows EPA guidance (2002) on this subject. The intent is that RAOs will not result in remedial action (or cleanup) levels that are below background levels, including anthropogenically caused background levels. This is consistent with EPA guidance (2002) on consideration of background in risk management. Site-specific background levels will be identified in a future technical memorandum.

3 GENERAL RESPONSE ACTIONS (GRA) AND REMEDIAL TECHNOLOGIES

Per EPA guidance (EPA 1988), GRAs have been developed for each RAO. GRAs describe those general actions that will satisfy the RAOs. GRAs have not been developed for RAOs addressing the river water matrix only because it is unclear at this time what the potential sources of risks associated with river water may be. Such risks may extend from point discharges of specific contaminants to generalized watershed contamination coming into the site from upstream. Consistent with the SOW, for specific point sources of water risk along the ISA, it is expected that GRAs will be developed and implemented through programs regulated by DEQ (e.g., the voluntary cleanup program). Through the Portland Harbor site the risk assessment and nature and extent investigations a better understanding of potential water related risks and sources causing those risks will be obtained. This information will be compared to DEQ and other regulatory efforts to determine where these water related risks are not expected to be remediated by those other efforts. For these cases, specific GRAs addressing water related risks will be developed at that time.

Per Section 4.6.1 of the SOW, the range of potential GRAs for the Site includes, where appropriate, alternatives such as treatment, containment, removal, and non-action. Within these GRAs, more specific remedial technologies can also be identified (EPA 1988). Remedial technologies applicable to disposal of sediments, for example, might be aquatic confined disposal, nearshore confined disposal, and upland confined disposal. The identification of GRAs and remedial technologies provides a menu of items from which potentially effective remediation alternatives (or combinations of alternatives) may be selected. It should be noted that GRAs and remedial technologies that are eventually found to be most appropriate may vary over portions of the Site depending on the local physical conditions, habitats, and water

dependent uses. Thus, different GRAs and remedial technologies may be used on different portions of the Site.

GRAs are matrix specific and are established for each RAO, except as noted above. Table 1 presents potentially appropriate GRAs and remedial technologies for each RAO. The GRAs in Table 1 are generally defined in the following subsections. It is important to note that all GRAs assume that upland sources have been sufficiently controlled by the time that in-river remediation commences. In addition, the GRAs focus on the sediment matrix more than the

Table 1. General Response Actions (GRA) and Remedial Technologies.

Matrix	Remedial Action Objective	General Response Actions (GRAs)	Remedial Technology Types
Sediment	1. Reduce human health risks from direct contact with and incidental ingestion of chemicals of concern (COCs) in sediments in the Site to acceptable (or background) levels.	No action	
		Institutional controls	Fencing Warning signs Deed site use restrictions Statutory site use restrictions
		Natural attenuation (with monitoring)	Unenhanced Enhanced (adding clean material) Enhanced with active mixing
		In-situ containment	Natural material capping Capping with geotextiles Inverted cap Shoreline berms/dams or fill
		In-situ treatment	Chemical Biological Stabilization/solidification Electrokinetic Thermal
		Removal and disposal	Unconfined aquatic disposal Confined aquatic disposal Nearshore confined aquatic disposal Unconfined upland disposal New upland confined disposal Existing upland confined disposal
		Removal and treatment	Physical Chemical Biological Stabilization/solidification Electrokinetic Thermal
Fish Tissue	2. Reduce COC concentrations in sediments in the Site to levels that will result in acceptable (or background) risks to humans that eat fish and shellfish from the Site.	All other GRAs same as 1.	All other technologies same as 1.
Sediment	4. Reduce ecological risks from contact with and ingestion of COCs in sediments or prey in the Site to acceptable (or background) levels.	Same GRAs as 1 except institutional controls not applicable.	Same technologies as 1 except institutional controls not applicable.

1. General Response Actions for Remedial Action Objectives relevant to river water are not shown at this time. See text for details.

tissue matrix. However, in some cases (particularly for institutional controls) specific activities may focus almost exclusively on the tissue matrix.

3.1 No Action

Essentially, this GRA is leaving the Site alone. This GRA is generally included as an alternative to compare against other alternatives. It would likely only be considered when other GRAs appear to have outstanding potential impacts on human health or the environment. It might also be appropriate if the risk assessment indicated only very minimal or no risks for the existing conditions at the Site.

3.2 Institutional Controls

Institutional controls are activities that do not involve active remediation of sediments. In most cases, these are activities, documents, or legal restrictions that minimize, limit, or prevent exposures to chemicals. Institutional controls can include physical Site activities such as installation of warning signs, fencing, guards, or types of monitoring. They can also include purely legal documents and methods of public communication such as deed restrictions, new regulations, and fishing advisories. In the case of a fishing advisory, institutional controls may be used as a "temporary" remedy until it can be determined that remedial actions targeting sediment have been effective at decreasing tissue chemical concentrations.

3.3 Natural Attenuation

Natural attenuation is when natural processes are allowed to decrease the concentration, mobility, bioavailability, toxicity, and/or exposure of chemicals. Generally, it is allowed to occur over a given time frame and is expected to achieve specified goals within that time frame. Natural attenuation always includes a monitoring component to confirm that decreases in concentrations or exposures are actually taking place as predicted. For this reason, this GRA is often called "monitored natural attenuation".

Natural attenuation processes can generally include one or more of the following over time: dilution, dispersion/transport, burial, adsorption and degradation. Natural attenuation can sometimes be enhanced through human action that is intended to augment natural processes. For example, burial might be enhanced through placement of an initial layer of clean material over sediments.

3.4 In-situ Containment

In-situ containment is where contaminated sediments are not dredged or moved from their present location. Barriers are placed around the sediment to prevent the exposure and mobility of those sediment chemicals from their existing location. The most common aquatic in-situ containment is capping in-place. However, where chemicals posing risks exist along shoreline areas, this could also include placement of isolation berms or dams to prevent exposure to the rest of the river and/or creation of new upland or new aquatic shoreline areas.

3.5 In-situ Treatment

In-situ treatment can include a number of methods that alter sediments in their existing environment to reduce their concentration, mobility, bioavailability, and/or toxicity. Generally, some agent is added to the sediment such as energy (e.g., electricity or heat), chemicals (e.g., binding agents, catalyzing agents, nutrients that speed degradation), or microorganisms (e.g., bacteria or fungus that degrade organic compounds).[1] In some cases, the treatment may involve physical mixing or other manipulation of the sediments, in other cases (particularly thermal and electrokinetic methods) the sediments are not manipulated. Some forms of in-situ treatment require isolation (via berms or dams) of the area to be treated to prevent loss of chemicals or other agents to surrounding areas. In other cases, such as electrokinetic methods, physical isolation of the area to be treated is not necessary.

3.6 Removal and Disposal

Removal and disposal includes physically dredging contaminated sediments from their existing location and disposing of the sediments in a new location that minimizes the mobility, exposure, or impacts to human health and the environment. Disposal sites can be in-water (aquatic), along shorelines (nearshore), or in upland areas. They can be unconfined (e.g., land application), partially confined, or completely confined from the surrounding environment by relatively impermeable barriers and caps. In addition, disposal sites can be new sites specifically created for the project, sites created and shared by other cooperating entities that also need to dispose of materials, or existing facilities that accept contaminated

[1] The addition of clean sediment in-situ with no other form of treatment is usually referred to as "enhanced natural attenuation" and this technique is addressed in Section 3.3.

materials (e.g., privately or publicly owned landfills). Upland sites must comply with the requirements for the appropriate disposal of hazardous waste and should not violate any local land ban restrictions.

3.7 Removal and Treatment

This GRA is a combination of the treatment and removal actions described in Sections 3.5 and 3.6, respectively. Instead of treating sediments at their existing locations, they are dredged and taken to a location where they can be treated. Usually this is in an upland area that is temporarily used for treatment purposes. There is a vast array of different treatment types, but as with in-situ treatment, they all reduce the concentration, mobility, bioavailability, and/or toxicity of the chemicals present in the sediments. Depending on the physical and chemical characteristics of the sediment after the treatment process, sediments might have a variety of end uses or disposal sites. In some cases, sediments might be left where they are treated and used as, for example, fill for an upland development. In other cases, the material might be taken to another location for disposal including the options listed for disposal in Section 3.6. In still other cases, treated sediments can be sold or given away because they have some commercial value.

4 DATA GAPS SUMMARY FOR GENERAL RESPONSE ACTIONS

Data gaps are identified in detail in the Work Plan. For all GRAs the following general information will need to be available before they can be evaluated:

- RI information particularly related to the spatial extent, depths, volumes, and concentrations of chemicals in sediments and tissue.
- RI information related to a working understanding of the river physical system including bathymetry, shoreline topography, hydrodynamics, and sediment transport.
- RI information related to the physical nature of any contaminated sediments (grain size, water content, specific gravity, organic carbon content, etc.)
- Baseline risk assessment results defining exposure pathways, areas of risk, and receptors at risk as well as acceptable levels of chemicals in surface sediments, subsurface sediments, and tissues.

The data gaps relevant to each of the GRAs are summarized below. In many cases, the exact data required to evaluate a GRA is dependent on the specific technology and process options that are potentially being considered. Consequently, at this early stage it is impossible to completely identify in great detail all the data gaps that potentially exist. Rather, the discussion below is intended to provide context for the types of sampling, analysis, and other data collection that will be necessary to evaluate each GRA in general terms.

4.1 No Action

To understand whether no action is a viable GRA, the baseline (or existing) risks for the Site must be fully understood. This can be compared to the risks potentially present from other GRAs (evaluated through the data described below) to determine whether no action is a desirable GRA.

4.2 Institutional Controls

Evaluation of institutional controls as a GRA will require the same information as the No Action GRA and the general information described in Section 4.

4.3 Natural Attenuation

Natural attenuation data gaps are described in detail in the Draft Natural Attenuation Data Gaps Technical Memorandum in Appendix A, Attachment A4 of the Programmatic Work Plan. This section summarizes that document.

Natural attenuation in sediments is primarily governed by burial, transport, and degradation of chemicals. The potential for natural attenuation in various areas of the river will be evaluated through the following three-step process:

Step 1 Identify areas that have basic physical processes that may be important for natural attenuation based on general information about the river system.

Step 2 Conduct select sampling and simple probabilistic modeling for areas with potential processes supporting natural attenuation and eliminate from further evaluations any areas that have a low probability of natural attenuation.

Step 3 Conduct detailed sampling and modeling of remaining areas that have process that support natural attenuation to determine viability and rate of natural attenuation.

Existing information on sediment grain size, sediment transport analysis (Hill and McLaren 2001), bathymetry, and surface sediment chemistry will be sufficient to conduct Step 1. Additional data in select areas will be needed for Step 2 including: surface sediment chemistry, water content, specific gravity, and organic carbon; hydrodynamic modeling of sediment transport; sedimentation rates; chemical concentrations of incoming suspended sediments; and possibly sediment mixed layer depth. For Step 3, additional data for specific potential natural attenuation areas will be needed including those items described for Step 2, additional grain size data, and the mixing rate of surface sediments. In addition, existing time-series surface sediment chemistry data will be evaluated for evidence of ongoing natural attenuation.

4.4 In-situ Containment

Evaluation of the in-situ containment GRA will require the same general information as natural attenuation particularly as it relates to major scour accretion areas and frequencies, incoming sediment concentration, and benthic current velocities. In addition, the following information will be needed:

- Existing sediment physical characteristics (e.g., Atterberg limits, water content, specific gravity, grain size, and organic carbon content)
- Existing sediment geotechnical characteristics of areas to be contained (e.g., shear strength, consolidation potential)
- Cap material chemistry, grain size, organic carbon, water content, specific gravity
- Possibly cap material geotechnical characteristics
- Possibly groundwater chemistry and flow information (groundwater monitoring and/or modeling)

The testing requirements and potential sources of cap material are discussed in more detail in the Capping Material Memorandum.

4.5 In-situ Treatment

The data requirements for in-situ treatment are highly dependent on the treatment method under consideration. An initial evaluation of the viability of treatment as a GRA will be made in the Determination of Candidate Treatment Technologies and the Need For Testing Technical Memorandum (Section 8.1 of the SOW). Based on the candidate technologies developed, this memorandum will detail testing requirements to fully evaluate them, including treatability studies as necessary. In general, the physical and chemical characteristics of the contaminated sediment must be understood in sufficient detail to determine whether a candidate technology might be feasible. The RI sampling described above should be sufficient for development of the technical memorandum.

4.6 Removal and Disposal

The data needed to evaluate the dredge and disposal GRA are dependent on the type of technology being evaluated. The information that could be needed in addition to the expected RI/RA data discussed above includes:

- Bioassays (for open water disposal options)
- Subsurface sediment chemistry and physical characteristics
- Groundwater chemistry and flow information (modeling and/or monitoring)
- Nearshore and/or aquatic habitat surveys
- Toxicity Characteristic Leaching Procedure (TCLP) testing
- Disposal site soil chemistry and physical characteristics (e.g., water content).

4.7 Removal and Treatment

The data needs for dredge and treatment options would include both the needs described in Sections 4.5 and 4.6.

5 POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

As discussed in Section 1, the SOW requires that this document present ARARs and "To Be Considered" (TBC) initiatives that will be used to help determine the content and extent of the remediation consistent with the RAOs described above. Compliance with ARARs is a "Threshold Criterion" under CERCLA Guidance (EPA 1988), which means the preferred remedial alternative must meet ARARs wherever possible. However, compliance with ARARs is not the only criterion determining the preferred remedial alternatives. Rather, the nine evaluation criteria (including compliance with ARARs) set forth in CERCLA Guidance (EPA 1988) determine the preferred remedial alternatives. Further, it is important to note that CERCLA guidance allows for waivers from complying with ARARs under some specific circumstances (EPA 1988) including technical impracticability. TBC initiatives can be included in the ARAR-based evaluation of alternatives, but these initiatives do not necessarily have to be met by the preferred remedial alternative.

An extensive review of State and Federal regulations was conducted to determine those ARARs and TBCs that may be applicable to this Site. Table 2 presents the potential ARARs and TBCs that will be considered during evaluation and determination of potential remedial alternatives that meet the RAOs defined in this document. Comments pertaining to application or use of specific ARARs and TBCs for this Site are also contained in Table 2.

It should be noted that as more information is developed and alternatives are considered, additional ARARs may be identified and/or certain ARARs in Table 2 may be deleted.

Table 2. Proposed Applicable or Relevant and Appropriate Requirements and To Be Considered Initiatives for the Portland Harbor Superfund Site RI/FS.

Potential ARAR	TBC	ARARs	Citation	Summary	Comment
		FEDERAL ARARS			
		CLEAN WATER ACT	33 U.S.C. §§1251 et. seq.		
√		Federal Water Quality Criteria	CWA §§303 and 304	Pursuant to CERCLA §121(d)(B)(i), otherwise non-enforceable water quality criteria, developed by EPA for surface water, are ARARs. Two kinds of water quality criteria have been developed: one for protection of human health, and another for protection of aquatic life. Includes establishment of TMDLS.	This requirement is potentially relevant to the determination of risks but should not over-ride any site-specific toxicity values or risks determined through the risk assessment process. It is also relevant to the identification of potential sources and the short-term and long-term effectiveness of remedial alternatives.
√		Discharge of dredge and fill material	33 U.S.C. §404 including 40 CFR Part 230, Section 404(b)(1)	Regulates discharge of dredged and fill material into waters of the United States.	This requirement is potentially relevant to dredging, capping, enhanced natural attenuation, and construction of in-water or nearshore disposal facilities. It includes compliance with substantive requirements, if any, of RWA § 401.
√		Criteria and standards for imposing technology-based treatment requirements under Sections 309(b) and 402 of the Act	40 CFR Part 125 Subpart A	Standards of control for direct discharges must meet technology-based requirements. Best conventional pollution control technology (BCT) is applicable to conventional pollutants. Best available technology economically achievable (BAT) applies to toxic and non-conventional pollutants.	For CERCLA sites, BCT/BAT requirements are determined on a case-by-case basis using best professional judgment. This is likely to be a potential requirement only if treated water or excess dredge water is discharged to the Willamette during remediation.
√			40 CFR Part 125 Subpart K	Best management practices (BMPs) must be observed when undertaking industrial activities that may result in significant amounts of pollutants reaching surface waters.	BMPs are applicable to control the release of hazardous pollutants into surface waters during the cleanup. This requirement is potentially relevant to in-water remediation activities as well as upland activities that may discharge water or treated water to the Willamette.
√		Statement of Procedures on Floodplain Management and Wetlands Protection	40 CFR Part 6 App. A and Executive Orders 11988 and 11990,	Requires federal agencies to conduct their activities to avoid, if possible, adverse impacts associated with the destruction or modification of wetlands and occupation or modification of floodplains. Executive Orders 11988 and 11990 require federal projects to avoid adverse effects and minimize potential harm to wetlands and within flood plains.	This requirement is potentially relevant to disposal or treatment activities in the upland as well as any in-water facilities that might displace floodwaters.

Table 2. Proposed Applicable or Relevant and Appropriate Requirements and To Be Considered Initiatives for the Portland Harbor Superfund Site RI/FS.

Potential ARAR	TBC	ARARs	Citation	Summary	Comment
√		Discharge of pollutants to waters	Section 401 of Clean Water Act	Applies to any discharge of a pollutant from a point source and would require that such discharge comply with state water quality standards.	
		RIVERS AND HARBORS ACT OF 1899	33 U.S.C. §§401 et. seq.		
√		Obstruction of navigable waters generally; wharves; piers, etc.; excavation and filling-in	33 U.S.C. §403 including Section 10	Controls the alteration of navigable waters (i.e. waters subject to ebb and flow of the tide shoreward to the mean high water mark). Activities controlled include construction of structures such as piers, berms, and installation of pilings. Section 10 may be applicable for any action that may obstruct or alter a navigable waterway.	No permit is required for on-site activities. However, substantive requirements that might limit in-water construction activities, including capping activities, related to remediation would be potentially "relevant and appropriate."
		CLEAN AIR ACT	42 U.S.C. §§7401 et. seq.		
√		**ENDANGERED SPECIES ACT**	16 U.S.C. §§ 1531 et. seq.	Federal agencies must ensure that actions they authorize, fund, or carry out are not likely to adversely modify or destroy critical habitat of endangered or threatened species. Actions authorized, funded or carried out by federal agencies may not jeopardize the continued existence of endangered or threatened species as well as adversely modify or destroy their critical habitats.	This requirement is potentially relevant to determination of clean up areas/volumes, preliminary remediation goals, and determination of remedial alternatives. Pursuant to CERCLA 121(e) and EPA's policy separate consultation with USFWS and NMFS, obtaining permits not required. Consultation would occur through EPA. Although no independent consultation and biological assessment with the services may be required of the Respondents, the Respondents likely will need to prepare a BA for EPA to consult with the services and for the impacts of the selected remedy to be assessed after completion of the RI/FS.
√		**MARINE MAMMAL PROTECTION ACT**	16 U.S.C. §§ 1361 et. seq.	EPA must ensure that its actions do not involve the unauthorized taking of marine mammals.	This requirement is potentially relevant to development of remedial alternatives and short-term impacts of remediation.
√			50 CFR 216	Regulations restricting the taking, possession, transportation, selling, offering for sale and importing of marine mammals.	This requirement is potentially relevant to development of remedial alternatives and short-term impacts of remediation.

Table 2. Proposed Applicable or Relevant and Appropriate Requirements and To Be Considered Initiatives for the Portland Harbor Superfund Site RI/FS.

Potential ARAR	TBC	ARARs	Citation	Summary	Comment
		HAZARDOUS MATERIALS TRANSPORTATION ACT	49 U.S.C. Ap. §§1801 et. seq.		
√		U.S. Department of Transportation – Subchapter C – Hazardous Materials Regulations	40 CFR Parts 171-177	Regulations provide for packaging, documentation, and transport of hazardous waste.	This requirement is potentially relevant to hazardous wastes shipped off-site for disposal or remediation. This would not be relevant to onsite cleanup.
√		Toxicity Characteristic Leaching Protocol (TCLP)	40 CFR 261.24	The TCLP test for contaminant leaching triggers handling and disposal requirements if contaminated sediment or soils are disposed in a land-based disposal site.	
√		**NATIONAL HISTORIC PRESERVATION ACT**	16 U.S.C. §§ 470 et. seq.	This statute requires EPA to consider effects of remedial actions on historic properties.	This requirement is potentially relevant to some invasive investigation activities and remediation activities. The administrative requirements, such as the Cultural Resources Plan, are not ARARs.
√		**ARCHEOLOGICAL AND HISTORICAL PRESERVATION ACT**	16 U.S.C. §4699-1	In the event that significant scientific, prehistoric, or archeological data is present on a site, EPA must approve the remedial activities so that such data is preserved.	This requirement is potentially relevant to some invasive investigation activities and remediation activities.
√		**MIGRATORY BIRD TREATY ACT**	16 U.S.C. §§703-712 and 50 CFR §10.12	Makes it unlawful to take, import, export, possess, buy, sell purchase, or barter any migratory bird. "Take" is defined as pursuing, hunting, shooting, poisoning, wounding, killing, capturing, trapping and collecting.	This requirement is potentially relevant to remediation activities.
		RCRA	42 USC §6901 et. seq.		
√		HAZARDOUS WASTE MANAGEMENT	40 CFR Parts 264 & 268 (adopted by reference in OAR §340-100-0002(1))	RCRA is intended to protect human health and the environment from the hazards posed by waste disposal and management as well as reduce the production of wastes. Portions of RCRA concerning hazardous wastes are most relevant to this Site. Oregon's program for hazardous waste management is authorized under RCRA. Most of the requirements that are potential ARARs are federal rules that have been adopted by reference under Oregon's regulation.	This requirement is potentially relevant where sediments contained RCRA listed or characteristic hazardous waste ("waste"). Further, RCRA requirements are applicable only if waste was treated, stored, or disposed after effective date of RCRA requirement under consideration or if CERCLA activity constitutes treatment, storage, or disposal as defined by RCRA. Regulations on obtaining permits or complying with administrative requirements are not ARARs for cleanup work performed onsite.

Table 2. Proposed Applicable or Relevant and Appropriate Requirements and To Be Considered Initiatives for the Portland Harbor Superfund Site RI/FS.

Potential ARAR	TBC	ARARs	Citation	Summary	Comment
√		Closure and Post-Closure	40 CFR §§264.111 and 117	Closure and post-closure performance standards and care requirements, *e.g.*, prevent run-on and run-off from damaging cover; maintenance and monitoring of waste containment systems.	This requirement is potentially relevant to a remediation involving permanent land disposal and closure. It is not applicable if waste is treated in-situ or consolidated within area of contamination (see also CAMU rule below).
√		Groundwater Monitoring	40 CFR §264.97	General requirements for groundwater monitoring.	This requirement is potentially relevant if waste is treated, stored, or disposed in a new landfill built for remediation purposes.
√		Land Disposal Restrictions	40 CFR Part 268	Requirements for treatment of waste prior to land disposal. Restrictions only apply to waste placed after effective prohibition date.	This requirement is potentially relevant if waste is placed in a landfill built for remediation. Placement does not occur when waste is consolidated within an area, capped or place, or treated in-situ (see also CAMU rule below).
√		Waste Piles	40 CFR Part 264, Subpart L	Requirements if waste is stored in waste piles.	This requirement is potentially relevant if waste is stored and/or dewatered onsite in a waste pile.
√		Surface Impoundments	40 CFR Part 264, Subpart K	Requirements if waste placed in surface impoundment.	This requirement is potentially relevant if waste is stored and/or dewatered onsite in a surface impoundment (*e.g.*, in a pond or lagoon).
√		Incinerators	40 CFR Part 264, Subpart O	Requirements for incineration of waste.	This requirement is potentially relevant if waste is treated onsite in an incinerator.
√		Landfills	40 CFR Part 264, Subpart N	Requirements for construction of uplands disposal facility, *e.g.*, liners, cover, and leachate collection system.	This requirement is potentially relevant if waste is placed in a new, replacement, or expanded landfill.
√		Corrective Action Management Unit (CAMU)	40 CFR §§264.550 - 264.555	The regulation provides flexibility for managing CAMU-eligible wastes when implementing a cleanup. A CAMU is an area within a site that is used only for managing CAMU-eligible waste for implementing a remedial action. Placement of CAMU-eligible wastes into or within a CAMU does not constitute land disposal. CAMU establishes minimum design requirements for landfill construction, treatment standards for waste disposed in a CAMU, cap requirements, and storage and/or treatment requirements within a CAMU, *i.e.*, where the CAMU is not used for disposal.	This requirement is potentially relevant to waste management activities that are performed within a CAMU.

Table 2. Proposed Applicable or Relevant and Appropriate Requirements and To Be Considered Initiatives for the Portland Harbor Superfund Site RI/FS.

Potential ARAR	TBC	ARARs	Citation	Summary	Comment
√		Prohibition on land disposal	OAR §340-104-0339	DEQ may prohibit land disposal of hazardous waste if there are more environmentally sound beneficial use, reuse, recycle, reclamation, treatment or disposal options.	This requirement is potentially relevant to remediation or disposal that takes place in upland areas.
√		SOLID WASTE MANAGEMENT	40 CFR Part 258 (adopted by reference in OAR §340-094-0010)	Requirements for construction for municipal solid waste landfills, including MSWLF units that receive RCRA Subtitle D wastes, including industrial solid waste. Requirements for run-on/run-off control systems, groundwater monitoring systems, surface water requirements, etc.	This requirement is potentially relevant if a landfill is constructed for the disposal of non-hazardous "solid waste."
√		Solid Waste Disposal Facilities	40 CFR 257, Subpart A	Deals with solid waste disposal facilities and practices that pose a reasonable probability of adverse effects on health of the environment under RCRA.	
√		FEMA (Federal Emergency Management Act)		Avoid alterations to river or floodplains that may increase potential for flooding.	This requirement is potentially relevant to remedial activities in upland flood plains and in the Willamette.
√		Flood Insurance Act	42 USC Cap. 50	This program provides federal flood insurance to the City of Portland and requires that the City not allow fill in the river that would cause in increase is the flood rise. This may limit the size and locations of caps in the river.	
		STATE ARARs			
		ENVIRONMENTAL CLEANUP ACT	ORS 465-200 et. seq.		

Table 2. Proposed Applicable or Relevant and Appropriate Requirements and To Be Considered Initiatives for the Portland Harbor Superfund Site RI/FS.

Potential ARAR	TBC	ARARs	Citation	Summary	Comment
√			ORS 465.315	Standards for degree of cleanup required. Establishes acceptable risk levels for protection of human (1 in 1 million excess cancer risk; Hazard Index of 1) and ecological (point before significant adverse impacts to health or viability of a T&E species or point before significant adverse impacts to health or viability of a population of other animals or plants) receptors. Requires risk assessment. Identifies acceptable remedial action methods, including treatment, excavation and off-site disposal, containment or other engineering controls and institutional controls. Site-specific remedial measures selected by balancing effectiveness, implementability, long term reliability, short term implementation risk, and cost reasonableness. Hot spots must be treated (or excavated for off-site disposal) unless treatment is not feasible considering the remedy selection factors (with a higher threshold of cost reasonableness. Allows DEQ to exempt on-site removal or remedial actions from hazardous and solid waste and water and air quality requirements so long as human health and the environment are protected. Allows waiver of state and local permits, licenses and authorizations so long as substantive requirements are met.	This requirement is potentially relevant to investigations, risk assessment, and remediation goals and methods. However, in many cases these regulations overlap and can be inconsistent with EPA guidance and policy on Superfund Cleanup. Generally, EPA guidance and policy will be followed for conduct of investigations, risk assessment, evaluation of remedial alternatives, and determination of remediation goals and methods. Where State regulations are consistent with EPA guidance and policy or extend beyond specific EPA guidance and policy requirements, State regulations are a relevant ARAR.
√		Selection or Approval of the Remedial Action	OAR 340-122-0090	Furnishes criteria for selection or approval of a remedial action including effectiveness, long-term reliability, implementability, risk, and cost.	This requirement is potentially relevant to evaluation and selection of remedial alternatives. See comment immediately above.
√		Standards	OAR 340-122-040	Hazardous substance remedial action levels and requirements.	This requirement is potentially relevant to the evaluation and selection of cleanup levels and remedial alternatives. See the two comments immediately above.
		HAZARDOUS WASTE	ORS 466.005 - 465.225		See RCRA comments above
√		Additional Hazardous Wastes	OAR 340-101-0033	Identifies residues that are subject to regulation as hazardous wastes.	This requirement is potentially relevant to determination of sediments as hazardous wastes.
		AIR QUALITY	ORS Chapter 468A		

Table 2. Proposed Applicable or Relevant and Appropriate Requirements and To Be Considered Initiatives for the Portland Harbor Superfund Site RI/FS.

Potential ARAR	TBC	ARARs	Citation	Summary	Comment
√		Policy and Application	OAR 340-226-0100	Provides general emission standards for fugitive emissions of air contaminants and requires the highest and best practicable treatment of control of such emissions.	This requirement is potentially relevant to remediation activities and could apply to earth moving equipment, dust from vehicle traffic and mobile source exhaust, among other things.
√		**Noise Control**	OAR 340-035-0035	Sets noise standards for equipment, facilities, operations, or activities employed in the production, storage, handling, sale, purchase, exchange, or maintenance of a product, commodity, or service, including the storage or disposal of waste products.	This requirement is potentially relevant to some remedial activities.
√		**Visible Air Contaminant Limitations**	OAR 340-208-0110	Prohibits the emission of any air contaminant from a new source for a period or periods aggregating more than three minutes in any one hour that is equal to or greater than 20% opacity. These are special rules for "special control areas," including Multnomah County.	This requirement is potentially relevant to some remedial activities.
		Fugitive Emission Requirements	OAR 340-208-0200, 0210	Prohibits any handling, transporting or storage of materials, or use of a road, or any equipment to be operated, without taking reasonable precautions to prevent particulate matter from becoming airborne. These are special rules for "special control areas," including Multnomah County.	This requirement is potentially relevant to some remedial activities.
		WATER QUALITY			
√		Statewide Water Quality Plan	OAR 340 Div. 41; OAR 340-041-0442	Designates beneficial uses for water bodies and water quality standards and criteria necessary to protect those uses. In particular, OAR 340-041-0442 provides the beneficial uses that shall be protected in the Willamette Basin. The Tables referenced therein provide for particular water quality criteria and standards.	This requirement is potentially relevant to the determination of risks but should not over-ride any site-specific toxicity values or risks determined through the risk assessment process. It is also relevant to the identification of potential sources and the short-term and long-term effectiveness of remedial alternatives. Where Federal and State water quality criteria differ, the most stringent criteria should be considered.

Table 2. Proposed Applicable or Relevant and Appropriate Requirements and To Be Considered Initiatives for the Portland Harbor Superfund Site RI/FS.

Potential ARAR	TBC	ARARs	Citation	Summary	Comment
√		**THREATENED OR ENDANGERED WILDLIFE SPECIES**	ORS 496.171 - .192	Sets forth procedure and standards for the State Fish and Wildlife Commission to list species as threatened or endangered; authorizes the Commission to enact regulations necessary to ensure survival of listed species, such as protecting habitat; expressly provides that ORS 496.171 to 496.192 do not, by themselves, require an owner of private land to take action protect an endangered or threatened species.	These statutory provisions do not themselves contain any substantive requirements that might constitute ARARs. However, the listed species may be different from those under ESA.
		OTHER CRITERIA, ADVISORIES, GUIDANCE, AND TO BE CONSIDERED INITIATIVES			
	√	**Guidance for Identification of Hot Spots (4/98; Figure 3-1 corrected 7/98)**		Describes procedures for delineating "hot spots" in water and other environmental media.	This TBC may be relevant to the selection of remedial alternatives but only where consistent with overall EPA guidance and policy on Superfund cleanup.
	√	**Guidance for Use of Institutional Controls (4/98)**		Guidance for selection or approval of institutional controls as a part or all of a remedy.	This TBC may be relevant to the selection of remedial alternatives but only where consistent with overall EPA guidance and policy on Superfund cleanup.
	√	**Watershed Management & Enhancement and The Oregon Plan**	ORS Chapter 541	Establishes the Oregon Plan for "integrating regulatory efforts while fostering incentives and voluntary action for environmental stewardship"; creates the Oregon Watershed Enhancement Board and watershed councils and requires those entities to conduct a watershed enhancement program; creates some funds for watershed enhancement.	This TBC may be very generally relevant to remediation.

Table 2. Proposed Applicable or Relevant and Appropriate Requirements and To Be Considered Initiatives for the Portland Harbor Superfund Site RI/FS.

Potential ARAR	TBC	ARARs	Citation	Summary	Comment
	√	**WY-KAN-USH-MI WA-KISH WIT**	www.critfc.org /text/TRP. HTM	The plan's objectives are to halt the decline of salmon, lamprey and sturgeon populations above Bonneville Dam within seven years. To rebuild salmon populations to annual run sizes of four million above Bonneville Dam within 25 years in a manner that supports tribal ceremonial, subsistence and commercial harvests. To increase lamprey and sturgeon to naturally sustaining levels within 25 years in a manner that supports tribal harvests. To achieve these objectives, the plan emphasizes strategies and principles that rely on natural production and healthy river systems. Simply stated, the plan's purpose is to *put fish back in the rivers and protect the watersheds where fish live.* Sets forth the Columbia River Anadromous Fish Plan of the Nez Perce, Umatilla, Warm Springs, and Yakama Tribes; goals: to restore anadromous fishes to the rivers and streams that support historical cultural and economic practices of the tribes, (generally in areas above Bonneville Dam); to emphasize natural production and healthy river system strategies, to protect tribal sovereignty and treaty rights, and to reclaim the anadromous fish resource and the environment on which it depends; geographic scope of the plan extends to Columbia River Basin and Pacific ocean regions where anadromous fish migrate and wherever activities occur that directly affect them.	This Plan is a tribal document, and is not necessarily applicable to other sovereigns. It does not include substantive standards and does not expressly apply to the Willamette Basin. However, it's content can be generally considered in the development and selection of remedial alternatives.

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ATTACHMENT A2
DISPOSAL FACILITY SITING TECHNICAL MEMORANDUM

PORTLAND HARBOR SUPERFUND SITE

Prepared for

Lower Willamette Group

Prepared by

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November 13, 2003

Table of Contents

1 INTRODUCTION 1

2 DISPOSAL SITE TYPES 2

3 GENERAL SITING PROCESS 5

4 STEP 1: DEFINE GEOGRAPHIC LIMITS 9

5 STEP 2: VOLUME ASSUMPTIONS 11

6 STEP 3: PRELIMINARY SCREENING AND DISPOSAL SITE INVENTORY REPORT 12
- 6.1 Criteria That Apply to All Disposal Options 12
  - 6.1.1 Criterion 1: Site Size 12
  - 6.1.2 Criterion 2: Steepness 13
  - 6.1.3 Criterion 3: Threatened or Endangered Species. 13
  - 6.1.4 Criterion 4: Designated Parks, Sanctuaries, and Refuges 14
  - 6.1.5 Criterion 5: Tribal Land 14
  - 6.1.6 Criterion 6: Seismic Risk 14
- 6.2 Criteria That Apply to Upland Disposal 14
  - 6.2.1 Criterion 7: Land Use 14
  - 6.2.2 Criterion 8: Wetlands 15
- 6.3 Criteria That Apply to Nearshore and Aquatic Disposal 15
  - 6.3.1 Criterion 9: Navigation Channels and Water Dependent Use 15
  - 6.3.2 Criterion 10: Sensitive or Critical Aquatic Habitats 15
  - 6.3.3 Criterion 11: Tribal or Recreational Fishing Areas 16
  - 6.3.4 Criterion 12: Surface or Groundwater Discharge Areas 16
  - 6.3.5 Criterion 13: Currents 16
- 6.4 Criteria That Apply to Aquatic Disposal 17
  - 6.4.1 Criterion 14: Mudline Slope 17

7 STEP 4: VOLUME AND OTHER CHARACTERISTICS REFINEMENT 18

8 STEP 5: RESCREEN SITES (OPTIONAL) 19

9 STEP 6: FINAL SITE RANKING 20
- 9.1 Disposal Site Effectiveness 20
- 9.2 Disposal Site Implementability 21
- 9.3 Disposal Site Cost 22
- 9.4 Final Site Ranking 23

10 REFERENCES 25

Figure 1. Draft Disposal Facility Siting Process Flow Chart 7
Figure 2. Draft Flow Chart – Relationship of Facility Siting Process to Feasibility Study 8

List of Acronyms and Terms

AOC	Administrative Order on Consent
ARAR	Applicable or Relevant and Appropriate Requirement
CD	Consent Decree
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DMMS	Dredged Material Management Study
EPA	Environmental Protection Agency, U.S.
FS	Feasibility Study
ISA	Initial Study Area
LWG	Lower Willamette Group
NMFS	National Marine Fisheries Service
NRDA	Natural Resource Damage Assessment
ODFW	Oregon Department of Fish and Wildlife
ONHP	Oregon Natural Heritage Program
RA	Risk Assessment
RI	Remedial Investigation
ROD	Record of Decision
Site	Portland Harbor Superfund Site
SOW	Statement of Work
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
WDFW	Washington State Department of Fish and Wildlife
WDNR	Washington State Department of Natural Resources

1 INTRODUCTION

This Draft Disposal Facility Siting Technical Memorandum proposes a process to identify and obtain contaminated sediment disposal site options for the Portland Harbor Superfund Site (Site) administered by the U.S. Environmental Protection Agency (EPA). This memorandum has been prepared to fulfill specific requirements of the Administrative Order on Consent (AOC; Docket No CERCLA – 10-2001-0240) and accompanying Statement of Work (SOW) between the members of the Lower Willamette Group (LWG) and EPA. It is important to note that this memorandum proposes and describes an appropriate process and methods for disposal facility siting, but does not contain the results of conducting the facility siting evaluation. The facility siting evaluation will be conducted once EPA has reviewed and approved the process and methods proposed in this document.

This memorandum is one element of a larger Remedial Investigation (RI) and Feasibility Study (FS) that was recently initiated for the Site. Dredging and disposal of contaminated sediments is one potential remedial option that will be evaluated in the FS for the Site. The process for locating potentially suitable disposal sites is the focus of this memorandum. Other potential remedial options that may be evaluated in the overall FS, such as capping in place, natural attenuation, and treatment, are not considered in this memorandum.

The overall RI/FS will eventually identify the extent and volume of any contaminated sediments that may need to be dredged. However, the locations and volumes of these sediments have not been identified at this time. Consequently, the process for locating potentially suitable disposal sites is necessarily general at this point and encompasses a wide range of potential scenarios that could eventually result from the RI/FS. This includes the use of single or multiple facilities for sediment disposal and remediation of sediments all at once or in phases.

2 DISPOSAL SITE TYPES

For the purposes of this memorandum, disposal sites are defined as those areas, either in the upland, nearshore, or aquatic environments that might be suitable for the placement of contaminated sediments. Under this definition, the site is considered a designated facility for the permanent disposal of sediments that would be maintained and monitored. Definitions of disposal site types are:

- **Upland Disposal Sites**: Upland disposal sites are facilities above the ordinary high water mark. Use of upland sites can involve hydraulic dredging and pipeline transport to the disposal site. Alternatively, dredging and disposal can be performed by mechanical methods, followed by rehandling of sediments possibly with transport by barge, truck, or rail to the disposal site. Provisions are required for the management of entrained water during the sediment handling and dewatering process. Upland disposal includes alternatives that may involve siting one or more new upland facilities exclusively or partially for disposal of this Site's sediments or use of a pre-existing publicly or privately operated landfill.

  Upland disposal site design features often include bottom and surface liners or impermeable layers and/or a surface cap. The facilities surfaces could be a variety of materials and could allow for a variety of uses on top of facilities after they are constructed (e.g., parks, parking, recreation areas, and commercial development). A water collection and treatment system for controlling leachate over the long term could be required. If the disposal site is a pre-existing landfill, these features may already be in place and managed by the operator of that landfill. Upland solid waste landfills are regulated by DEQ under OAR Chapter 340 Division 95, and where materials are considered hazardous waste, under OAR 340.100-OAR 340.135. Both rules set requirements overseen by DEQ for design, operation and monitoring of such landfills.

- **Nearshore Disposal Site:** Nearshore disposal sites involve dredging and placing sediments in a shoreline location below ordinary high water surrounded by a berm or dike on the water side of the facility. Dredging and placement can be achieved through hydraulic or mechanical (with rehandling) methods. Dewatering is not necessary. Contaminated sediments are placed within the saturated zone. A cap can be placed over the dredged sediments for isolation and to construct an upland area above ordinary high water. Land use on the surface of such facilities could include the same options as

described for upland facilities. Alternatively, the surface of a nearshore facility could be below ordinary high water and could be designed to provide aquatic and nearshore habitat features.

- **Aquatic Disposal Site:** Aquatic disposal involves dredging, transport, and placement of the sediments in an aquatic environment, usually followed by covering with clean cap sediments. In some cases, unconfined (without a cap) aquatic disposal can also be appropriate. Dredging and disposal can take place hydraulically or mechanically. Mechanical disposal can involve rehandling by mechanical dredge or placement by bottom dump barge. In areas of high energy or scour, a cap must be adequately protected with a gravel or rock covering.

  Variations of aquatic disposal include disposal in natural depressions, disposal on a flat or gentle slope, and excavation to create depressions followed by placement of contaminated sediments in the resulting pits. Confinement berms can be constructed at aquatic sites to prevent the dredged material from moving downhill, which allows for construction on somewhat steeper slopes.

In most cases when dealing with "contaminated" sediments, remediation requires some type of confinement (such as a cap) to isolate chemicals in the sediments. Although some type of confinement is generally assumed for the purpose of this memorandum, this assumption should not be inferred to exclude any option from FS evaluation that potentially meets the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) requirements for remediation. This could include reuse of materials either in aquatic or upland environments for development, habitat enhancement, or other purposes. Further, some options might involve placement of sediments after they have been treated to some extent. Treated sediments may not require confinement. Feasibility study evaluations of remedial alternatives that include any type of disposal site will be conducted consistent with CERCLA FS criteria to determine the final suitability of any site/remedial option regardless of whether it involves confined or unconfined disposal alternatives.

Some types of dredging and disposal operations (particularly for upland sites) require sites to rehandle or dewater sediments. In some cases, these activities can take place on a portion of the site that will be the final destination of the sediments (i.e., the disposal site). In other cases,

separate sites are needed for rehandling or dewatering prior to transport of the sediments to the disposal site. The process described in this memorandum does not explicitly evaluate rehandling or dewatering sites. However, the initial disposal site inventory will yield a list of sites that will be potentially suitable for those purposes. Consequently, as remedial alternatives are developed in the FS process, the disposal site inventory results will be used to identify potentially suitable rehandling and/or dewatering sites.

3 GENERAL SITING PROCESS

The factors that must be considered when siting disposal facilities generally fall into the following categories:

- Technical/Regulatory – facilities must be of sufficient size, constructible, stable, accessible, consistent with Applicable or Relevant and Appropriate Requirements (ARARs), and available for use
- Environmental – facilities must be able to adequately minimize contaminants from entering the surrounding environments (human and ecological) and not cause unacceptable impacts to the pre-existing habitat at or near the site
- Economical – the facilities' construction costs must be relatively consistent with other equally effective options
- Community – there must be community and political acceptance to the location, appearance, and ancillary uses of facilities.

More specific factors could be mentioned, but most of these fall into one or more of the above general categories. A disposal facility siting evaluation must sift through a substantial number of possible sites based on the above general criteria in an efficient manner. Consequently, our general approach uses an iterative screening process to efficiently winnow down the number of realistic possibilities.

With these general considerations in mind, this memorandum defines the following steps for identifying potential disposal sites:

1. Define the geographic limits of the study area to be considered for facility siting.
2. Make necessarily simple assumptions about the volume of sediments to be disposed.
3. Evaluate the study area for sites of appropriate size (given Step 2 volume assumptions) and use preliminary screening criteria to create a preliminary inventory of sites.
4. Determine the specific volume, and the chemical, physical, and geotechnical characteristics of the sediments to be disposed (information from the FS process).
5. Optional step that rescreens sites from Step 3 to create a refined site list, based on the information from Step 4 and any additional useful criteria that become evident from the information gathered in Step 4. (If Step 4 information is insufficient to further refine the site list we will skip this step and go directly to Step 6.)

6. Conduct a brief evaluation of each site on the refined list using CERCLA-based criteria to arrive at a final ranked list of potential sites.

These steps (and how they fit into the overall RI/FS process) are shown in Figures 1 and 2. Although this memorandum is primarily concerned with disposal facility siting evaluation **methods**, some preliminary results regarding Steps 1 and 2 are presented below. For the remaining steps, only methods are discussed (as opposed to conducting the evaluation and presenting results).

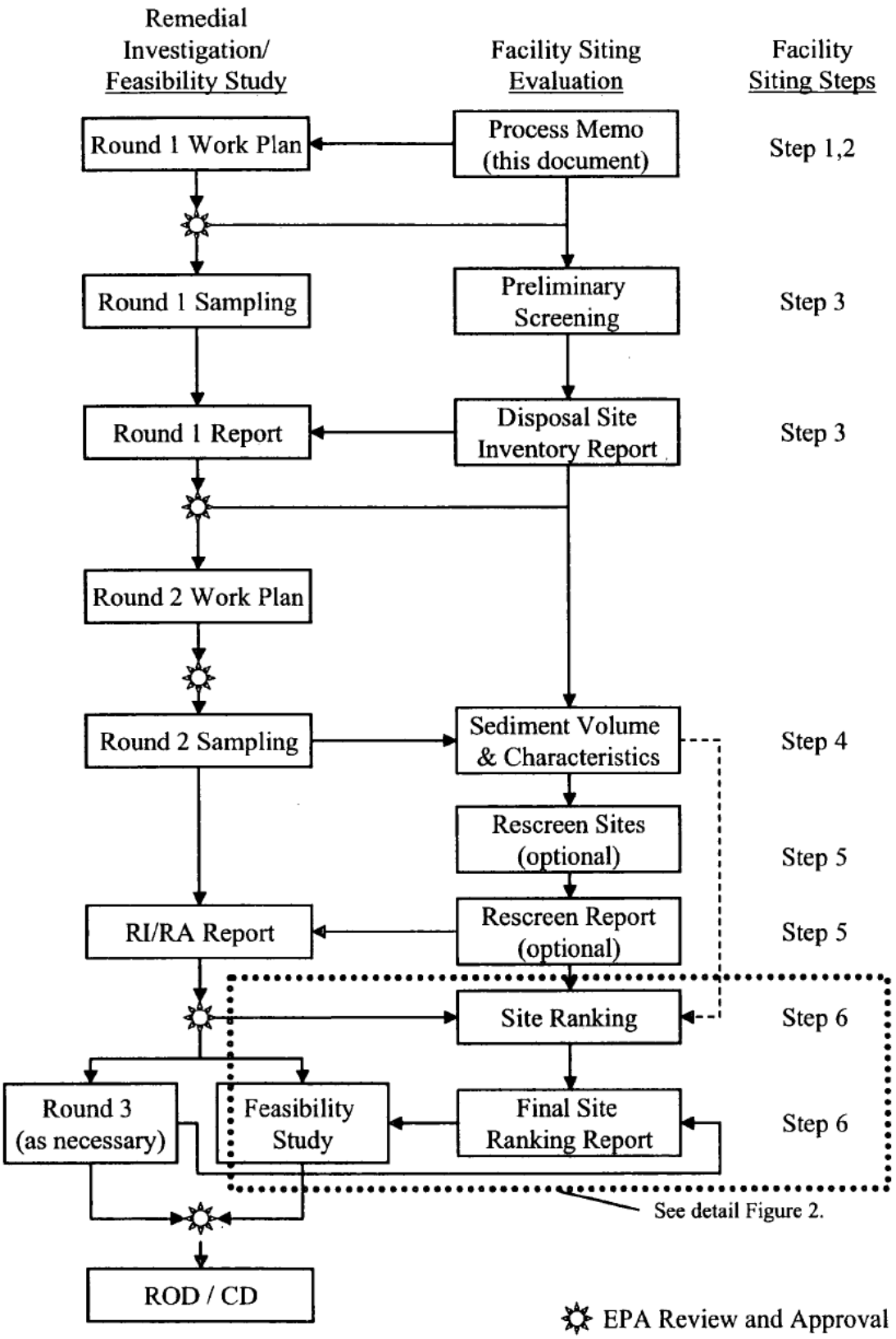

Figure 1. Disposal Facility Siting Process Flow Chart

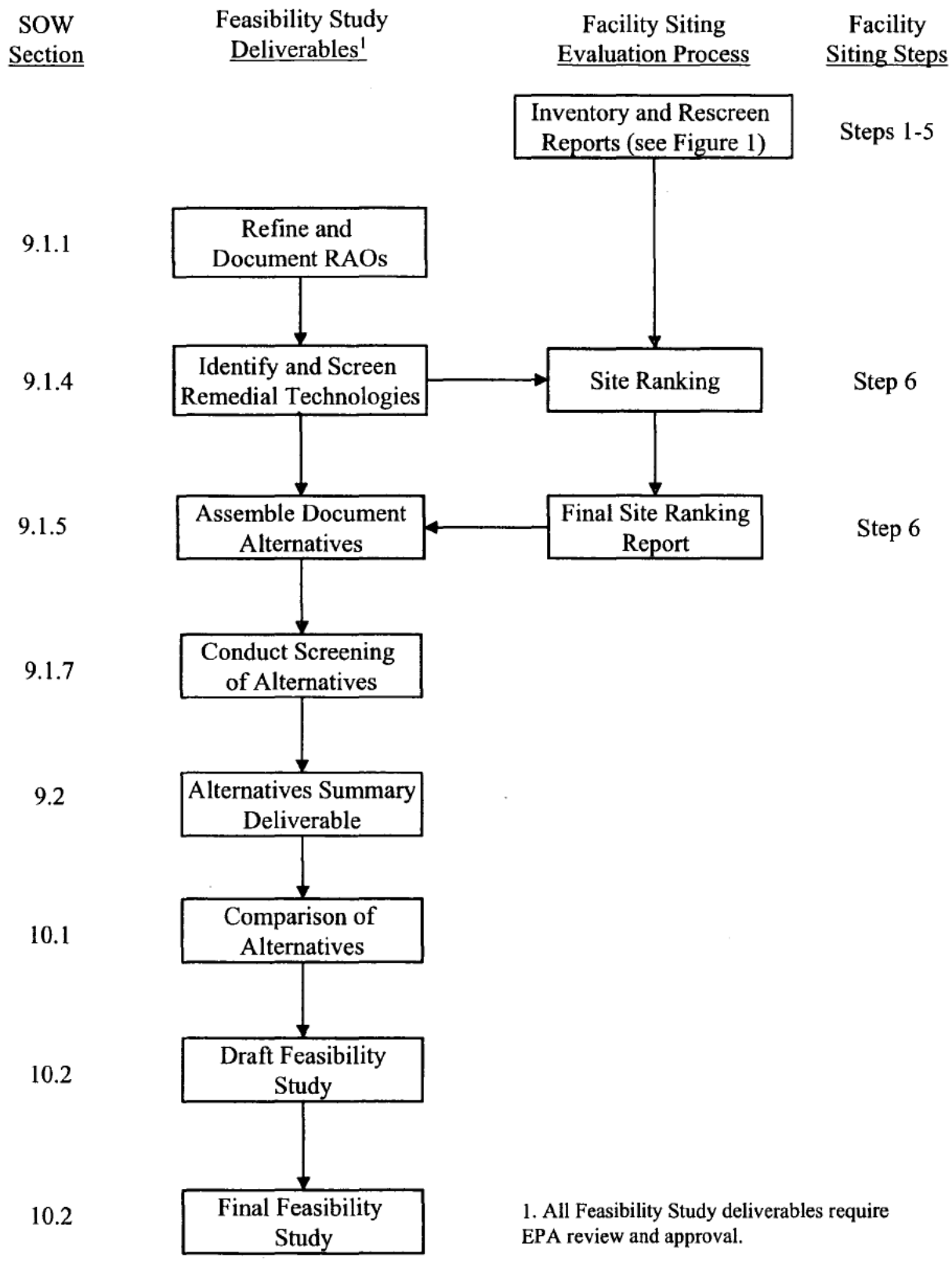

Figure 2. Flow Chart – Relationship of Facility Siting Process to Feasibility Study

4 STEP 1: DEFINE GEOGRAPHIC LIMITS

The Disposal Facility Siting Evaluation must be conducted within a defined geographic context and limitations. This provides a way to quickly eliminate sites that are too distant to be economically feasible under any circumstances. However, the geographic limits must not be so restrictive as to preclude options that are relatively cheap in terms of final disposal costs, and therefore, could be cost competitive even given relatively high transport costs.

Because two of the three disposal options are water dependent, the geographic limitations can be initially defined based on distances up and downstream from the site. The upstream limit for large-scale navigation on the Willamette River is the Willamette Falls at Oregon City, about 20 miles from the Initial Study Area (ISA). A reasonable upstream limit in the Columbia River is the Bonneville Dam (Columbia River mile 145) about 44 miles from the Site.

There is no obvious downstream limit for this study on the Columbia River. In their 1996 Dredge Material Management Study, the Port of Portland limited their evaluation downstream to Sauvie Island (about 15 miles from the Site), upstream to the Bonneville Dam (Multnomah County line) on the Columbia River, and upstream to the Sellwood Bridge on the Willamette River (just above Ross Island). A downstream limit similar to the Port of Portland study also appears reasonable for this facility siting process. The Port study upstream limit for the Willamette River also appears reasonable because the river becomes relatively channelized above this point with mostly steep slopes on both sides of the river, creating few prospects for upland, nearshore, or aquatic disposal sites.

Based on these general considerations, the following geographic limitations for an in water disposal site appear reasonable:

- Upstream on the Willamette River to just above Ross Island
- Upstream on the Columbia River to Bonneville Dam
- Downstream on the Columbia River to at least Sandy Island (about 24 miles from the Site).

There are potentially many more sites further downstream on the Columbia River (USACE 1998). It is important to note that, if viable prospects in this area become known during the course of the facility siting process, this downstream limit may be further expanded.

Upland disposal options can be broken down into two categories: (1) new sites that are built and maintained for the project, and (2) pre-existing publicly or privately owned and operated sites. Consequently, two geographic limits are proposed for upland sites:

- New upland sites will be limited to those areas within 10 miles of the river's edge within the geographic area defined for aquatic sites
- Pre-existing sites will be limited to those landfills within Oregon and Southern Washington State currently operating and accepting fill material.

Confining the search for new upland sites to the river corridors is reasonable because it is expected that water transport would be one of the most economical methods for transport of sediments to an upland site. Further, upland sites along the river will have a viable location for discharge of large amounts of water. Rail is another potentially viable transport option that is preserved with these criteria because all of the major rail lines also follow these river corridors.

All of these geographic limits are somewhat arbitrary and based on professional judgment given the information available at this time. They provide a reasonable context in which to start a search. However, as more detailed information is obtained, it may be reasonable to expand or reduce these boundaries. One method that can be used to set geographic limits is based on the relationship between cost and distance for various transport methods. We have not developed site-specific transport costs at this time. However, such cost information will be developed in the course of the FS, and this may be one type of information that will be used to further refine the geographic limits of the study area.

In addition to the specific search area provided by the above geographic limits, information on other potential sites outside these limits may become available through other means (i.e., word of mouth, regional documents, etc.). These sites will be considered (at least initially) regardless of their location relative to the above geographic boundaries. Distance and transport method (both relating to cost) will be the primary initial considerations use to determine whether these sites should be included in the disposal site inventory.

5 STEP 2: VOLUME ASSUMPTIONS

Because the FS has not yet been conducted, some general assumptions must be made about the volume of sediments that might require disposal for the purposes of Step 3 of the Disposal Facility Siting Evaluation. This information can be used to eliminate any sites that are clearly too small for further consideration.

The following basic factors affect the potential volume of sediments to be dredged and the resulting size of the disposal facility needed:

- The risk-based values or other approaches used to define "contaminated" sediments
- The areal extent of sediment contamination
- Depths of sediment contamination
- Amount of sediments remediated via dredging and disposal versus in-situ or treatment methods
- Depth of fill in the disposal facility
- Number of disposal facilities used (either at one time or in phases).

Based on these factors, a reasonable size range for a single disposal facility that would handle all of the project sediments is from approximately 30 to 200 acres. It is preferable to use a minimum estimate rather than a larger estimate, because this avoids prematurely screening out smaller sites. Also, it is possible that more than one site could be used. Consequently, a **minimum site size criterion of 5 acres** appears reasonable.

6 STEP 3: PRELIMINARY SCREENING AND DISPOSAL SITE INVENTORY REPORT

The preliminary site screening criteria were developed with the objective of eliminating early in the process areas that are technically, environmentally, economically, or otherwise unacceptable for further consideration. Generally, these criteria are expressed in exclusionary terms. That is, if a site does not meet the criteria it will be "excluded" from further consideration. However, some criteria will likely require more case-by-case judgments. In these cases, a site failing to meet the criterion will be "avoided" under most circumstances but may be included where the site has other potentially desirable characteristics. This determination will be made in conjunction with EPA and partners to ensure that potentially desirable sites (as judged by other parties and stakeholders) are not unnecessarily excluded from later more detailed evaluations.

The preliminary screening process is a simple one. We will examine aerial photos and topographic, bathymetric, geologic, soils, land/water use, and property maps. Based on this information, we will compare all sites within the geographic limits set in Step 2 against the criteria discussed below. Some criteria will require reference to additional sources of information, and these sources are discussed below for each criterion. The screening process will result in an inventory of potentially acceptable sites that pass all of the exclusionary criteria. There will be no relative ranking of these sites with the exception that any sites that do not pass one or more avoidance criteria will be categorized as secondary opportunities. The preliminary screening results will be presented in a Disposal Site Inventory Report after Round 1 Sampling has been conducted (Figure 1).

Proposed screening criteria are described in the following subsections segregated by disposal option type.

6.1 Criteria That Apply to All Disposal Options

The following criteria apply to upland, nearshore, and aquatic disposal sites.

6.1.1 Criterion 1: Site Size

As described in Step 2, the sites smaller than 5 acres in size will be excluded from further consideration.

6.1.2 Criterion 2: Steepness

The site cannot be overly steep. The exact determination of unacceptably steep sites will be made on a case-by-case basis and will differ for upland versus aquatic sites. However, sites with slopes 10 to 20 percent (10 horizontal to 1 vertical [10H:1V] to 5H:1V) are generally considered marginal (avoided) and slopes greater than 20 percent are generally considered unacceptable (excluded). This criteria will be applied with consideration of special situations where surrounding bathymetry and topography may allow facility designs on steeper slopes (e.g., in a slip where a berm could be built across the existing mouth of the slip).

6.1.3 Criterion 3: Threatened or Endangered Species.

The presence of threatened or endangered species within or near a potential sediment disposal site has often been identified as a "fatal flaw" to site acceptability (Ecology 1990). Within this study area, almost all in-water disposal options can be considered to be generally within areas used by threatened or endangered fish species. However, no program in Oregon or Washington has ruled out disposal of sediments in water on this basis alone.

As existing information allows, in-water areas that have been identified as containing habitat of unique and/or outstanding value for threatened and endangered fish species will be excluded from further evaluation. Identification of these habitats will be primarily based on information provided and maintained by the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), Oregon Natural Heritage Program (ONHP), Oregon State Department of Fish and Wildlife (ODFW), Washington State Department of Fish and Wildlife (WDFW), and Washington State Department of Natural Resources (WDNR).

Similarly, if existing information identifies terrestrial/shoreline critical habitats and breeding areas for upland threatened or endangered species at or adjacent to a site, that site will be excluded from further consideration. The same sources of information as above will be used in this assessment.

6.1.4 Criterion 4: Designated Parks, Sanctuaries, and Refuges

Potential sediment disposal sites in existing public parks, sanctuaries, preserves, or refuges will be excluded from further consideration.

6.1.5 Criterion 5: Tribal Land

Tribal territories and reservations will generally be avoided as disposal sites. However, if any specific tribe desires a particular site be considered on their land, these areas will be included where consistent with other screening criteria.

6.1.6 Criterion 6: Seismic Risk

Oregon State is a seismically active region. Damage can result from ground liquefaction or differential settlement during seismic events. Areas susceptible to violent shaking as defined by Oregon Department of Geology and Mineral Industries (2000) will be avoided. Although the artificial fill along shorelines can be susceptible to seismic shaking, past experience at similar sites in Puget Sound (e.g., Elliott and Commencement Bays) indicates that this condition can often be relatively easily mitigated through appropriate design. Accordingly, the presence of uncompacted fill or other materials susceptible to sliding (as identified by US Department of Agriculture [USDA] soils maps) will not necessarily constitute an unacceptable site condition but will be avoided.

6.2 Criteria That Apply to Upland Disposal

6.2.1 Criterion 7: Land Use

Upland areas that are currently occupied by buildings, residences, or other structures, or that are used for parking areas, container yards, stockpile areas, or similar activities will be excluded from further consideration. This criterion will be evaluated through examination of aerial photos. This process may eliminate some potential sites where owners may be willing to consider selling land or otherwise converting from existing uses. However, this criterion provides a viable method to discriminate over a large area between sites with current economically viable uses and those that are generally vacant. If through other means it is determined that currently developed sites might be converted to a disposal site (after negotiation with owners, as appropriate), these areas would be included where consistent with other screening criteria.

6.2.2 Criterion 8: Wetlands

Wetlands, as currently identified in City, County, State, and Federal inventories and including streams, ponds, and lakes will be excluded from further consideration. Some sites may contain small or hydrologically isolated wetlands, and historically, in some cases such sites can be filled under a Nationwide permit. However, there have been considerable changes (including several court decisions) recently to both Clean Water Act related regulations and USACE polices regarding when small or isolated wetlands can be filled using Nationwide permits. Consequently, we are not proposing specific definitions of small or isolated wetlands at this time. When the disposal site inventory is conducted, the prevailing determinations and policies at that time will be used to define wetlands that might reasonably be filled consistent with applicable wetland regulations. Thus, some sites with limited wetlands may be included in further evaluations.

6.3 Criteria That Apply to Nearshore and Aquatic Disposal

6.3.1 Criterion 9: Navigation Channels and Water Dependent Use

Federally authorized navigation channels will be avoided as possible nearshore and aquatic fill disposal sites. However, berthing areas located immediately adjacent to navigation channels can be preferred disposal locations, and thus are not excluded by this criterion. Sites that otherwise might reduce commerce or water dependent access (that is not a part of a specific berthing area that may be filled) will be avoided as disposal sites.

6.3.2 Criterion 10: Sensitive or Critical Aquatic Habitats

Sensitive or critical aquatic habitats (for example highly productive fish spawning areas or juvenile feeding and rearing areas) will be excluded as possible nearshore or aquatic disposal sites. Using the above example, critical fish habitats would have an abundance of attributes that juvenile fish need to feed or adult fish need to spawn. This evaluation will be made using sensitive or critical habitat inventories of USFWS, NMFS, ODFW, as well as city and county databases.

6.3.3 Criterion 11: Tribal or Recreational Fishing Areas

Primary fishing areas currently used by tribes will be excluded as possible nearshore fill or aquatic disposal sites. Primary recreational fishing sites will be avoided. This information will be obtained from ODFW.

6.3.4 Criterion 12: Surface or Groundwater Discharge Areas

The presence of surface water inflows along the shoreline can affect the ability to design an effective nearshore disposal site that ensures long-term physical and chemical containment of sediment contaminants. Accordingly, primary surface water discharge areas will be avoided for nearshore sites.

Zones of preferential groundwater discharge or seeps can affect the ability to design effective nearshore and/or aquatic disposal sites. Accordingly, preferential groundwater discharge areas will be avoided for nearshore and aquatic sites.

This is not an exclusionary criterion because in many cases facilities can be designed to effectively deal with these discharges. However, these discharges can substantially complicate facility design.

6.3.5 Criterion 13: Currents

Strong currents capable of achieving bottom velocities above approximately 50 cm/sec (the rough threshold for incipient motion of sand-sized materials often considered for capping materials) can affect the long-term stability of nearshore or aquatic disposal sites. However, most of the areas to be considered are likely to periodically achieve these water velocities during high flow events. Further, nearshore and aquatic disposal facilities can be constructed and effectively armored against such currents. Consequently, this is an avoidance criterion only. In general, areas that show evidence of high or repeated shoreline erosion or river bottom areas that are chiefly rock or hard scoured substrate will be avoided.

6.4 Criteria That Apply to Aquatic Disposal

6.4.1 Criterion 14: Mudline Slope

Existing mudline slopes of greater than 6 percent (16H:1V) are typically avoided for confined aquatic disposal sites to ensure site stability both during and after construction (Ecology 1990). However, through the use of berms or other retaining devices, aquatic disposal can be achieved on significantly steeper slopes. Mudline slopes exceeding 10 (10H:1V) percent will be excluded from further consideration.

7 STEP 4: VOLUME AND OTHER CHARACTERISTICS REFINEMENT

The first three steps in the facility siting process will yield a preliminary list of potential disposal sites presented in the Disposal Site Inventory Report. Information gathered during the course of the RI/FS process on sediments to be remediated will be useful in ruling out some disposal sites on the Disposal Site Inventory. The most important piece of information will likely be the volume of sediments requiring disposal. However, information on other characteristics that could also be useful include:

- **Grain Size and Organic Carbon Content**: If the majority of sediments to be dredged are particularly fine or colloidal in nature, this could greatly impact handling and disposal requirements. Grain size is relevant to Criteria 1, 2, 6, 12, 13, and 14
- **Geotechnical Strengths**: Geotechnical strengths affect many aspects of disposal including compaction and slumping, and are relevant to Criteria 1, 2, 6, 12, 13, and 14
- **Natural Water Content**. The natural water content of the sediments affects the extent of leachate and dewatering control and treatment needed. Water content is relevant to Criteria 1, 6, and 12
- **Chemical Concentrations**: The contaminant concentrations in the dredged material may affect determination of acceptable dredge methods, leachate quality, dewater quality, and entrained water disposal treatment and disposal requirements. Chemical concentrations are relevant to Criteria 1 and 12.

Some Step 4 information will be available after Round 1 sampling (particularly grain size, water content and chemical concentrations). Additional Step 4 information will be available after Round 2 sampling (particularly geotechnical data) including additional information on areas most likely to be remediated. This information will not be separately presented or reported for the Facility Siting Process but will be used in Step 5 or/and Step 6 described below.

8 STEP 5: RESCREEN SITES (OPTIONAL)

Based on the information obtained in Step 4, the Disposal Site Inventory may be rescreened against the same criteria shown in Step 3. Volume is expected to be the primary factor resulting in refinement of the Disposal Site Inventory. However, in some cases the sampling information may not provide a clear means to further eliminate sites on the inventory and/or too few sites may be on the inventory to make Step 5 useful. In these cases, we will proceed directly to Step 6 following the general schedule shown in Figure 1.

If Step 5 is conducted, additional information gathered in the two rounds of sampling will be evaluated to determine whether there are any other important characteristics of the Lower Willamette River or the contaminated sediments that could be used to differentiate between potential sites. For example, it is expected that the two sampling rounds will provide considerable insight on the physical dynamics of the river, which may be very helpful in siting nearshore and aquatic sites in particular.

This step is left purposely flexible. That is, we will not try to define any new refining criteria in detail here. This is because it appears that the types and extent of useful information obtained out of the two rounds of sampling is not entirely predictable at this point.

Any new criteria and the rescreening results (if conducted) will be presented in a Rescreening Report, which will be submitted at the same time or prior to the RI/Risk Assessment (RA) Report (Figure 1). The Rescreening Report will be a separate document from the RI/RA Report.

9 STEP 6: FINAL SITE RANKING

In Step 6, additional information will be gathered on each site in the Disposal Site Inventory (or the Rescreened List if Step 5 is conducted) sufficient to briefly evaluate them against CERCLA-based criteria: effectiveness (including ecological impacts), implementability, and cost. Although these criteria are typically applied to remedial options, the same issues are relevant to selecting the most appropriate sites for disposal. This process has been used successfully at other aquatic Superfund sites including the Hylebos Waterway in Tacoma, Washington (Hartman et al. 1997).

Use of the CERCLA-based criteria should not be confused with the overall project FS evaluations, which will be conducted for the full range of remedial options (not just disposal options). The overall project FS will use the sites obtained through Step 6 of the Disposal Facility Siting Evaluation (and other information) to evaluate disposal remedial options in comparison to other remedial options (such as capping, natural attenuation, treatment, etc.).

The specific criteria that will be used for Step 6 are discussed below. These criteria will be evaluated using existing information gathered for each site on the refined list. It is not anticipated that additional sampling or survey work will be conducted for each site (e.g., site-specific groundwater sampling, topographic surveys, habitat surveys, chemical sampling, etc.). However, the project FS may determine the need for such sampling or surveys in order to fully evaluate disposal as a remedial option at a particular site, and such work would be conducted at that time (most likely Round 3 sampling). Specific sources of existing information that may be useful are discussed for each criterion.

9.1 Disposal Site Effectiveness

For the purposes of the facility siting process, effectiveness potentially afforded by a particular site on the refined list includes evaluation of the following issues:

- Long-term protection of human health and the environment
  - Contaminant mobility after construction (e.g., migration, diffusion, and dispersion)
  - Leachate quality (with or without treatment)
  - Erosion and/or physical loss
  - Exposure pathways from proposed site uses

- Short-term protection of human health and the environment (during construction)
  - Contaminant loss during dredging, transport, rehandling, and disposal
  - Dewater discharge quality (with or without treatment)
  - Worker exposures necessary to construct the site

- Potential ecological impacts of using the site
  - Existing ecological functions, abundance, diversity
  - Proposed ecological functions, abundance, diversity
  - Temporary ecological impacts.

- Potential ecological enhancements of using the site
  - Existing ecological functions, abundance, diversity
  - Proposed ecological functions, abundance, diversity

The characteristics of each site on the refined list will be evaluated relative to these issues. Typical evaluations might include:

- Are there any characteristics of the site like groundwater flow rates or water currents that make it difficult to isolate contaminants from the environment?
- Will handling and transport required to place sediments at the site present potential short-term impacts or loss of contaminants to the environment?
- Are there ecological functions at the site that will be improved, reduced, or eliminated by use of the site?

Existing information will be obtained through regulatory agency files, City and County files on the site, site owner files, and interviews with site owners or adjacent owners. This may include gathering of information on the site in question or adjacent sites.

9.2 Disposal Site Implementability

For the purposes of the facility siting process, the implementability of a particular site on the refined list will include evaluation of the following issues:

- Transport and handling logistics
- Access issues

- Placement logistics such as dewatering, water treatment
- Locations and requirements of capping and/or liner materials
- Geotechnical constraints, slope, depths of water
- Long term operation and monitoring requirements
- Ability to meet the Applicable or Relevant and Appropriate Requirements (ARARs)
- Local zoning and regional land use plans
- Existing and planned site uses
- Owner acceptance (and/or willingness to sell land)
- Adjacent property uses
- Management and administrative structure during disposal
- Political and community acceptance
- Cultural resource constraints
- Distance from dredging area
- Storage capacity
- Availability of necessary equipment and skilled workers.

Many of the issues related to engineering the facility (e.g., transport, access, distance) will be readily apparent from the location and physical characteristics of the site. ARAR and land use information will be obtained from State, City, and County files and regulations as well as interviews with landowners and adjacent landowners. Future site uses and owner acceptance may only be identifiable through detailed negotiations with landowners. Availability of equipment and workers will be determined through interviews with potential local contractors.

9.3 Disposal Site Cost

Many of the issues related to implementability also directly effect costs. A planning level (order-of-magnitude) cost estimate will be prepared based on the theoretical use of each site. For the purposes of this facility siting process, cost for a particular site on the refined list will include evaluation of the following issues:

- Design and bid costs
- Site acquisition costs
- Dredging costs (considers removal method that is suitable for disposal site)
- Transport costs (e.g., barge, rail, truck, distances, etc.)
- Handling/rehandling costs (e.g., stockpiling)

- Disposal costs (e.g., placement)
- Tipping or other fees
- Dewatering costs (with or without treatment)
- Ancillary feature costs (dikes, berms, caps, liners, armoring, fencing, vegetation, habitat features, leachate collection systems, water treatment, hydraulic gradient controls, etc.)
- Site operation and maintenance costs
- Short- and long-term monitoring costs
- Mitigation costs, to the extent this can be determined
- Cost sharing availability, to the extent this can be determined (e.g., owner development opportunities)
- Natural Resource Damage Assessment (NRDA) restoration credit value
- Value of any habitat, endangered species, or other enhancements created.

Most of this cost information will be available for the purposes of planning level cost estimates through information from contractors, disposal site owners/operators, and standard engineering costing guidance. Mitigation costs, cost sharing, and NRDA restoration credit value may be difficult to assess at this stage in the project. Reasonable estimates will be made given agency policies and informal discussions with agency representatives.

9.4 Final Site Ranking

Unlike the preliminary screening and rescreening steps, the final list of sites will be ranked relative to their expected performance against the criteria. Each site will be given a score from 0 to 5 for each of the three major criteria: effectiveness, implementability, and cost. These scores will be added on an equal weighting basis to yield overall scores from 0 to 15. Highest scoring sites will be considered first in the project FS. In addition, the process of gathering information and evaluating against the criteria may reveal fatal flaws with the site (e.g., an owner indicates complete unwillingness to negotiate site use). In these cases, the site will be removed from the refined list and not included in the final ranking.

As shown in Figure 2, the final site ranking will be conducted concurrently with FS Report development. Information from Round 3 FS sampling and FS evaluations will be used in

the final site ranking. The final site ranking will be presented in a report, which will be part of the Assemble and Document Alternatives Technical Memorandum (Section 9.1.5 of the SOW) (Figure 2).

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ATTACHMENT A3
CAPPING MATERIAL EVALUATION
TECHNICAL MEMORANDUM

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November 13, 2003

Table of Contents

1 INTRODUCTION 1

2 SOURCES OF CAPPING MATERIALS 3
2.1 Dredged Material Sources 3
2.1.1 General Sources of Dredged Materials 3
2.1.2 Specific Locations and Quantities of Potential Dredged Materials 4
2.2 Upland Quarries or Commercial Sources 6

3 CAP MATERIAL TESTING REQUIREMENTS 8

4 CONCLUSION 9

5 REFERENCES 10

1 INTRODUCTION

This Technical Memorandum is prepared to fulfill the requirements of Subtask 2e: Preliminary FS Planning Tasks, Section 4.6.3 Capping Evaluation, of the Statement of Work (SOW) attachment to the Administrative Order on Consent (Order) for the Portland Harbor Superfund Site (United States Environmental Protection Agency (EPA) Docket Number CERCLA-10-2001-0240). The Order requires the members of the Lower Willamette Group to prepare a Remedial Investigation/Feasibility Study (RI/FS) for the Portland Harbor Superfund Site (Site) in Portland, Oregon.

Although no specific remedies have been selected for the Site, the SOW requires that a range of alternatives be investigated including dredging with confined disposal, capping, monitored natural attenuation, treatment, and no action. The purpose of this Technical Memorandum is to identify potential sources of capping material that could be used either in capping alternatives or confined aquatic disposal alternatives. The testing requirements needed to determine the suitability of potential capping material for use at this Site are also discussed.

Capping involves the placement of clean material over contaminated material. Capping can be performed over in-situ contaminated materials or over dredged material that is placed in an aquatic disposal facility. For the purposes of this Memorandum, "clean" is defined as material that is determined to be suitable for open water disposal (when compared to the Dredged Material Management Program [DMMP] Screening Level criteria put forth in the Lower Columbia Dredged Material Management Framework; USACE et al. 1998a) and that meets Portland Harbor risk-based goals defined in the RI/FS.

A cap serves three primary functions (Palermo et al. 1998a):

- Physical isolation of the contaminated dredged material from the benthic environment
- Stabilization of contaminated material, preventing resuspension and transport to other sites
- Reduction of the flux of dissolved contaminants into the cap and overlying water column.

The contaminated sediment characteristics, cap material characteristics, and the physical environment of the capping site (e.g., water depth, bathymetry, potential for erosion,

geotechnical conditions, and waterway uses) need to be taken into account when designing a cap. Additionally, the extent of the area to be capped and the design requirements addressing isolation, bioturbation, erosion, consolidation, and operation components of the cap need to be identified so the quantities and characteristics (e.g., grain size, percent fines, and total organic carbon content) of the cap materials can be determined. At some locations, a simple layer of granular material can effectively perform all three cap functions. In other cases, more complex cap designs may be required. Capping materials such as geotextiles and plastic liners may be able to perform one or more of the basic cap functions. These materials may also be used in conjunction with granular materials for constructability or stabilization purposes (Palermo et al., 1998a).

Because no specific capping sites have been identified (and therefore no site specific information for the aforementioned parameters exist) this Technical Memorandum identifies a range of potential sources of capping materials as well as the characteristics and approximate quantities of those source materials. The unit costs for cap materials are not addressed in this memorandum due to the large degree of uncertainty regarding the volumes of materials needed and the fact that implementation is at least several years away. Geotextiles, liners, and other non-naturally occurring materials are not addressed here, because they are generally available through construction materials vendors.

2 SOURCES OF CAPPING MATERIALS

As stated above, the selection of capping sediments for remediation purposes is a function of the level and type of contamination of the in-situ sediments as well as the physical environment of the site to be capped. Previous in-situ capping projects have used sediment or soil materials, either dredged from nearby waters or obtained from upland sources, including commercial quarries. For the Lower Willamette River, sediments could also be obtained from the Columbia River. In general, it is more cost-effective to use nearby sediments that will be removed for some other reason such as required maintenance dredging. If no nearby dredging projects are taking place during cap construction, clean sediments located near the capping site could be dredged and used. Otherwise, materials from an upland source may be required.

Studies have proven that fine-grained and sandy sediments can be effective capping materials. However, the physical characteristics of the capping sediment should be compatible with the contaminated sediment, considering the dredging and placement techniques used for both (Palermo et al. 2000). High energy environments (e.g., locations with high currents or subjected to propeller wash) may require a layer of coarse-grained material to prevent erosion of the cap.

2.1 Dredged Material Sources

The general types of dredge material sources that could be used for capping material are discussed below. This is followed by a more detailed discussion of specific locations and quantities of material likely produced from potential future dredge projects based on historical precedents and information.

2.1.1 General Sources of Dredged Materials

Over 99 percent of the volume of sediment dredged annually in the Lower Columbia River Management Area (LCRMA) and adjacent channel reaches has been found to be suitable for placement at ocean and flow-lane disposal sites or beach nourishment sites (USACE et al. 1998a). This clean material could be beneficially used as capping material rather than disposing of it in the ocean or in a dispersive site. The Port of Portland (Port), US Army Corps of Engineers (USACE), and private firms routinely dredge within the LCRMA. These types of dredge projects are all potential sources of cap materials if their timing overlapped with the Portland Harbor remediation construction.

Ogden Beeman & Associates (OBA 1996) identified the amount of sediments that will have to be dredged from 1996 to the year 2020 in the Port of Portland. They estimated that between 4.7 million and 6.3 million cubic yards (cy) of sediments will require dredging during this time frame depending on whether the Willamette River navigation channel is deepened or not. The Port would likely be required to dredge between 600,000 and 750,000 cy of this total. The portion of these sediments that is found to be "clean" could be used for capping material if dredging operations overlapped with Portland Harbor remediation construction.

2.1.2 Specific Locations and Quantities of Potential Dredged Materials

Historically, the Port has periodically performed maintenance dredging at Terminals 1, 2, 4, and 5 and at the Portland Shipyard. Between 1973 and 1996 they dredged over 100,000 cy of material at Terminal 1. This terminal is no longer used as a cargo terminal, and the Port anticipates little dredging in the future (OBA 1996). The Port has dredged approximately 80,000 cy at Terminal 2 between 1973 and 1996, excluding the approximately 237,000 cy dredged for new construction in 1986. They have dredged approximately 12,000 to 20,000 cy of suitable material from the vicinity of Terminal 2 (from the channel to the facility) every 3 to 5 years. This material was a sandy-silt with approximately 75 percent fines and 25 percent sand. Terminal 4 is dredged approximately every 3 to 5 years, normally removing between 2,000 to 5,000 cy each event (though approximately 29,000 cy was dredged in 1988). This year, approximately 2,000 cy of suitable material was dredged from Terminal 4. The material from Terminal 4 was a sandy-silt with approximately 60 percent fines and 40 percent sand. Terminal 5 has approximately 2,000 cy of material dredged every 3 to 5 years. The dredged material from Terminal 5 has had varying grain size depending on the dredge location. Dredge material from Berth 501 was about 90 percent sand and 10 percent fines while Berth 503 had 32 percent sand and 68 percent fines. The Portland Shipyard has performed maintenance dredging every 4 to 6 years. The Port dredged approximately 280,000 cy from the area between 1981 and 1994, with quantities varying between 1,200 cy and 153,416 cy for each event.

The Port also dredged (mined) large amounts of channel material between river mile (RM) 8 and RM 10 in the Willamette River for use as borrow/fill material in 1981 (176,000

cy), 1982 (631,000 cy), 1985 (1,285,000 cy), and 1988 (876,000 cy). The grain size distribution of these materials is not clear, but it is assumed that they were similar to the grain sizes documented by the USACE in this area (discussed below; approximately 30 to 40 percent sand and 70 to 60 percent fines).

The USACE routinely (approximately every 3 to 5 years) performs maintenance dredging of clean material from the Willamette River, as required to maintain navigation channels. They last dredged the Willamette River in 1999. At RM 2, (Post Office Bar, located downstream on the right side, off of the Oregon Steel Mill Dock) they removed 50,000 cy of material. At RM 8 to RM 10 (adjacent to and upstream of the Texaco Dock) they dredged approximately 450,000 cy. These volumes are typical of the quantities removed every 3 to 5 years. The USACE also dredged US Moorings (at RM 6) approximately 20 years ago, but has not needed to since then. There may be some need to dredge the area now, but the chemical quality of the sediments may make them unsuitable for use as cap material. The average grain size distribution of the samples collected from the material removed in 1999 was 63.7 percent silt/clay, 35.2 percent sand and 1.2 percent gravel. These values are similar to the grain sizes collected in the same general locations in 1988, 1992, and 1996.

The USACE also performs periodic maintenance dredging in the Columbia River. In the 1990's the USACE dredged an average of approximately 4 million cy per year from the mouth of the Columbia River to RM 106 (USACE 1998b). Reach 1 of the Columbia River, as defined in the Draft Environmental Impact Statement (USACE 1998b; RM 98 to RM 106.5) is located relatively close to the Site and could be used to supply clean cap material. There are 4 bars located in this reach in the Columbia River that the USACE routinely dredges including: Willow Bar, Morgan Bar, Lower Vancouver Bar, and the Vancouver Turning Basin. Between 1996 and 2000 these locations were dredged several times removing a total of 1.7 million cy (or an average of 343,000 cy per year). The material removed was medium to coarse sand.

As noted above, there are also a considerable number of dredging projects conducted by private entities and these projects may also be a source of clean cap material. Specific, histories and predictions of these types of dredging projects were not found.

2.2 Upland Quarries or Commercial Sources

There are several sand and gravel companies that have quarries or sources (e.g., mining the Columbia River) located within a reasonable distance to facilitate economical shipping of cap materials to the site. These include, but are not limited to, the Avery Pit operated by Ross Island Sand and Gravel, the Angel Quarry operated by Morse Bros, Inc., and Glacier Northwest facilities.

Ross Island Sand and Gravel tows two to three barges of material approximately four times each week from their Avery Pit located on the Columbia River to their facility near Ross Island (Godsil 2001). Additional trips could be made if there was a need. Each tow contains approximately 5,300 to 8,000 tons of material. The material is fairly uniformly graded 6- to 8-inch minus material with minimal fines. This material can be graded to any size at their facility on Ross Island to meet the specific needs of the given cap design, though the barges could deliver directly to a site if the pit run material was the proper gradation. They also stockpile a by-product material that is graded between medium sand (30 mesh) and silt (200 mesh), which could likely be used as a component of the cap for a nominal price.

Morse Bros, Inc. has several quarries and a sand and gravel plant that can all provide cap material via barge to the site (Gray 2001). Angel Quarry, located near Sauvie Island on Highway 30, has a total capacity of approximately 50 million tons that could be mined. They have two other quarries with capacities of 30 and 60 million tons. Morse Bros. can provide any size of cap material required, from 4-foot diameter rip rap to clay material. The overburden at the quarry is 100 percent clay and they also have a by-product that is approximately 50 percent clay and 50 percent 1.5-inch minus gravel that could be obtained relatively cheaply. Up to approximately 20,000 tons per day of pit run material could be produced, but if a specific blend were required it would be limited to the production rate required to crush/screen it.

Glacier Northwest utilizes several different sources for aggregate. They recently purchased Columbia River Sand and Gravel and therefore have access to their sources of sands from the Columbia River (via existing permits). They also have a quarry near Scappose still in use (Sweet 2002). Their river mining operation includes dredging both coarse and fine sands from the river bottom, loading them into a sand barge and then pumping the material off in a slurry. They can deliver one to two 1,500 cy barges (approx 1,800 tons each) of material per day (Gray 2001). Glacier Northwest also has 2-inch minus material from their quarry that could be purchased. This material is a by-product of their normal operations and therefore would be less expensive than other materials since it is a surplus product. They currently (December 2001) have 250,000 to 500,000 tons of this material available. This material would need to be delivered via truck and then offloaded on to a barge or placed directly into the river. A rehandling site to load the barges would need to be obtained.

3 CAP MATERIAL TESTING REQUIREMENTS

Both the physical and chemical characteristics of the cap material would need to be known to ensure it meets the design requirements of the remediation project. Cap design requirements would likely consider the following parameters:

- Grain size of chemical isolation layer for the cap
- Grain size of any protective layer for the cap
- Chemical concentrations in all cap layers
- Total organic carbon content (TOC) of chemical isolation layer for the cap
- Volumes of sediment required for each layer
- Specific gravity and water content of all cap layers.

Once the site-specific design requirements for capping material have been defined, potential sources of this material can be identified. The potential material will need to be tested to ensure that it is suitable for use. Physical testing requirements will at a minimum include: grain size, TOC content, specific gravity, and water content. Chemical testing will include Tier II testing outlined in the "Dredged Material Evaluation Framework, Lower Columbia Management Area" (USACE et al. 1998a). If all chemical concentrations are less than the Screening Levels (USACE et al. 1998a), the material would be judged suitable for use as cap material. However, if some chemicals exceed the Screening Levels, this does not necessarily preclude using the material for a cap. Additional biological tests (Tier III) could be performed as described in the Framework.

4 CONCLUSION

Typically, cap material consists of sand with some fines as the isolation layer. Depending on the potential for scour, there may also be a need for gravel in the cap material or a need to place gravel, cobble or even larger material over the isolation layer to prevent erosion. Because neither the areas nor the chemical/physical characteristics of the sites to be capped have been defined, it is impossible to specifically state preferred sources, volumes, and costs of cap materials at this time.

However, large quantities of capping material are available from both likely future dredge projects and commercial sand/gravel operations in any grain size distribution required. Some specific grain sizes may need to be manufactured by commercial operations by crushing or screening.

In terms of cost, the ideal capping source would be obtained from a clean maintenance dredge operation located near the capping site. However, the grain sizes and volumes available at the time of a given capping project may not be appropriate. If specific larger grain sizes such as coarse sand or gravel are needed for protective cap layers, local quarries have the capacity to provide sufficient quantities and the range of potential grain sizes required for any given project. These facilities also have the capacity to provide all of the cap materials currently anticipated (both protective layers and chemical isolation layers) for most capping projects that might be called for at the Site.

Using cap materials from local quarries would likely cost more than using materials from local maintenance dredge projects. Consequently, despite the ready availability of materials from commercial operations, potential sources of clean cap materials from dredge projects should continue to be pursued as the timing of any cap construction becomes more certain.

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ATTACHMENT A4
REVISED INTERIM DRAFT
NATURAL ATTENUATION DATA GAPS TECHNICAL MEMORANDUM

PORTLAND HARBOR SUPERFUND SITE

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November 13, 2003

Table of Contents

1 INTRODUCTION 1

2 PROPOSED NATURAL ATTENUATION EVALUATION METHOD 3
- 2.1 General Approach 5
- 2.2 Step 1 – Preliminary Evaluation 6
- 2.3 Step 2 – Simple Modeling and Select Sampling 7
- 2.4 Step 3 – Detailed Sampling and Modeling 9

3 DATA GAPS 12
- 3.1 General Physical Information 12
- 3.2 Surface Sediment Chemistry and Physical Characteristics 13
- 3.3 Sedimentation Rate 13
- 3.4 Incoming Sediment Chemical Concentrations 14
- 3.5 Mixed Layer Depth and Mixing Rate 14
- 3.6 Biodegradation Rates 14
- 3.7 Groundwater Advection/Subsurface Chemistry 15

4 STUDIES TO FILL DATA GAPS 16
- 4.1 Major Tasks and Sequence of Events 16
- 4.2 Summary of Proposed Studies to Fill Data Gaps 16

5 OTHER NATURAL ATTENUATION MECHANISMS 20

6 REFERENCES 22

List of Tables

Table 1. Current Data Gaps for Natural Attenuation Evaluation. 11
Table 2. Potential Studies to Fill Data Gaps for Natural Attenuation Evaluation 17

List of Figures

Figure 1. Natural Attenuation Processes. 4

1 INTRODUCTION

This Preliminary Draft Natural Attenuation Data Gaps Technical Memorandum proposes an overall method for evaluating natural attenuation at the Portland Harbor Superfund Site (Site) administered by the U.S. Environmental Protection Agency (EPA). Natural attenuation is when natural processes such as burial and biodegradation cause an overall reduction in sediment chemical concentrations over time. In addition, this document presents information needed to conduct the proposed natural attenuation evaluation method and compares these data needs to existing data sets to determine data gaps. This memorandum has been prepared to fulfill specific requirements of the Administrative Order on Consent (AOC; Docket No. CERCLA – 10-2001-02040) and the attached Statement of Work (SOW) between the members of the Lower Willamette Group (LWG) and EPA. This memorandum is one element in the overall Remedial Investigation and Feasibility Study (RI/FS) currently underway for the Site.

Section 4.6.4 of the SOW calls for the LWG to "...identify the data needed to evaluate natural attenuation options and include this information in an RI planning task..." To identify the data needed, the overall method for evaluating natural attenuation must first be determined. The proposed method is described in Section 2 of this memorandum along with the data needed to conduct this method. Section 3 compares these data needs to the compiled existing database and literature for the project to identify data gaps. Section 4 briefly describes the types of sampling, analysis, and/or estimation studies that are likely necessary to fill these data gaps. The methods for these proposed studies will be described in more detail in subsequent modeling technical memoranda, where necessary.

It should be noted that natural attenuation is only one potential General Remedial Action (GRA) currently being contemplated for the site. The Remedial Action Objectives (RAO) Technical Memorandum discusses the full range of GRAs that are applicable to the Site including: no action, institutional controls, in-situ containment, in-situ treatment, removal/disposal, and removal/treatment. Natural attenuation is unlikely to be a viable GRA for the entire Site. However, it may be useful in combination with other GRAs and/or on portions of the Site.

In addition, natural attenuation is a process that occurs over time. For most sediment remediation projects where natural attenuation is considered, regulators typically define an

acceptable period of time over which natural attenuation can occur. Natural attenuation processes that take longer than this time period are generally deemed inappropriate as GRAs. No acceptable time period for natural attenuation for this Site has yet been established. However, EPA has set precedents at other Region 10 Superfund sediment sites where a 10-year period is allowed for natural attenuation to occur.

Natural attenuation modeling and evaluations proposed in this memorandum attempt to predict changes in surface sediment concentration over time given the physical and chemical conditions of an aquatic system. Consequently, they can also be used to understand the potential for recontamination given an understanding of ongoing sources. Although the focus of this memorandum is not recontamination evaluations, it should be noted that the same models discussed here will also be used to make predictions about the potential for recontamination under various potential cleanup scenarios. For example, an area may be proposed for capping. Given information on incoming sediment concentrations (see below), these models can be used to predict how the cap surface chemical concentrations will change over time. If the cap surface reaches unacceptably high concentrations in the modeling, this provides valuable information that additional source controls need to be considered before such a remedial action should be undertaken.

2 PROPOSED NATURAL ATTENUATION EVALUATION METHOD

Natural attenuation, also referred to as natural recovery or monitored natural recovery, is usually defined as a natural[1] process where chemicals in sediments is reduced over time once source controls have been established. Natural attenuation can occur through a variety of physical, chemical, and biological processes that can act singly or in combination to reduce observed chemical concentrations in sediments. Natural attenuation usually includes the following primary processes:

- Mixing of incoming clean sediments with sediment chemicals causing dilution of chemical concentrations (often the first step before complete burial)
- Burial of sediment containing chemicals by incoming clean sediments from the water column
- Diffusion/advection of chemicals to the water column (i.e., loss to the water column)
- Degradation of organic compounds within sediments
- Transport (erosion) of sediments containing chemicals and dispersion over wider areas at lower concentrations.

Figure 1 illustrates these natural attenuation processes and how they are inter-related. It is important to note that all these processes do not always work in synergy. For example, if sediments with high chemical concentrations from the water column are settling onto the riverbed sediments, these chemical concentrations may overwhelm any decreases in sediment chemical concentrations caused by burial, diffusion/advection, and/or degradation. This is why source control is a necessary first step to any natural attenuation scenario. In addition, it should be noted that advection and dispersion of chemicals to other areas or matrices may not be desirable in all cases. For these processes, their potential to cause unacceptable impacts or risk to other areas during the period of natural attenuation must be evaluated in the project Feasibility Study and weighed against the costs and risks associated with other potential remedial methods.

[1] This term includes processes that may occur due to human activities that are not intended to remediate sediments containing chemicals. For example, river sedimentation due to agricultural runoff is considered a "natural" process for the purpose of this definition. Similarly, mixing of surface sediments caused by prop-wash would be considered a "natural" process.

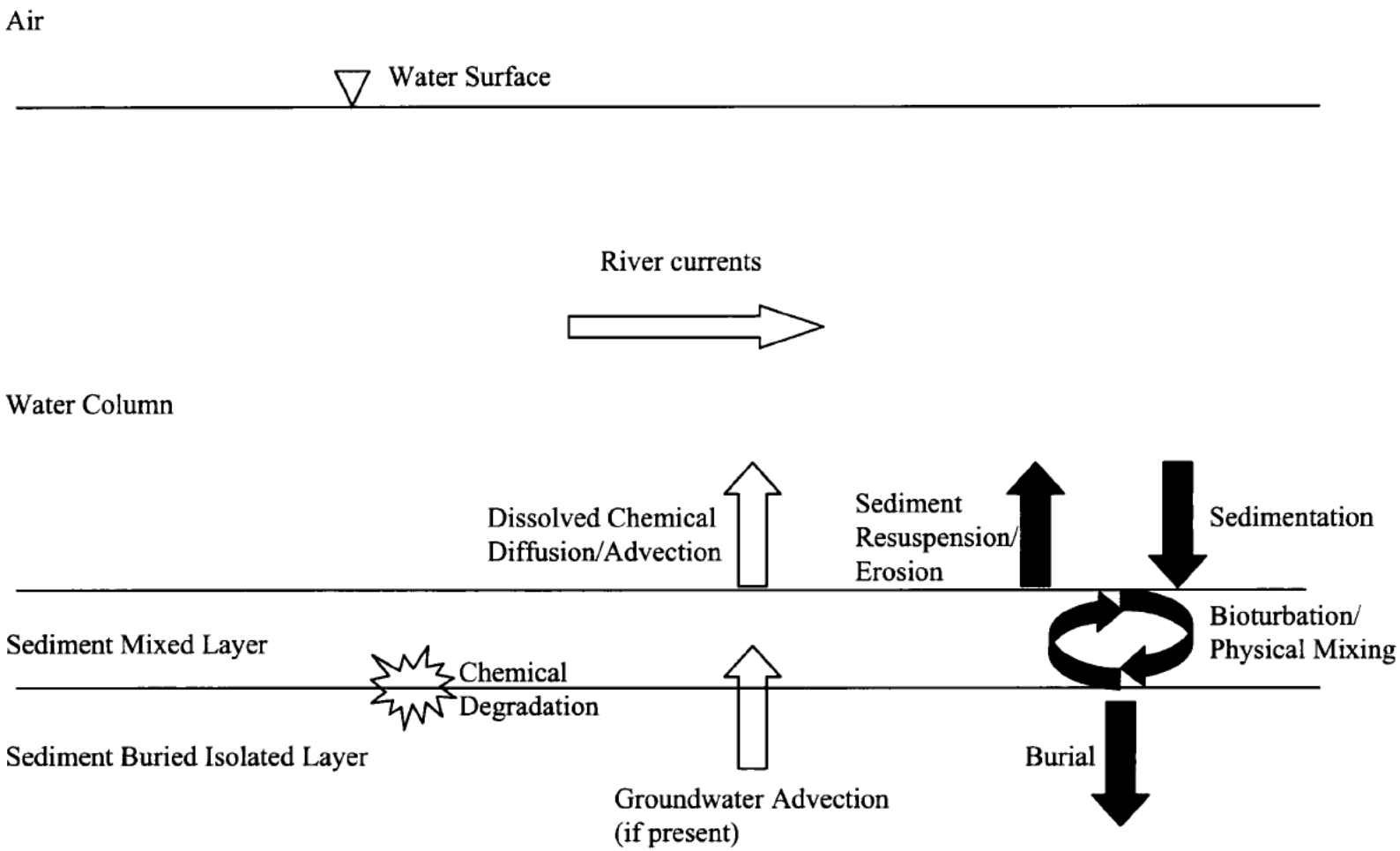

Figure 1. Natural Attenuation Processes

2.1 General Approach

For natural attenuation to be selected as a potential GRA on portions of the site, it must be predicted whether the processes present at the Site are likely to cause natural attenuation to occur, and if so, how fast that attenuation will progress. Because natural attenuation occurs through numerous physical, chemical, biological processes, the most common method of predicting the potential for natural attenuation is through the use of computer models.

However, indiscriminant application of detailed computer models over the entire Site would be data intensive, time consuming, and expensive. Consequently, we propose the following three-step process to evaluate natural attenuation at the Site and reduce the amount of detailed computer modeling needed:

Step 1 Identify areas that have basic processes that are potentially suitable for natural attenuation based on general information about the river system.

Step 2 Conduct select sampling (in Round 2B) within a few areas that appear characteristic of the range of potential natural attenuation processes at the Site and simple probabilistic modeling. Eliminate from future evaluations the types of areas that have a low probability of having processes that support natural attenuation.

Step 3 Conduct detailed sampling (in Round 3) and modeling in Sediment Management Areas (SMAs) that appear to have suitable processes for natural attenuation (based on Step 2 results) to determine viability and rate of natural attenuation.

Each of these steps is defined in more detail below. It should be noted that although some steps in the evaluation process may focus on processes, such as sedimentation, that can be particularly important "drivers" of natural recovery in many situations, this does not mean that other processes such as diffusive and advective movement and loss are ignored by the modeling efforts. All of the processes shown in Figure 1 will be considered as potentially important to natural recovery processes at some point in the evaluation process.

2.2 Step 1 – Preliminary Evaluation

General physical information on the Site will be used to initially identify areas that could have the types of processes that would typically be expected to support natural attenuation. The primary process of importance (although not the only process to be considered) is deposition, which generally would be found in relatively quiescent areas that show some evidence of substantial net deposition of new sediments. Although areas of this type may have periodic erosion, for example during storm events, the primary process of importance is one of long-term net deposition over time. Relevant information that will be reviewed includes:

- Sediment grain size
- Sediment Trend Analysis (STA) results
- Current and historical bathymetric information
- Existing surface sediment chemical concentrations
- Preliminary runs of a Site-wide hydrodynamic/sediment transport model (when available).

Areas of the Site that have the following characteristics will be identified as having potential representative important processes:

- Smaller sediment grain sizes (e.g., mud or sandy mud), which indicates a depositional environment
- Depositional or accretional environments (as defined in the STA [Hill and McLaren 2001] and/or the Site-wide hydrodynamic/sediment transport model)
- Relatively low bed current velocities, indicating low probability of erosion
- Not subject to historical large-scale scour events
- Relatively low surface sediment chemical concentrations[2].

Step 1 identifies areas of the river that potentially have natural attenuation processes that are characteristic of types or river conditions (e.g., embayments, backwaters, eddies, slips, otherwise protected areas, etc.). These areas will be reviewed and particular sites will be selected for sampling in Step 2 that are representative of the range of overall site characteristics that may be conducive to natural attenuation. These characteristic areas do not represent proposals for natural attenuation, but will help focus future natural

[2] Concentrations that are relatively low, but still sufficiently high to require some type of remediation.

attenuation sampling in Round 3. Based on Round 3 information, modeling will be conducted that will identify specific areas where natural attenuation may be a viable remedial alternative.

With this approach in mind, the existing information listed above would be reviewed to select several (e.g., 1 to 5) areas that appear to represent a range of physical conditions that might be conducive to natural attenuation. For example, the area behind Swan Island is a relatively large and unique quiescent area. It may be reasonable to gather information here to see what types of processes exist. Similarly, coves along the shoreline may represent eddy conditions that could exist in various areas along the shorelines. In this case, it might be reasonable to select one cove-like area on each side of the river within the ISA. Finally, several relatively narrow slips exist within the ISA, which could also be relatively quiescent areas. Conversely, it may be unclear how much prop wash may counter-act the natural processes in these areas. Thus, investigation to understand the prevailing condition in one representative slip might be worthwhile to focus future efforts.

We anticipate that the Round 2A Field Sampling Plan (see main text of Work Plan) will select locations for sampling and information gathering following this type of rationale. Each sample location selected will be reviewed in a manner similar to above to describe how it was selected.

2.3 Step 2 – Simple Modeling and Select Sampling

The initial areas identified in Step 1 will be the focus of limited sampling (as described above) and simple modeling to help confirm their potential for natural attenuation in various characteristic environments of the site. The SEDCAM model (Jacobs et al. 1988) will be used for this step. This model assumes that the entire mixed-layer is completely mixed, with no gradations. The following information would be needed to conduct this modeling:

- Chemical concentrations in surface sediments (the mixed layer)
- Sedimentation rate
- Chemical concentration of the incoming (settling) sediments
- Mixed layer depth
- Sediment physical characteristics (grain size, water content, specific gravity).

The goal is to collect information in Step 2 that will allow an evaluation of whether natural attenuation is even possible in the representative types of river environments. The data collection and subsequent Step 2 evaluations done in these areas will not be provided as evidence to support potential remedial options for specific areas. Rather, it will be used as an indication of where more detailed sampling and data evaluation should be conducted to develop potential natural attenuation areas.

Some of the information required for simple modeling may come from existing data while other information would be yielded by the targeted sampling described above. Data sources to conduct modeling runs are described more in Section 3.

The SEDCAM model is simplistic in several respects, including that it deals only with the mixed sediment layer and it does not have separate variables for degradation and diffusion. Further, it does not expressly consider advection of porewater or resuspension. However, SEDCAM approximates the primary processes that are most often drivers in natural attenuation (e.g., sedimentation). Other processes not considered by SEDCAM such as flux of subsurface contaminants to the mixed surface layer, may be important at some sites and may limit the potential for natural recovery. However, although these sites may be initially screened in as potentially suitable for natural recovery in Step 2, Step 3 will ensure that these other processes are not overlooked in final determinations of natural recovery areas. Alternatively, it is possible in some cases that fluxes of clean groundwater, for example, might accelerate natural recovery and these areas might be erroneously screened out in Step 2 as not suitable for natural recovery. However, past experience with these models and their sensitivities at other sites indicates that such a scenario is unlikely

To better understand the implications of the simplifying assumptions in the SEDCAM model, it will be coupled with Monte Carlo simulation techniques to provide statistical estimates of the likelihood (cumulative probability) of natural attenuation in each of the candidate areas. The commercially available @RISK software will be used to conduct Monte Carlo simulations. This information will be used to conduct a sensitivity analysis to identify those parameters that are most important in determining natural recovery rates. The magnitude of changes in important variables that cause differing conclusions (i.e., natural recovery vs no natural recovery) will be compared to the precision and accuracy of the site-

specific data available. From this information, critical data gaps to improve accuracy or precision of data on the most sensitive parameters will be identified.

The types of areas that have a high probability of natural attenuation processes present will be selected for more detailed sampling and modeling in Step 3.

2.4 Step 3 – Detailed Sampling and Modeling

The prime types of areas that support natural attenuation processes (obtained through Step 2) will be the subject of detailed sampling and computer modeling. Detailed sampling will be conducted in Round 3 (see main text of Work Plan).

This sampling and subsequent modeling will be used to demonstrate where natural attenuation is a feasible GRA. The modeling will be performed with the Boudreau numerical model (Boudreau 1997). This model has been applied in Hylebos and Middle Waterways of Commencement Bay in Tacoma, Washington, and it includes the attenuation and mixing processes of sedimentation, biologically-enhanced mixing, resuspension, chemical adsorption, groundwater advection, and organic biodegradation. The specific input parameters that would be required for the Boudreau model include:

- Chemical concentration in surface sediments
- Sedimentation rate
- Chemical concentration in incoming sediments
- Mixing parameters (mixed layer depth, mixing rate)
- Sediment physical characteristics (grain size, water content, specific gravity)
- Biodegradation rate (not applicable to metals)
- Groundwater advection rates
- Chemical concentrations of porewater and/or contaminated groundwater in subsurface sediments.
- Bulk sediment chemistry of subsurface sediments.

The Boudreau model proposed requires sufficient information to estimate the porewater chemical concentrations of underlying sediments. This can be obtained directly from measurements of porewater (could be termed groundwater) in these layers or estimated from bulk sediment chemistry using either site-specific or literature equilibrium partitioning

assumptions. Although both subsurface porewater chemistry and bulk sediment chemistry are listed as data needs, in some situations one type of information alone may be sufficient (e.g., an area with clean groundwater inputs).

A sensitivity analysis will be conducted for the Boudreau model. All parameters will be varied over their likely ranges and the resulting outcomes will be compared to identify the most important parameters driving natural recovery processes. This information will be compared to accuracy and precision of data available for the most important parameters. The effects of data accuracy on natural recovery conclusions will be discussed.

Where detailed modeling indicates natural attenuation is a viable GRA, it will be considered in remedial alternative development for the Feasibility Study. Remedial alternatives will most likely include natural attenuation for portions of the site in combination with other GRAs for other portions of the site.

Step 3 will also include a review of historical information on trends in surface sediment concentrations in to determine whether there is any evidence of historical natural attenuation. Where sufficient information is available, the natural attenuation model may be used to understand whether natural attenuation would even be expected historically given the levels of ongoing sources to sediments. It is important to note, that the absence of historical attenuation in sediments does not necessarily rule out natural attenuation as a future remedial action. This is because many sources have either been recently controlled or are expected to be controlled by the time the RI/FS is completed.

The results of the Step 1 evaluation based on existing information as well as a Modeling Technical Memorandum presenting the details of the proposed Step 2 model will be presented in one document, which will be submitted to EPA prior to or concurrent with submittal of the Round 2B FSP. The Round 2B FSP will contain the sampling types, locations, and methods needed to collect data to conduct Step 2 of the natural attenuation approach. The results of the Step 2 modeling and a Modeling Technical Memorandum presenting the details of the proposed Step 3 model will presented in one document, which will be submitted to EPA prior to or concurrent with submittal of the Round 3 FSP. The

Round 3 FSP will contain the sampling methods needed to collect data to conduct Step 3 of the natural attenuation approach.

3 DATA GAPS

A database of existing information has been compiled by Striplin Environmental Associates for the Site as a part of the RI/FS Work Plan development. In addition, a comprehensive literature and data review was conducted for the Site (see main text of Work Plan). Both the database and literature review have been evaluated to determine which of the data needs described in Section 2 are currently available in sufficient detail for the purposes of the natural attenuation evaluation. The summary of data gaps found is shown in Table 1. These primary data gaps are described below for each type of information needed.

Table 1.
Current Site-Specific Data Gaps for Natural Attenuation Evaluation.

Grain Size	+	+	Gap
STA Results	+	+	+
Bathymetry	+	+	+
Surface Sediment Chemistry	+	Gap	Gap
Water Content/Specific Grav.	NR	Gap	Gap
Hydrodynamic Modeling	NR	Gap	Gap
Sedimentation Rate	NR	Gap	Gap
Chemistry of Incoming Seds.	NR	Gap	Gap
Mixed Layer Depth	NR	Gap	Gap
Mixing Rate	NR	NR	Gap
Biodegradation Rate	NR	NR	Gap
Subsurface Sediment Chemistry	NR	NR	Gap
Groundwater Flow/Chemistry	NR	NR	Gap

+ Existing information sufficient for this step.

NR – This information not required for this step.

? – Existing information augmented by very selective confirmatory sampling.

3.1 General Physical Information

This information is primarily useful in Step 1, but also provides basic information that may be used to estimate or bound specific model parameters in Steps 2 and 3 (e.g., sedimentation rate). There is considerable information on sediment grain size throughout the Site through various studies, and particularly the STA (Hill and McLaren 2001). This information should be more than sufficient to conduct Step 1. Additional area-specific grain size sampling may be need in Steps 2 and 3. Similarly, the STA and the existing/historical bathymetry, which are already completed by the RI/FS team, will provide adequate information for Steps 1 through 3. Should site-wide bathymetry be updated during the course of the RI/FS, this

updated information will also be useful in refining some key parameters used in Steps 2 and 3 (i.e., sedimentation rate).

A Site-wide hydrodynamic/sediment transport model is proposed in the RI/FS Work Plan. No existing river model is sufficient to provide the general information needed to complete Steps 2 or 3 (see main text of Work Plan). Preliminary and then more detailed modeling runs of the proposed model will be necessary to complete Steps 2 and 3, respectively.

3.2 Surface Sediment Chemistry and Physical Characteristics

All three steps of the proposed evaluation method require information on surface sediment chemistry and basic physical characteristics. As the study progresses through each step, this information will need to be more detailed and specific to particular locations within the Site.

The existing information on surface sediment chemistry and physical characteristics (see main text of Work Plan) appears to be sufficient to conduct Step 1, but more detailed site-specific chemistry data is probably needed for Steps 2 and 3. However, the existing data tend to focus on particular sites that have been of interest in past studies. Thus, there may be an area of the Site that has the appropriate general physical conditions for potential natural attenuation, but there is little or no information on the sediment chemistry in this area for the Step 1 evaluation. Further, for this same reason, it may not be known whether this area is even likely to be an area needing remediation due to the lack of existing sediment chemistry information.

3.3 Sedimentation Rate

Sedimentation rates would be needed for both Steps 2 and 3. In most river systems there are several potential sources of sediment contributing to overall sedimentation rates including upland erosion, transport from upstream, and local resuspension/settling due to currents and wave action. There is very little specific information on sedimentation rates within the Lower Willamette River. There is some limited information on suspended sediment concentrations, primarily from USGS as well as a few other water quality studies (see main text of Work Plan). However, most of these studies appear to focus on turbidity measurements. Further, none of these studies attempt to determine sedimentation rates for various river reaches either as net sedimentation (including erosional resuspension) or total gross sedimentation. Finally, there are no detailed sediment transport models for the Lower

Willamette (see main text of Work Plan), which is another potential method of estimating sedimentation rates.

3.4 Incoming Sediment Chemical Concentrations

Incoming sediment chemical concentrations associated with newly deposited sediments are needed for both Steps 2 and 3. Total concentrations of metals and some other chemicals in the water column were measured in a few existing studies (see main text of Work Plan). If it is assumed that all chemicals measured were in particulate form[3] and suspended sediment concentrations were simultaneously measured by the study, this information could be used to determine incoming sediment chemical concentrations. However, because such information is sporadically available and often not associated with suspended sediment measurements, it appears that existing information is insufficient to determine a reasonable range of incoming sediment chemical concentrations applicable to the Step 2 or 3 models.

3.5 Mixed Layer Depth and Mixing Rate

The depth of the surface sediment mixed layer is needed for both Steps 2 and 3, and Step 3 requires an estimate of mixing rate, which is partially determined by bioturbation. An approximate range of mixing depths of surface sediments can be estimated from physical observations of oxidation/reduction boundaries and depths of biological activity (e.g., burrowing). Considerable visual information is available through the ongoing Sediment Profile Imaging (SPI) work underway for the RI/FS. This information could be used to make an initial determination of mixing depths sufficient for Step 2. However, this initial determination may need to be confirmed through other measurements such as radioisotope cores and/or applied tracer studies in select areas.

Mixing rate is not directly determinable from visual observations. There appears to be no existing information with which to estimate mixing rate (see main text of Work Plan), particularly on a site-specific basis within the Site.

3.6 Biodegradation Rates

Biodegradation rates are needed for Step 3 modeling. Biodegradation rates can be highly site specific. Generally, studies measuring degradation of the same compounds in similar

[3] For most chemicals, the majority of chemicals present in most river waters are in particulate form.

environments (e.g., rivers or streams) can report degradation rates that differ by several orders of magnitude (Eisler 2000). Methods of measurement can also affect results. There appear to be no site-specific biodegradation rates in the Site for any compounds of potential interest (see main text of Work Plan).

3.7 Groundwater Advection/Subsurface Chemistry

The Boudreau model contains variables to address advection of groundwater and diffusion of chemicals from subsurface sediments. This is likely an important process in some areas of the site. The model can accommodate both advection of groundwater buried sediment contamination that causes the mobilization of those contaminants as well as advection of contaminated groundwater itself. The model also explicitly considers the diffusion of subsurface chemicals in sediments to upper layer sediments. The primary information that would be need is the advective velocity of groundwater (which can be obtained from overall gradient and hydraulic conductivity), the chemical concentrations in subsurface groundwater/porewater, and the bulk sediment chemical concentrations in buried sediment layers. Measuring groundwater velocities can be difficult and a variety of techniques using both existing and new collected data exist with which to measure this parameter. We will propose specific methodologies for measuring this parameter in technical memoranda specific to Step 3 evaluations.

The model proposed also requires sufficient information to estimate the porewater chemical concentrations of underlying subsurface sediments. This can be obtained directly from measurements of porewater/groundwater in these layers or estimated from bulk sediment chemistry using either site-specific or literature equilibrium partitioning assumptions. The method used to estimate subsurface porewater concentrations will dependent primarily by the area of the river being modeled and the importance of groundwater flow and contamination in that area.

4 STUDIES TO FILL DATA GAPS

As noted in the introduction, this memorandum does not contain a detailed work plan and/or sampling and analysis plan for filling the data gaps identified in Section 3. More detailed submittals will be made to EPA as needed to describe specific sampling proposals and modeling in more detail. This section briefly summarizes some potential future studies that can be used to fill these data gaps, and when they need to occur so that evaluation of natural attenuation as a viable remedial technology can be included in the FS. Depending on the results of the first round of RI sampling and hydrodynamic/sediment transport modeling, the studies needed to fill natural attenuation data gaps could change from those described in this document.

4.1 Major Tasks and Sequence of Events

The following general tasks and sequence of events are proposed at this time to fill natural attenuation data gaps and evaluate natural attenuation as a GRA:

- Conduct Step 1 of the natural attenuation evaluation to identify areas of representative processes
- Use preliminary runs of the Site-wide hydrodynamic/sediment transport model to understand representative process areas, if available
- Complete Round 2 of RI Sampling and Analysis including select information for Step 2 of the natural attenuation evaluations
- Conduct Step 2 natural attenuation modeling in areas of representative processes using information available through Round 1 and identify environments that may have processes that support natural attenuation
- Complete Round 3 of RI Sampling and Analysis including area-specific natural attenuation information to support the development of remedial alternatives
- Conduct Step 3 of the natural attenuation evaluation
- Identify any areas suitable for natural attenuation in Feasibility Study alternatives development.

4.2 Summary of Proposed Studies to Fill Data Gaps

Table 2 summarizes the potential studies and sources of information that could be used to fill the data gaps identified in Section 3 and Table 1. These studies are briefly summarized below.

Table 2
Potential Studies to Fill Data Gaps for Natural Attenuation Evaluation.

Data Needs	Step 1	Step 2	Step 3
Grain Size			Round 3 sampling
STA Results			
Bathymetry			
Surface Sediment Chemistry		Round 2B sampling	Round 3 sampling
Water Content/Specific Grav.		Round 2B sampling	Round 3 sampling
Hydrodynamic Modeling		Preliminary model runs	Detailed model runs
Sedimentation Rate		Water column samples and select radioisotope cores (Round 2B)	Water column samples, sediment traps, and/or radioisotope studies (Round 3)
Chemistry of Incoming Seds.		Water column samples (Round 2B)	Water column samples/sediment traps (Round 3)
Mixed Layer Depth		Select radioisotope cores (Round 2B)	Radioisotope cores (Round 3)
Mixing Rate			Radioisotope cores (Round 3)
Biodegradation Rate		Literature values	Literature values
Subsurface Sediment Chem.			From Round 2B and 3 Subsurface Cores
Groundwater Flow/Chem.		LWG Lead and DEQ Lead Groundwater Studies	LWG Lead and DEQ Lead Groundwater Studies

Grain size – For Step 3, additional grain size samples may be needed within prime candidate natural attenuation areas to fill in spatial gaps from existing grain size data.

Surface Sediment Chemistry/Physical – Rounds 1 and 2 RI sampling should provide sufficient characterization of surface sediments. Similar to grain size, some additional samples may need to be included in the RI Sampling Plans that focus on particular potential natural attenuation areas for either Steps 2 or 3.

Hydrodynamic Modeling – At least preliminary runs of the hydrodynamic/sediment transport model must be available for Step 2. More detailed model runs with finer grids at prime candidate areas will be needed for Step 3.

Sedimentation Rate – Some sampling of suspended sediment concentrations under various river conditions will be needed for Step 2. From this information, sedimentation

rates can be estimated through comparison of these data to hydrodynamic/sediment transport modeling results. Alternatively or in addition, sedimentation rates could be directly measured in select locations of interest either through the use of sediment traps and/or radioisotope core measurements. It may be necessary to conduct grain size measurements on suspended sediments depending on the settling environments present in prime candidate areas.

Chemistry of Incoming Sediments – Some direct measurement of suspended sediment chemistry will be needed in both Steps 2 and 3, with Step 3 investigations requiring higher sample frequency but over smaller more specific areas. Most likely, total chemical concentrations would be analyzed and the entire mass of chemical would be assumed to be associated with particulate fraction for the purposes of natural recovery modeling.

Mixed Layer Depth and Mixing Rate – For Step 2, radioisotope and/or applied tracer measurements in select locations would be needed to confirm mixed layer depth ranges obtained through visual observations. For Step 3, radioisotope and/or applied tracer measurements would be needed with greater sample density, but only in specific areas of interest. Step 3 investigations would also focus on establishing area-specific mixing rates from radioisotope and/or applied tracer information.

Biodegradation Rate – Because of the expense of biodegradation testing and variability of experimental methods, development of site-specific biodegradation rates are not proposed. Literature values for a variety of similar sites will be obtained. The overall range of reported values will be compiled and reasonable high and low estimates will be used in natural attenuation modeling to determine the importance of this parameter in this particular situation and the overall probability of natural attenuation given the uncertainty associated with this parameter.

Groundwater Advection Rates, Concentrations, Subsurface Chemistry – As noted in the data gaps section, the movement of chemicals from subsurface sediment layers and contaminated groundwater itself to surface sediments will be evaluated in the natural attenuation model proposed for Step 3. The primary information needed is the

advective velocity of groundwater (which can be obtained from gradient and hydraulic conductivity), the chemical concentrations in the subsurface groundwater/porewater, and the chemical concentrations in buried sediment layers. This information will be collected from LWG lead groundwater investigations discussed in the main text of the Work Plan, DEQ lead groundwater investigations for upland sites, and subsurface core results conducted as a part of Round 2B and Round 3 RI/FS sampling discussed in the main text of the Work Plan. Information from these various sources will likely include upland well gradient and hydraulic conductivity measurements, similar shoreline well measurements, sediment bed flux measurements, and chemical measurements of pore water either upland or in river.

5 OTHER NATURAL ATTENUATION MECHANISMS

In Section 2, the basic physical, chemical, and biological processes that can cause natural attenuation are summarized and depicted in Figure 1. Among the processes discussed is transport (i.e., erosion) of sediments from one location and their dispersion over a wider downstream area at lower concentrations. Depending on the site, the resettling of such resuspended sediments might occur immediately downstream, many miles away, or even in the ocean. In certain circumstances, dispersion is a component of a natural attenuation process that results in destruction of chemicals of concern in sediment. Certain chemicals, for example, may be present at concentrations that inhibit biodegradation. Dispersion can reduce concentrations to levels that do not pose unacceptable risk and that promote degradation. This process has been recognized by EPA (Bishop, 1997).

Most models that can be applied to evaluate natural attenuation were developed to understand natural attenuation in terms of dilution and burial that occur in predominately settling environments such as bays or lakes. However, in a dynamic river system such as the Lower Willamette there are many areas that are predominately erosional or exist in a dynamic equilibrium of constant sedimentation and resuspension. The Hill and McLaren (2001) study identifies many such areas, particularly just upstream of the Site and just downstream of the railroad bridge. The computer models proposed in Steps 2 and 3 are not designed to address natural attenuation through resuspension and downstream dispersion that might occur in these areas.

To address river transport of sediments as a potential method of natural attenuation, we propose using the hydrodynamic/sediment transport model that will be developed for the RI/FS. This model will provide an estimate of areas that are both erosional and depositional. It probably will not be possible to exactly predict the rate of downstream transport of bed sediments using this model. (Although once the model is selected, this uncertainty will be resolved.) However, it will provide an estimate of the probability of any area eroding given certain river flow conditions. These flow conditions can be compared to the flood frequency curve for the river to determine the average expected frequency of such scouring events.

If these scour events are expected to occur (in an area requiring remediation) frequently within the period of time deemed acceptable[4], then natural attenuation via downstream sediment transport may be a component of a viable GRA for that area. However, such a decision will need to be coupled with other considerations such as the concentrations of chemicals present and potential impacts to downstream areas before natural attenuation via transport could be judged as an environmentally effective remedial alternative. Where transport could not be expected to reasonably provide immediate downstream dilution/dispersion of chemical concentrations to acceptable levels, early actions prior to any further erosion of sediments containing chemicals may be the more appropriate alternative in some cases.

Once potential remediation areas have been identified through the RI process, this information will be compared to hydrodynamic/sediment transport modeling results to identify areas that are potentially suitable for natural attenuation via transport mechanisms. If these areas are extensive, then additional transport and dispersion estimation methods and/or computer modeling may be proposed at that time to better understand whether natural attenuation via transport mechanisms in these areas is a environmentally effective remedial alternative.

Any such detailed investigations would be coupled with an assessment of potential risks of sediments that are mobilized into the water column and deposited downstream. Such a risk assessment would have to consider the level of risk posed in the water column during the mobilization as well as risk posed to areas where sedimentation of contaminated sediments might occur. Where such dispersion processes cause more risks or similar risks over a wider areas, dispersion driven natural attenuation would not be an acceptable remedial alternative.

[4] As noted in the introduction, the acceptable period of time in which natural attenuation should occur has not yet been defined for this project.

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Appendix B

LWG
LOWER WILLAMETTE GROUP

PORTLAND HARBOR RI/FS
PROGRAMMATIC WORK PLAN

APPENDIX B:
ECOLOGICAL RISK ASSESSMENT APPROACH

REVISED DRAFT FINAL
November 13, 2003

Prepared For:
The Lower Willamette Group

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TABLE OF CONTENTS

1.0 INTRODUCTION 1
1.1 PROJECT AND SITE DESCRIPTION 1
1.2 DOCUMENT DESCRIPTION 1
1.3 ECOLOGICAL RISK ASSESSMENT PROCESS 1
1.4 INTEGRATION WITH RI/FS WORKPLAN 5
1.5 UTILIZATION OF ERA PROCESS IN PROJECT DECISION-MAKING 5
1.6 DELIVERABLES 6

2.0 PROBLEM FORMULATION 8
2.1 SELECTION OF ASSESSMENT ENDPOINTS AND MEASURES 8
2.1.1 Assessment Endpoints 8
2.1.2 Testable Hypotheses 14
2.1.3 Measures 15
2.2 HABITAT TYPES IN THE LOWER WILLAMETTE RIVER 16
2.2.1 Open-water Habitat 16
2.2.2 Bank and Riparian Habitat 17
2.3 HABITAT UTILIZATION AND POTENTIAL ECOLOGICAL RECEPTORS 18
2.3.1 Benthic Invertebrate Community 18
2.3.2 Fish Species 25
2.3.3 Birds 39
2.3.4 Mammals 43
2.3.5 Amphibians and Reptiles 44
2.3.6 Aquatic Plants 45
2.4 SPECIAL-STATUS SPECIES 46
2.4.1 Invertebrates 46
2.4.2 Fish 46
2.4.3 Birds 47
2.4.4 Amphibians and Reptiles 47
2.4.5 Aquatic Plants 48
2.5 IDENTIFICATION OF REPRESENTATIVE SPECIES 48
2.5.1 Aquatic Plants 49
2.5.2 Benthic Invertebrates 50
2.5.3 Fish Species 50
2.5.4 Amphibians and Reptiles 56
2.5.5 Birds 56
2.5.6 Mammals 58
2.6 POTENTIAL EXPOSURE PATHWAYS 59
2.6.1 Aquatic Receptors 60
2.6.2 Wildlife Receptors 63

3.0 EXISTING DATA 66
3.1 DATA QUALITY ASSESSMENT 66
3.2 SURFACE WATER DATA 66

3.3 SEDIMENT DATA 67
3.4 INVERTEBRATE DATA 67
3.5 TISSUE DATA 67
3.6 TOXICITY TESTING 68
3.6.1 Interpretive Criteria 68
3.6.2 Test Results 69
3.7 SUMMARY 69

4.0 COPC SELECTION PROCESS 70
4.1 AQUATIC PLANTS 71
4.2 BENTHIC INVERTEBRATES 71
4.3 FISH 71
4.4 AMPHIBIANS AND REPTILES 72
4.5 WILDLIFE 72

5.0 ANALYSIS AND RISK ESTIMATION PLAN 73
5.1 EXPOSURE POINT CONCENTRATIONS 74
5.2 THE HAZARD QUOTIENT APPROACH 75
5.3 ANALYSIS PLAN BY ASSESSMENT ENDPOINT 76
Assessment Endpoint No. 1: Survival, growth, and reproduction of aquatic plant populations 76
Assessment Endpoint No. 2: Survival, growth, and reproduction of benthic invertebrate populations 77
Assessment Endpoint No. 3: Survival, growth, and reproduction of fish 80
Assessment Endpoint No. 4: Survival, growth, and reproduction of amphibians and reptiles 83
Assessment Endpoint No. 5 and 6: Survival, growth, and reproduction of birds and mammals 84
5.4 DATA GAP IDENTIFICATION AND COLLECTION OF ADDITIONAL DATA 86

6.0 RISK DESCRIPTION 87

7.0 UNCERTAINTY ANALYSIS 89

8.0 REFERENCES 90

LIST OF FIGURES

Figure 1-1. Ecological risk assessment framework (from EPA 1998)

Figure 2-1. Wildlife food-web model

Figure 2-2. Fish food-web model

Figure 2-3. Bank and riparian conditions

Figure 2-4. Timing of Adult and Juvenile Salmonid Migrations in the Willamette River below Willamette Falls

Figure 2-5. Relative size of fish species home ranges

Figure 2-6. Smallmouth bass, juvenile chinook, Pacific lamprey, and largescale sucker habitat

Figure 2-7. Sculpin and crayfish habitat

Figure 2-8. Hooded merganser habitat

Figure 2-9. Spotted sandpiper habitat

Figure 2-10. Mink habitat

Figure 2-11. Amphibian habitat

Figure 2-12. Preliminary Conceptual Site Model for Ecological Risk Assessment

Figure 3-1. Results of historical bioassay studies in the ISA

Figure 5-1. Process for the Assessment of Benthic Community

Figure 5-2. Process for the Fish Receptor Assessment

Figure 5-3. Process for the Wildlife Receptor Assessment

LIST OF TABLES

Table 2-1. Benthic invertebrates found in the lower Willamette River

Table 2-2. Fish of the Lower Willamette River

Table 2-3. Habitat associations of fish in Portland Harbor

Table 2-4. Potentially resident birds breeding along the lower Willamette River

Table 2-5. Birds seasonally occurring in or minimally associated with aquatic habitat in the ISA

Table 2-6. Mammals potentially utilizing the lower Willamette River

Table 2-7. Amphibians and reptiles possibly occurring in or near the ISA

Table 2-8. Species of special interest in the ISA

Table 3-1. Surface water surveys within the ISA

Table 3-2. Concentrations of chemicals detected in surface water samples collected from the ISA

Table 3-3. Sediment surveys within the ISA

Table 3-4a. Category 1 concentrations of chemicals detected in 0-4 ft sediment samples collected from the ISA

Table 3-4b. Category 1 & 2 concentrations of chemicals detected in 0-4 ft sediment samples collected from the ISA

Table 3-4c. Category 1 concentrations of chemicals detected in 0-1 ft sediment samples collected from the ISA (Category 1 data)

Table 3-4d. Category 1 & 2 concentrations of chemicals detected in 0-1 ft sediment samples collected from the ISA

Table 3-5. Fish tissue surveys conducted in the ISA

Table 3-6. Concentrations of chemicals detected in fish tissue samples collected from within the ISA

Table 3-7. Concentration ranges of chemicals in great blue heron egg tissues from Ross Island in 1994 and 1995

Table 3-8. Bioassay data from environmental investigations in the ISA

Table 5-1. The DQO Process for the Ecological Risk Evaluation - Amphibians and Plants

Table 5-2. The DQO Process for the Ecological Risk Evaluation – Benthic Invertebrate Community

Table 5-3. The DQO Process for the Ecological Risk Evaluation - Fish

Table 5-4. The DQO Process for the Ecological Risk Evaluation - Birds

Table 5-5. The DQO Process for the Ecological Risk Evaluation - Mammals

Table 5-6. Limited list of secondary stressors that may influence receptor populations within the LWR

LIST OF ATTACHMENTS

Attachment B.1: Benthic Macroinvertebrate Community Sampling
Attachment B.2: Aquatic Plant and Amphibian/Reptile Reconnaissance Survey
Attachment B.3: Lamprey Ammocoete and Benthic Infaunal Biomass Reconnaissance Surveys of the Lower Willamette River
Attachment B.4: Proposed Process for Assessment of Benthic Risks at the Portland Harbor Superfund Site
Attachment B.5: Ecotoxicological Profiles
Attachment B.6: Portland Harbor Round 1 Fish TRV Selection
Attachment B.7: A Review of Aquatic Food Web Models for Potential Application to the Portland Harbor Superfund Site
Attachment B.8: Fish Stomach Contents Screening
Attachment B.9: Portland Harbor Round 1 Birds and Mammal TRV Selection

LIST OF ACRONYMS

AOC	Administrative Order on Consent
AWQC	Aquatic Ambient Water Quality Criteria
BERA	Baseline Ecological Risk Assessment
COI	Chemical of Interest
COPC	Chemical of Potential Concern
CSM	Conceptual Site Model
CRD	Columbia River Datum
DQO	Data Quality Objective
EPA	U.S. Environmental Protection Agency
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
ESA	Endangered Species Act
ft	feet
ISA	Initial Study Area
LWR	Lower Willamette River
LWG	Lower Willamette Group
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
m	meter
mm	millimeter
mg/kg	milligrams per kilogram, dry weight
mg/L	milligrams per liter
NMFS	National Marine Fisheries Service
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
ONHP	Oregon Natural History Program
PCB	polychlorinated biphenyl
PRE	Preliminary Risk Evaluation
PRG	Preliminary Remediation Goal
QA/QC	Quality Assurance/Quality Control
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RM	River Mile
ROD	Record of Decision
SOW	Statement of Work
SMA	Sediment Management Area
TRV	Toxicity Reference Value
USFWS	U.S. Fish and Wildlife Service
yr	year

1.0 INTRODUCTION

1.1 PROJECT AND SITE DESCRIPTION

This document presents the Ecological Risk Assessment Approach for the Portland Harbor Superfund site. This approach is prepared based on the requirements of the scope of work (SOW) and Administrative Order on Consent (AOC) (EPA 2001) entered into with the U.S. Environmental Protection Agency (EPA) for conducting the Remedial Investigation/Feasibility Study (RI/FS). This ecological risk assessment approach was developed according to EPA guidance for conducting ecological risk assessments (ERAs) (EPA 1997, 1998).

The Portland Harbor Superfund site focuses on the lower Willamette River (LWR) in the vicinity of the City of Portland. Although the boundaries of the site have yet to be defined (and will be defined as a result of the RI/FS process), EPA has defined an initial study area (ISA) as the LWR from river mile (RM) 3.5 to 9.2 (Figure 1-2, RI/FS Work Plan).

1.2 DOCUMENT DESCRIPTION

The remainder of this document is organized into 9 sections. Section 2 presents the problem formulation including assessment endpoints and measures, representative species, and exposure pathways. Existing data are summarized in Section 3. The process of identifying chemicals of potential concern (COPCs) is discussed in Section 4. Section 5 includes steps of the analysis for each assessment endpoint: the exposure characterization, effects characterization, and risk estimation. Section 6 discusses risk description and Section 7 addresses uncertainties. References are given in Section 8.

1.3 ECOLOGICAL RISK ASSESSMENT PROCESS

This appendix presents the information and processes critical to completing the preliminary risk evaluation (PRE) and baseline ecological risk assessment (BERA) for the Portland Harbor Superfund Site, including processes for intermediate decisions. This appendix presents the compilation of background information used to help guide the ecological risk assessment process at this Superfund site, and presents the rationale and tasks necessary to complete the ecological risk assessment. It is anticipated that the risk assessment will be an iterative process, with production of a PRE at an intermediate stage of data collection, a draft BERA, and a final BERA after any further data collection concludes. LWG has engaged in continuous discussions with EPA and its partners regarding the ERA approach. Agreements have been reached on some

methods and issues and these are reflected in this appendix. Discussions will continue as the ERA process progresses.

An ERA is an integral part of the RI/FS process. This process is designed to facilitate risk management decisions for Superfund sites. Ecological risk assessment draws on many fields of science, such as environmental toxicology, ecology, and environmental chemistry, to characterize potential adverse effects caused by exposure to site-related chemicals. According to EPA guidance, the ERA is "a qualitative and/or quantitative appraisal of the actual or potential impacts of chemicals from a hazardous waste site on plants and animals other than humans and domesticated species (EPA 1997)." Using the results of this process, it is possible to determine if actual or potential ecological risks exist at a site, identify which chemicals present at a site pose an ecological risk, and generate data to be used in evaluating cleanup options (EPA 1997). Figure 1-1 presents the ecological risk assessment framework, as presented in EPA (1998). The Portland Harbor Superfund Site ERA process will be consistent within this framework.

An ERA, conducted under EPA guidance (EPA 1997, 1998), has three major components:

- Problem Formulation: The information needed to focus the analysis phase of the ERA
- Analysis: The characterization of effects and characterization of exposure
- Risk Characterization: The calculation of risk estimates and discussion of uncertainties

The problem formulation considers the historical background and conditions of the site, the ecological management goals and important aspects to be protected (assessment endpoints), the means by which the assessment endpoints will be evaluated (measures), and the habitats and ecological receptors (EPA 1998). The end product of the problem formulation process is the conceptual site model (CSM), which describes the potential chemical sources and transport mechanisms, evaluates potential exposure pathways, and identifies the receptors that will be assessed.

A clear picture of the site conditions and ecological resources potentially at risk is important in preparing and conducting the risk assessment. The problem formulation is the tool used to do this, thus framing the scope and scale of the risk assessment. The problem formulation is also used to prepare for the analysis phase of the ERA. The analysis phase of the risk assessment includes the characterization of exposure and the characterization of effects. The risk characterization is the final phase of the risk assessment, where risk assessors use

the results of the analysis phase to estimate risk, describe the risk (using multiple lines of evidence), and finally to identify and summarize the uncertainties, assumptions, and qualifiers in the risk assessment (EPA 1998). Following the risk characterization, an evaluation of background chemical concentrations will be conducted, consistent with EPA guidance on background (EPA 2002). This information will be used to help in making risk management decisions for the site.

Consistent with EPA guidance (1989), the goal of the ERA process is not to eliminate uncertainties, but to reduce them to a level that can support sound risk management decisions. This process will result in the identification of those pathways and areas of the site that warrant evaluation for possible remedial action. To assist in this process, risk management decision points (e.g., COPC selection for fish) will be considered at various intervals in the Portland Harbor Superfund Site remedial process. Additional field sampling plans will be developed as the project proceeds through each round of data collection.

To evaluate ecological risks at the site, the following overall process has been established:

- Compile and review existing data and information about the LWR
- Develop, using the problem formulation process, a CSM and identify assessment endpoints, representative species, risk questions, and measures for the PRE and BERA
- Develop a work plan that presents an analysis approach for assessing risks and identify data needed to assess risk
- Collect and analyze data as required to complete a PRE
- Identify remaining data gaps
- Collect additional data
- Conduct PRE and prepare report
- Refine CSM and identify remaining data gaps
- Fill data gaps (e.g., collect site-specific ecological information on selected receptors)
- Conduct a draft BERA for the site
- Collect remaining data
- Conduct final BERA and prepare report.

In this process, data needs will be identified through an iterative process of data analysis and field work. In this document, existing ecological data are used to

determine data needs for field sampling events through a problem formulation approach. Using this approach, representative species for the site were selected and data needed to further evaluate risks to these species were identified. The first data collection efforts occurred before issuance of the AOC in 2000 and 2001 (Round 0). Since the AOC, a single round of data collection has occurred — Round 1 in 2002. Additional sampling rounds will begin in 2003. To design the 2003 sampling round, the spatial coverage of the Round 1 and historical data will be reviewed with regard to known contaminant sources and representation of receptor habitat and home ranges. In addition, co-located sample analyte concentrations will be reviewed to evaluate the relationship between tissue and sediment concentrations. If no correlation is seen between the tissue and sediment chemistry, various hypotheses will be evaluated with EPA and EPA's Partners and additional sampling may be conducted. Additional sampling needs may be identified for subsequent rounds, as needed, based on this review of Round 1 data.

Existing data and data from the 2002 sampling events will be analyzed in an upcoming PRE document to determine remaining data needs that will be addressed either in the remainder of the Round 2 sampling season or in subsequent rounds if needed. The PRE is used as an interim tool to assist in the risk assessment process. The intent of the PRE is to facilitate a better understanding of the CSM and to assist in future discussions regarding uncertainty in making risk management decisions.Because ERA sampling in Round 1 targeted mainly fish and invertebrate (crayfish) tissues and sediments, the PRE will focus on assessing risk to fish and wildlife receptors. The PRE will include data presentation and an evaluation of the potential ecological risk based on data collected as part of the Round 1 data collection effort. The PRE will be conducted using conservative exposure assumptions, with the purposes of identifying key exposure pathways on which to focus more detailed analyses and identifying potential data gaps. The PRE results will be used to identify preliminary COPCs for fish tissue and possibly some of the wildlife receptors (e.g., those with lower sediment ingestion rates; COPCs for the sandpiper, with it's high sediment ingestion rate, could not be identifed) for which additional evaluation is necessary in the BERA to answer risk assessment questions and risk management decisions. Specifically, the PRE will be used to help facilitate discussions at the site, but not to limit pathways or receptors. Any future limitations of COPCs, receptors, and/or pathways will be discussed with EPA and EPA's Partners prior to that decision.

Following Round 2 sampling, the database will be evaluated for any remaining data gaps and additional sampling will be conducted where necessary to complete the risk assessment. A BERA will be prepared to assess ecological risks at the site and to aid in the remedial decision-making process for the Portland Harbor Superfund Site using the RI/FS process.

1.4 INTEGRATION WITH RI/FS WORKPLAN

The ERA process outlined in this document will augment and support the RI/FS data collection effort and analysis that is described in the Programmatic RI/FS Work Plan. The ERA and the RI/FS approach have been developed in concert to meet project requirements and to facilitate combined data collection and evaluation efforts. The RI/FS Work Plan is organized into the following major sections:

Section 1. Introduction
Section 2. Physical Setting
Section 3. Chemical Sources
Section 4. Summary of Previous Investigations
Section 5. Preliminary CSM
Section 6. Overview of Portland Harbor RI/FS Process
Section 7. Site Characterization Approach
Section 8. Feasibility Study Approach
Section 9. Project Management Plan

The information presented in the RI/FS Work Plan Section 2 was used in the development of the ERA CSM. The information provided in Sections 3 and 4 of the RI/FS Work Plan was used to further refine and develop the ERA CSM. A summary of the ecological CSM is provided in Section 5 of the RI/FS Work Plan. A summary of the ecological risk assessment approach, ERA data quality objectives (DQOs), and the approach for evaluation of the groundwater pathway is provided in Section 7 of the RI/FS Work Plan.

1.5 UTILIZATION OF ERA PROCESS IN PROJECT DECISION-MAKING

The ERA process is a tool to help managers make informed risk management decisions about site remedial actions. The EPA-prescribed iterative process for ERAs (e.g., moving from conservative assumptions, such as 100 percent site use, to more realistic and accurate site-specific assumptions, such as actual site use (which may be less than 100 percent) helps to better understand the assessment on those critical pathways, receptors, and exposure scenarios that warrant further action (EPA 1992, 1998).

The PRE will provide data and evaluations for the following:

- Refinement/better understanding of the CSM
- Identification of data gaps to reduce uncertainty in the BERA

- Preliminary COPC list for fish tissue and possibly wildlife receptors (following discussion and agreement with EPA)

The PRE will not be used to limit the benthic assessment or to prematurely limit or focus Round 2 sampling for the wildlife assessment. In addition, the PRE will not be used to limit COPCs for pathways that have not been evaluated (e.g., surface water for fish). All COPCs will be carried forward for evaluation and discussion in the BERA.

The BERA will provide data and evaluations for the following:

- Refinement of the CSM
- Final COPC and COC list for ecological receptors
- Preliminary Remediation Goals (PRGs) for ecological receptors
- Maps of SMAs based on unacceptable ecological risk
- Technical basis for identification of potential remedial alternative
- Potential identification of data gaps to reduce uncertainty in risk management decisions

1.6 DELIVERABLES

A data report will be produced and delivered within 120 days of receipt of the validated analytical results for Round 1. In addition, the PRE will be developed. The target date for a draft of this document is winter 2004. This report will summarize the information gathered from Round 1 and present a preliminary ERA. The PRE report will summarize the data collection effort, evaluate the data in a risk assessment framework using conservative assumptions (e.g., 100 percent site use), and identify data gaps to reduce uncertainties as the ERA process moves through the EPA tiered process. These conservative assumptions are used at this initial stage in the ERA process to ensure no pathways, COPCs, receptors, or exposure scenarios are missed in the evaluation process (for those pathways that can adequately be assessed in the PRE). Following the PRE, more realistic, site-specific assumptions will be used to more accurately characterize risk. This iterative process, as prescribed by EPA (EPA 1997, 1998) will ultimately (following the BERA) result in a focus on only those problem areas, media, COPCs, or pathways that may warrant remedial action (i.e., an accurate depiction of true risk, based on site-specific considerations).

The PRE and BERA will contain the following information and evaluations:

- Introduction
- Summary of data collection effort (ecological field summary, ecological habitat/habitat characteristics summary, analytical data summary)
- Summary of data evaluation process
- Problem Formulation
- Exposure and Effects Analysis
- Risk Characterization
- Identification of Uncertainties and Data Gaps
- Recommendations for additional information/data to reduce uncertainties and fill data gaps
- Conclusions.
- Risk Management Recommendations

Risk management recommendations will be presented in a separate section (or separate document) after the conclusion of risk characterization and the identification of uncertainties. The target date for delivery of a draft PRE Report is winter 2004. Although there is no predetermined number of sampling rounds, it is anticipated that multiple rounds of sampling will be required for the BERA. The BERA Report will include results from multiple iterations of the ERA process, from the conservative assumptions used in the PRE (e.g., 100 percent bioavailability and/or site use) to more realistic assumptions (e.g., actual bioavailability and/or site use) and estimates of risk based on site-specific information. The analysis performed for the draft BERA may also identify the need to reduce uncertainties in the final ERA, either to support the risk characterization or to refine risk management decisions. Such data gaps will be addressed during subsequent rounds of sampling .

2.0 PROBLEM FORMULATION

This problem formulation defines assessment endpoints and examines historical and ecological information pertaining to the site to develop a CSM. A CSM is a depiction of the transport of COPCs from sources through exposure pathways to receptors. The CSM is important in providing a framework for the ecological risk assessment. Section 2.1 discusses selection of assessment endpoints and measures to be used during the PRE and BERA. Sections 2.2 and 2.3 characterize the ecological receptors in the site and the habitats they utilize. Special status species are considered in Section 2.4. Section 2.5 uses all the previous information to identify receptors for the PRE and BERA. Section 2.6 identifies potential exposure pathways for these receptors.

It is assumed that any unacceptable ecological risk that may exist is primarily derived from chemicals in sediment. The chemicals may have reached the sediment through groundwater, seeps, upstream sources via surface water transport, upstream sources via sediment transport, or local sources via storm drains, overland flow, bank erosion. The assessment endpoints were selected to evaluate potential impact from the sediments as the primary medium of concern, with potential secondary (contributing sources) media being groundwater and surface water. Potential chemical contaminants include a wide range of organic and inorganic chemicals.

2.1 SELECTION OF ASSESSMENT ENDPOINTS AND MEASURES

The identification of assessment endpoints and measures is essential to the preliminary risk evaluation process. These components are used to focus the ecological risk assessment and ensure that the various attributes of the site are considered from an ecological standpoint when making risk management decisions.

The overall objective for the ecological risk assessment is to identify the risks to ecological receptors from site-related chemicals. If unacceptable risk to ecological receptors is present at the site, the chemicals causing the risk and their pathways to ecological receptors will be identified and become input to risk management decisions about the site.

2.1.1 Assessment Endpoints

The selection of assessment endpoints is an important component of the ERA because the endpoints define the important ecological values that are to be protected (EPA 1998). Assessment endpoints describe both the ecological entity to be protected (i.e., a species, ecological resource, or habitat type) and the characteristics of the entity to be protected (e.g., reproductive success). They are

developed based on known information concerning the chemicals present, the environment, and the risk management goals. The development of assessment endpoints aids in clearly defining the goal of the risk assessment and helps to focus efforts.

The assessment endpoints for the ERA were selected based on the following criteria (EPA 1998) and consistency with the AOC:

- Ecological relevance
- Political, societal, and cultural relevance
- Susceptibility to known or potential chemical stressors at the site
- The concepts of habitat viability and functioning of the system
- Consistency with ecological management goals for the site

Assessment endpoints will be evaluated at one of the following levels:

- Individual level
- Population level
- Community level.

These levels are defined according to the values to be protected in the ERA. Species of special status are the only receptors that will be assessed at the individual level, as mandated by EPA guidance (EPA 1997, 1998). In an individual level assessment, the receptor is assessed with the objective of protecting every individual of the population as opposed to accepting adverse effects on some portion of the population.

If a population-level endpoint is selected, it is generally accepted that adverse effects on individuals may be acceptable as long as the overall viability of the population is not significantly affected. Often, single species are selected as a surrogate for populations of other species that have similar exposure pathways (e.g., feeding guilds). Population-level analysis is often an extrapolation from exposure and effects analyses at individual levels. This is usually done because the most precise information on toxicity is often available for the individuals in laboratory tests

A community-level assessment values the community as a whole, and assumes that adverse effects on some species in the community may be acceptable as long as the overall functional structure of the community is not adversely affected. Most ecological communities contain multiple species that occupy similar niches and serve similar ecological function (e.g., shredders and grazers in benthic

communities). Therefore, adverse effects on one species may not affect the overall function. However, significant effects on multiple species with similar function could affect the community to levels at are ecologically meaningful. Community-level assessment does not evaluate a single species as a receptor. Instead, risk assessment tools focus on multiple species in the community, often drawing on whatever relevant toxicological information is available.

Fish, birds, and mammals will be evaluated at the population level. Aquatic plants, amphibians, and reptiles will also be evaluated on population level. However, because very little exposure and toxicity information is available that allows assessment of any single species the assessment may be performed collectively as a community. Benthic invertebrates and aquatic plants are typically evaluated at the community level because many species are co-located in a localized "community" with little to no movement occurring within the habitat. A community-level assessment of benthic invertebrates will therefore be conducted in Portland Harbor. A population level assessment will also be conducted, as feasible. However, due to practical limitations and the available exposure and toxicity information, the population assessment will likely be more qualitative. Remedial decisions will be based on a community assessment. These levels of assessment were developed based on the SOW and are the levels at which the Lower Willamette Group (LWG), in collaboration with EPA and EPA's Partners, expects to make risk management decisions.

The following assessment endpoints were selected for the Portland Harbor Superfund site. Specific receptor species were selected for assessment to meet the goals set by the assessment endpoints and are identified in Section 2.5.

Assessment Endpoint No. 1: Survival, growth, and reproduction of aquatic plant populations

Aquatic plant communities play an important role in river ecosystems. Diverse and complex aquatic plant communities provide important resources for other aquatic species that inhabit the river ecosystem (Figure 2-1). Many birds, aquatic mammals, amphibians, fish, and invertebrate species rely on aquatic plant communities for nesting and breeding habitat. In addition, these communities provide food for herbivores as well as refuge for higher-trophic-level organisms and habitat for their prey. The physical presence of aquatic plants reduces the velocity and volume of water flowing close to river banks, decreasing erosion and protecting adjacent upland areas from flooding. Plants are also an important source of energy in the river ecosystem. Through photosynthesis, plants utilize light energy to produce biomass for higher trophic organisms. Plants also play an important role in the cycling of nutrients throughout the system. Nutrients in the soil and the water column are taken up and stored in plant tissues. These stored nutrients are further cycled through the system as herbivorous aquatic fauna consume plant tissues and pass these nutrients up the food web. Decomposing

plant litter is consumed by detritivorous organisms that return organic matter and nutrients to the soil.

Chemicals in the ecosystem may impact the survival and growth of plant species and adversely affect plant communities. In addition, chemicals can be taken up by plants and transferred through the food web through consumption by higher-trophic-level species.

Assessment Endpoint No. 2: Survival, growth, and reproduction of benthic invertebrate and shellfish populations

Benthic invertebrates serve various functions in large river ecosystems. Both infaunal and epifaunal benthic invertebrates often comprise a significant portion of the biomass and serve as a principal food resource for higher-trophic-level consumers (i.e., fish and wildlife). The benthic invertebrate community plays a vital role in nutrient cycling. This community acts as the link between detrital material deposited on the river bed and the higher trophic levels. Chemicals within the ecosystem can directly impact the survival, growth, and reproduction of the benthic community and can also be transferred through the food web through prey consumption by higher trophic level aquatic fauna.

The infaunal community occurs in the surface sediments, generally the uppermost 10–15 cm, feeding on decaying vegetation, decaying animal biomass, and feces. The epifaunal community occurs either on the surface of the river sediment or attached to hard substrates (e.g., rip-rap, pilings, bulkheads) and is the most diverse benthic invertebrate community in the ISA. This community plays an important role in nutrient cycling and also comprises a major portion of fish and aquatic bird diets. Large benthic invertebrates in the ISA, such as shellfish and crayfish, provide a valuable food resource for fish and avian species. Alteration in the community structure can result in the loss of forage species, which may result in a loss of the functionality of the system. For example, shorebirds, juvenile salmonids, and other carnivorous fish rely heavily on the invertebrate community for their prey base. Therefore, adverse impacts to the benthic community may result in adverse effects on these bird and invertivorous fish populations. In addition, higher trophic level animals that depend on these bird and fish populations can subsequently be affected.

Assessment Endpoint No. 3: Survival, growth, and reproduction of fish

Several different feeding guilds of fish comprise the fish community in the ISA. Each feeding guild plays a distinct role in the dynamics of the river ecosystem. Detritivorous fish feed predominantly on detritus, and are frequent prey of higher-trophic-level fish and birds (Figure 2-2). Omnivorous/herbivorous fish feed upon both vegetation and invertebrates, and also may serve as prey for piscivorous fish, birds, and mammals. Invertivorous fish feed predominantly on benthic and pelagic invertebrates. Both omnivores and invertivores impact invertebrate

community composition and size, and also transfer energy and nutrients to higher-trophic-level fish, birds, and mammals. Piscivorous fish feed predominantly on smaller fish species and serve as top fish predators. Chemicals within the ecosystem can have potentially adverse effects on the fish populations by directly impact the survival, growth, and reproduction of fish species. The specific assessment endpoints are as follows:

- Survival, growth, and/or reproduction of herbivorous fish
- Survival, growth, and/or reproduction of detritivorous fish
- Survival, growth, and/or reproduction of invertivorous fish
- Survival, growth, and/or reproduction of picivorous fish

The feeding guilds of fish represented in the ISA are important pathways of nutrients and energy throughout the food chain and the ecosystem. Many bird and aquatic mammal species rely on fish for food. Fish of all feeding guilds are important in the maintenance of a balanced ecosystem and in the nutrient and energy cycles between aquatic primary producers and higher levels in the food chain, both aquatic and terrestrial. Alteration in the fish community structure can result in a loss of the functionality of the system. Chemicals within the system can directly impact the survival, growth, and reproduction of the fish species and adversely affect fish populations. Threatened and endangered fish species will be assessed at the individual level and all other fish species at the population level.

Assessment Endpoint No. 4: Survival, growth, and reproduction of amphibian and reptile populations
Amphibian and reptilian communities play an important role in energy flow in aquatic systems. They feed on aquatic invertebrates and small fish and are prey items for birds, mammals, and fish (Figure 2-1). Many fish species consume tadpoles both as juveniles and as adults. Adult amphibians are preyed on by fish. Birds and mammals also consume adult and juvenile amphibians. In some aquatic systems, amphibians and reptiles provide an important pathway by which nutrients and energy are transferred between the aquatic and terrestrial ecosystems. The survival, growth, and reproduction of amphibian and reptilian populations can be adversely affected by chemicals in the aquatic ecosystem.

Assessment Endpoint No. 5: Survival, growth, and reproduction of birds
Birds utilizing the ISA are from several different feeding guilds, each filling a distinct ecological role in the ecosystem (Figure 2-1). Herbivorous birds feed predominantly on aquatic plants and provide a direct pathway of energy and

nutrients from primary producers in the aquatic environment to higher levels in the food chain, both aquatic and terrestrial. They also influence aquatic plant community composition, population size, and structure and serve as prey for organisms higher in the food chain. Invertivorous birds feed on insects and other benthic invertebrates and provide a pathway of energy and nutrients to higher levels in the food chain. Omnivores and invertivores help regulate insect community composition, population size, and structure and serve as prey for organisms higher in the food chain. Piscivorous birds feed on fish and may serve as the top predators in the ISA. They provide another pathway for energy and nutrients to be transferred from the aquatic to the terrestrial ecosystem, and regulate fish community composition and population size and structure. Because most piscivorous birds are in higher trophic levels, they are potentially exposed to greater levels of contamination due to biomagnification of certain chemicals up the food chain. Chemicals present in the food chain may adversely affect bird populations by impacting the survival, growth, and reproduction of avian species. The specific assessment endpoints are as follows:

- Survival, growth, and/or reproduction of invertivorous/omnivorous birds
- Survival, growth, and/or reproduction of carnivorous/omnivorous birds
- Survival, growth, and/or reproduction of picivorous birds

Birds are an important component of the ecosystem and are highly valued by society. They transfer energy and nutrients throughout the food chain and between ecosystems (aquatic and terrestrial), and regulate populations up and down the food chain. Threatened and endangered bird species will be assessed at the individual level and all other bird species at the population level.

Assessment Endpoint No. 6: Survival, growth, and reproduction of mammals
Mammals utilizing the ISA are predominantly piscivorous (Section 2.3.4); however, their diet may include amphibians and aquatic invertebrates (Figure 2-1). Piscivorous mammals provide a pathway for energy and nutrients to be transferred from the aquatic to the terrestrial ecosystem and may serve as prey for other predators. By feeding on fish and invertebrates, they influence fish and invertebrate community composition, population size, and structure. They are relatively high on the food chain and may be exposed to greater levels of chemicals due to biomagnification of chemicals up the food chain. Mammals are valued highly by society. Chemicals present in the food chain may adversely affect their populations by impacting their survival, growth, and reproduction. Mammals will be assessed at the population level. The specific assessment endpoints are as follows:

- Survival, growth, and/or reproduction of piscivorous mammals

2.1.2 Testable Hypotheses

Following selection of assessment endpoints, testable hypotheses and measures of effect must be developed to determine whether or not a potential risk to the assessment endpoint exists (EPA 1997). A testable hypothesis is an operational statement of an investigator's research assumption made in order to evaluate logical or empirical consequences (EPA 1997, 1998). For the purpose of this risk assessment, the testable hypotheses are presented as risk questions about the relationship between the assessment endpoints and the responses of receptors when exposed to chemicals at the site. The general risk question: "are the chemical concentrations in media in the ISA sufficient to cause adverse effects on the survival, growth, or reproduction"? applies to the following assessment endpoints (Section 2.1.1):

- Aquatic plants
- Benthic invertebrates
- Shellfish
- Herbivorous fish
- Detritivorous fish
- Invertivorous fish
- Picivorous fish
- Amphibians
- Reptiles
- Invertivorous/omnivorous birds
- Carnivorous/omnivorous birds
- Picivorous birds
- Piscivorous mammals

Habitat and receptors, where appropriate, will be considered outside of the ISA if there is a potential for exposure to site-related contamination. More specific

questions are addressed for each assessment endpoint. These questions and the proposed approach are presented in Sections 4 and 5. Development of risk questions correspond to the "Identify the Decisions" step in EPA's DQO process.

2.1.3 Measures

Three categories of measures that are, in combination, predictive of the assessment endpoints (EPA 1998) will be evaluated in the Portland Harbor ERA:

- Measures of exposure
- Measures of ecological effects
- Measures of ecosystem and receptor characteristics.

Criteria considered in the selection of measures include (EPA 1998):

- Corresponds to or is predictive of an assessment endpoint
- Can be readily measured or evaluated
- Is appropriate to the exposure pathway
- Is associated with low natural variability
- Is not disruptive to the ecological community and species variability
- Is appropriate to the scale of the ISA.

The scale of the ISA may be larger or smaller that the home range of a receptor of interest. Therefore, the scale will be defined in ecological terms. Localized effects will be evaluated based on exposure to the receptors of interest.

2.1.3.1 Measures of Exposure

Measures of exposure are measures of the contact or co-occurrence of the stressor and the receptor (EPA 1998), and include concentrations of COPCs in sediments, surface water, groundwater, and biota. Section 5.0 provides a discussion of the process that will be used to identify COPCs in the various media in the PRE and BERA.

2.1.3.2 Measures of Ecological Effects

Measures of ecological effects are used to evaluate the response of the assessment endpoint receptors when they are exposed to the stressor (EPA 1998). Measures of effect are measurable changes in an attribute of an assessment endpoint or its surrogate in response to a stressor to which it is exposed (EPA 1998). In practice, measurable changes can be based on site-specific measurements of effects, or extrapolation from empirical measurements at other site (e.g., application of TRVs to predict effects). Measures of ecological effects on an individual level

will be performed by comparison to a NOAEL and on a population level by comparison to a LOAEL. Identification of measures is also dependent on the level of biological organization being protected in the assessment endpoint.

Individual-level measures:
Effects on survival, growth, or reproduction for individuals of special-status species (see Table 2-8)

Population-level measures:
Effects on survival, growth, or reproduction for aquatic plants, benthic invertebrates, shellfish, amphibian, reptile, fish, bird, and mammalian populations

Community-level measures:
Effects on survival, growth, or reproduction for benthic invertebrate communities

2.1.3.3 Measures of Ecosystem and Receptor Characteristics
Stressors other than chemical toxicity affect the assessment endpoints and can be important in interpreting risks and making decisions. In addition, such factors may modify exposure, such as the frequency and duration of exposure and, therefore, are important considerations in estimating risks. Factors that may modify the potential for adverse effects include predation, habitat alterations, temperature and dissolved oxygen. These measures of ecosystem and receptor characteristics that may have an adverse effect on the ecological community or population will be identified and discussed qualitatively in the context of the chemical-specific risk estimates, the ultimate goal being to estimate those risks attributable to site-related COPCs.

2.2 HABITAT TYPES IN THE LOWER WILLAMETTE RIVER

The majority of the ISA is industrialized, with modified shoreline and nearshore areas. Wharves and piers extend out toward the channel, and bulkheads and riprap revetments armor the riverbank. Active dredging has produced a uniform channel with little habitat diversity. However, some segments of the ISA, as well as areas upstream and downstream of the ISA, are more complex with side channels, shallow water areas, and less shoreline development, providing habitat for a suite of local fauna. This section describes the general types of habitat in the LWR available to ecological species.

2.2.1 Open-water Habitat

The lower main stem of the Willamette River, i.e., Willamette Falls to the confluence with the Columbia River, is characterized by a developed navigation channel and shoreline. Most open-water habitat in the ISA is in the main river channel, but also includes several shallower backwater sites (e.g., Willamette

Cove, Swan Island Lagoon, and slips). The deep, open water provides foraging habitat for fish and wildlife that feed in the water column. Shallow-water habitats provide refuge for juvenile salmonids as well as greater foraging opportunities for birds and mammals. Aside from Willamette Cove and Swan Island Lagoon, shallow-water habitats are largely limited to the narrow strip between the shoreline and the navigation channel.

There are three types of benthic habitats in the open water of the LWR: 1) unconsolidated sediments (sands and silts) in the deeper water (greater than approximately 20 ft Columbia River Datum [CRD]) of the navigation channel and lower channel slopes, 2) unconsolidated sediments (sands and silts) in water depths less than 20 ft CRD in gently sloping nearshore areas (e.g., beaches and benches) and on the upper channel slopes, and 3) developed shoreline (e.g., rock riprap, sheet pile, bulkheads). The navigation channel habitat is subject to variable (seasonal and annual) hydrodynamic forces, the impacts of navigation, natural sediment deposition, erosion, and bedload transport, and periodic navigational dredging. These forces vary spatially through the system largely as a function of the channel cross-sectional area and this results in both relatively stable and unstable sedimentary environments that likely support heterogeneous infaunal communities controlled by the local physical regime. In the relatively shallow, nearshore areas, natural hydrodynamic forces are likely less temporally variable. The physical sedimentary regimes are a function of the local riverbank morphologies, and sheltered areas away from anthropogenic disturbance factors should support well-developed infaunal invertebrate communities. Conversely, exposed nearshore areas, particularly around berths, docks, and boat ramps, likely have limited benthic communities controlled by physical disturbance factors. The hard surfaces of the developed shoreline should provide habitat for an epibenthic community. Benthic surveys and maps have been done using sediment profile imaging (SCT 2002f and Work Plan Figure 2-14).

2.2.2 Bank and Riparian Habitat

The Portland Bureau of Planning mapped the banks of the Willamette River from the confluence with the Columbia River to Ross Island at RM 15 (Greenworks et al. 2001). They calculated the percentage of the banks in seven categories ranging from river beach to sea wall. Riprap and unclassified fill combined make up about half of the shoreline in this 15-mile section of the LWR (Figure 2-3).

The type of river bank is expected to influence the species of fish utilizing a given area. The Oregon Department of Fish and Wildlife (ODFW) has conducted several studies addressing this issue (see Section 2.3.2.2). A common factor associated with beneficial habitat for juvenile salmonids is the presence of large woody debris along river banks, which generates small shallow pools and provides cover (Sedell and Froggatt 1984; Bjornn and Reiser 1991). However, no comprehensive survey of large woody debris has been conducted for the LWR,

and little opportunity currently exists for large woody debris recruitment to the river banks due to the general absence of mature trees along much of the shoreline.

The upland environment near the LWR is primarily urban, with fragmented areas of riparian forest, wetlands, and associated upland forests. Historical development and filling of channels and wetlands has left only small strips or isolated pockets of riparian wildlife habitat. Therefore, isolated wildlife habitat areas along the LWR corridor exist, but linkages to the larger landscape are limited.

The City of Portland's natural resource inventory of the Willamette River corridor classified the habitat based on characteristics such as connectivity to other areas, access to water, and other factors in order to determine their overall habitat value (Adolfson et al. 2000). Ten distinct habitat classes were identified along the 16-mile stretch of the Willamette River from Sellwood to the Columbia River, including bottomland forest, foothill savanna, conifer forest, scrub/shrub, meadow, emergent wetland, beach, rock outcrop, open water, and unvegetated/disturbed. Fifteen sites of significant habitat value were designated as "habitat sites" for fish and wildlife. The habitat sites identified in the ISA were the South Rivergate corridor at the north end of the ISA, the Harborton forest and wetlands, Willamette Cove, the railroad corridor, and the Swan Island beaches and lagoon on the southern end (Adolfson et al. 2000). The available wildlife habitat in the ISA is shown in Figure 2-3. Other important habitat sites identified in the general area were Kelley Point at the confluence with the Columbia River, and Ross Island and Oaks Bottom Complex around RM 16. The habitat sites listed are known to be utilized by numerous aquatic birds and aquatic and semi-aquatic mammals (Adolfson et al. 2000).

2.3 HABITAT UTILIZATION AND POTENTIAL ECOLOGICAL RECEPTORS

2.3.1 Benthic Invertebrate Community

Benthic invertebrates serve various functions in large river ecosystems. Both infaunal and epifaunal benthic invertebrates often comprise a significant portion of the heterotrophic biomass in a river system (Jahn and Anderson 1986), and therefore, serve as a principal food resource for higher-trophic-level consumers. Invertebrates also control energy flow by acting as the principal processor of organic matter (Merritt et al. 1984).

Benthic invertebrates utilize various habitat types within a large river ecosystem. These habitats can generally be divided into soft and hard substrates, with soft substrates supporting an infaunal community and hard substrates an epifaunal

community. These habitats are typically quite different in their community structure and function.

The structure and function of invertebrate communities within portions of the Willamette basin have been extensively investigated. However, few studies have focused on the lower main stem. Tetra Tech (1994) reported benthic invertebrate community structure at six stations as part of the Willamette River basin water quality study. Dames & Moore (1998) sampled 16 stations in the Portland Harbor area, and Landau (2000) collected samples at 10 locations near Ross and Hardtack Islands. Other limited investigations have been conducted by Hjort et al. (1984) and Ward et al. (1988). Table 2-1 contains a list of all the invertebrate taxa collected in the LWR.

2.3.1.1 Infaunal Community Structure and Function

Limited site-specific data exist on the infaunal invertebrate community of the lower main stem of the Willamette River. Tetra Tech (1994), Dames & Moore (1998), and Landau (2000) sampled the infaunal invertebrate community in the LWR. The infaunal community was reported to be dominated by oligochaetes (segmented worms) and chironomids (midge larvae) that are considered gatherers consuming organic material associated with the sediments. Other infaunal species documented include the burrowing mayfly (*Hexagenia* sp.), nematodes, fingernail clams, and freshwater mussels.

Dames & Moore (1998) collected 16 benthic infaunal samples in the Portland Harbor area, and about a third of the sampling stations were located near the Portland Shipyard and in Swan Island Lagoon. They found the abundance of oligochaetes and chironomids at the Portland Shipyard stations to be approximately 50% less than in other sampled areas of the mainstem Willamette River.

Oligochaetes feed on bacteria, diatoms, detritus, and other microorganisms by ingesting large quantities of substrate and extracting organic material. Some species live from 1 to 3 cm below the sediment surface, while others live in tubes attached to filamentous algae, submerged plants, and terrestrial debris (Brusca and Brusca 1990). Most oligochaetes are found in waters less than 1 m deep; however, Tubificidae species can be found in the very deep waters of large lakes and rivers (Pennak 1978).

Chironomids are the only infaunal dipterans occurring in the LWR. Chironomids possess a juvenile aquatic life stage and become terrestrial after their metamorphosis into adult form. Chironomid larvae are herbivorous, feeding primarily on algae, aquatic plants, and detritus. Some species are solitary and free-living, while others are found in large congregations. Infaunal chironomids are burrowers. They are primarily algae collector/gatherers and detritus shredders. Chironomid larvae make up an important component of freshwater

fish diets and comprise the most diverse family of infaunal organisms found in the LWR (Pennak 1978).

Burrowing mayflies are primitive winged insects in which the aquatic nymph stage has come to dominate the life cycle. Larvae hatch in fresh water and are long-lived, passing through many instars. Mayfly nymphs are an important food source for many fishes (Brusca and Brusca 1990).

Nematodes are also found in the LWR. They are free-living and parasitic roundworms generally found in freshwater substrates. In natural freshwater habitats, most specimens are confined to the uppermost 5 cm of the substrate (Pennak 1978). Many infaunal nematodes are direct deposit feeders. Others are detritivores or microscavengers, living in or on dead organisms. Some of the free-living nematodes are predatory carnivores. Others are herbivorous, feeding on diatoms, algae, and bacteria (Brusca and Brusca 1990).

The LWG collected van Veen (0.1 m^2) grab samples from 22 locations within the ISA in the fall of 2002 as part of the Round 1 assessment of Portland Harbor. As in the previous studies, the community was dominated by oligochaete worms and chironomid larvae. Bivalves (*Corbicula* sp.) and amphipods (*Corophium* sp.) were also relatively common. A complete review of the data collected in this survey is included in Attachment B1.

2.3.1.2 Epibenthic Community Structure and Function

Hjort et al. (1984) and Ward et al. (1988) conducted limited investigations of the benthic invertebrate community associated with shoreline habitats in the lower main stem of the Willamette River as well as similar sites in more upstream reaches. Landau (2000) collected shallow water benthic samples from hard substrates around Ross Island. Hjort et al. (1984) found high densities of benthic invertebrates associated with revetted shorelines in more upstream reaches. The solid substrate supported a taxonomically and functionally diverse community consisting of scrapers, grazers, filter feeders, and gatherers (Table 2-1). The epibenthic community in the LWR was represented by the following epibenthic invertebrates: ephemeropterans (i.e., mayflies), trichopterans (caddis flies), dipterans (true flies), crustaceans (both amphipods and crayfish), annelids, platyhelminthans, and mollusks.

During the summer of 2002, the LWG conducted a survey of the epibenthic community present in the LWR by deploying artificial substrates in the water column at ten locations in the ISA and two reference locations just upstream. Multiplate samplers were used as artificial substrates. After six weeks, the multiplate samplers were retrieved and all organisms that colonized the available substrate were identified. Chironomid larvae, oligochaete worms, and amphipods (*Corophium* sp.) dominated the epibenthic community collected on the multiplate samplers. *Corophium* sp. were present at all sampling locations from RM 4

through RM 13.5. The highest abundances were seen around RM 4.5, 5.5, 6.5, 9 and 13.5. The lowest abundances were seen in Swan Island Lagoon. A complete review of results from the multiplate sampler survey is included in Attachment B.1.

Most organisms collected during the infaunal and epibenthic surveys conducted by the LWG were consistent with the type of species expected for a deep river like the LWR. According to the River Continuum Concept, the invertebrate community in deep rivers is expected to be dominated by the feeding group called collectors (Vannote et al. 1980). Collectors are composed of both gatherers—organisms that forage for organic matter in the sediments—and filterers, organisms that filter organic matter out of the water column (Cummins and Klug 1979). The dominant taxa in the infaunal and epibenthic communities collected in the LWR all belong to the collector feeding group.

The following invertebrate taxa may be locally abundant in areas of the LWR that provide suitable habitats:

Oligochaeta
Oligochaetes feed on bacteria, diatoms, detritus, and other microorganisms by ingesting large quantities of substrate and extracting organic material. Some species live from 1 to 3 cm below the sediment surface, while others live in tubes attached to filamentous algae, submerged plants, and terrestrial debris (Brusca and Brusca 1990). Most oligochaetes are found in waters less than 1 m deep; however, Tubificidae species can be found in the very deep waters of large lakes and rivers (Pennak 1978).

Diptera
Four families of true flies are found in the LWR: Chaoboridae, Empididae, Simuliidae, and Chironomidae. All of the LWR dipterans are aquatic as juveniles and become terrestrial after they metamorphose into their adult form. *Chaoborus* larvae, also known as phantom midges, are predatory, feeding on small crustaceans and insect larvae. This genus is found throughout the water column, spending most of their time in the bottom waters and on the mud during the day and migrating to the surface water at night. Empididae larvae are sprawlers found on the substrate surface. They are collector/gatherers. The larvae of *Simiulumus*, also known as black flies, attach themselves to rocks and vegetation in shallow areas with swift current and feed on plankton and organic debris by straining prey items from the water with anterior fans. Chironomid larvae are herbivorous, feeding primarily on algae, aquatic plants, and detritus. Some are sprawlers and clingers, attaching themselves to or lying flat against rocks and other substrate. Others are infaunal burrowers, gathering organic matter in and on the sediments. They can be collector/gatherers, detritus shredders, or engulfing predators. Chironomid larvae make up an important component of freshwater fish diets and comprise most diverse and one of the most abundance families of benthic organisms found in the LWR (Pennak 1978).

Amphipoda

Amphipods are scavenging omnivores, feeding on various kinds of plant and animal material. They rarely feed on live animals, but they will consume freshly killed animals. During the daytime, amphipods are found in vegetation and in the crevices of and under debris and rocks. Amphipods, such as *Gammarus* spp., generally occur in water depths no greater than 1 m, and in large rivers such as the Willamette they are mainly found in shallow backwater and overflow pond areas (Voshell 2002). However, estuarine amphipods, such as *Corophium* spp., are locally abundant in the LWR and are commonly found in fine sediments over many depths (McCabe et al. 1997).

Decapoda

Two species of decapods occur in the LWR: Western freshwater crayfish (*Pacifastacus leniusculus*) and the Siberian prawn (*Exopalaemon modestus*). Crayfish have been collected throughout the LWR (Salmon 1972; ODEQ 1994; PTI 1992). Crayfish are omnivores with a diet composed mainly of aquatic vegetation, but they will eat fish, aquatic insects, and detritus when aquatic vegetation is less available (Pennak 1978). Adult crayfish remain in burrows, under stones or debris, or half-buried in substrate during the day and more actively feed between dusk and dawn. Juveniles, however, can be active during the day. Crayfish usually prefer shallow habitats but can be found in depths greater than 1 m. Most stream-dwelling crayfish have home ranges of less than 30 m (Pennak 1978). *Pacifastacus* sp. can live up to eight yr (Hobbs 2001). The Siberian prawn (*Exopalaemon modestus*) is an introduced decapod species in the LWR and the lower Columbia River that may have become well established (Emmett et al. in press). There are no native freshwater shrimp in the Pacific Northwest.

Mollusca

Two classes of mollusks occur in the LWR: Gastropoda and Bivalvia. The five genera of gastropods that may occur in the LWR are all freshwater snails. These gastropods are generally herbivorous, ingesting algae that coats submerged surfaces and other dead plant material by scraping the surfaces with a sclerotized jaw. On occasion they will also ingest dead animal material. Gastropods generally occur in water from 0-3 m deep. Hydrobiidae species generally occur in areas with aquatic vegetation. The barren juga (*Juga hemphilli hemphilli*) and Columbia pebblesnail (*Fluminicola fuscus*) are generally found in creeks and rivers with gravel-boulder substrate and that lack aquatic macrophytes and epiphytic algae (Frest and Johannes 1995). Little is known about the ecology of the rotund physa (*Physella columbiana*). It is thought that they occur in large rivers in relatively deep, well-oxygenated waters and prefer gravel-boulder substrates (Frest and Johannes 1995). Distribution of freshwater snails in the Willamette River is not well understood. Tetra Tech (1995) found *Fluminicola* species and *Juga* species at RM 25.5 in 1994, but no snails were found farther downstream. No snails were found at any stations sampled in 1993. No snails

were reported in the benthic grab samples collected by Dames & Moore (1998) or Landau (2000).

Two species of epibenthic bivalves may be found in the LWR. They include the Asiatic clam (*Corbicula fluminea*) and Western pearlshell (*Margaritifer falcata*). These species feed on zooplankton, phytoplankton, and organic detritus. They can occur in water up to 30 m deep, but are predominantly found in water depths from 0-2 m. They prefer stable sand and gravel substrates and are not generally found in areas of high turbidity or clay or rock substrate (Pennak 1978).

The introduced Asiatic clam is the most abundant bivalve in the LWR (Tetra Tech 1995; Dames & Moore 1998; Landau 2000). Tetra Tech (1995) found the highest densities of Asiatic clams between RM 1 and RM 6. Dames & Moore (1998) collected *C. fluminea* at 3 of 14 sampling stations, located at RM 9, RM 10.6, and in the Swan Island channel. Landau (2000) found *C. fluminea* in both deep water and shallow water locations around Ross and Hardtack Islands. The pearlshell mussel is common in the lower Clackamas River (Ellis 1998). However, benthic invertebrate surveys conducted in the LWR during the last seven years have not collected freshwater mussels (Tetra Tech 1995, Dames & Moore 1998, Landau 2000, Frest and Johannes 1995).

Nematoda

Nematodes are also found in the LWR. They are free-living and parasitic roundworms generally found in freshwater substrates. In natural fresh-water habitats, most specimens are confined to the uppermost 5 cm of the substrate (Pennak 1978). Many infaunal nematodes are direct deposit feeders. Others are detritivores or microscavengers, living in or on dead organisms. Some of the free-living nematodes are predatory carnivores. Others are herbivorous, feeding on diatoms, algae, and bacteria (Brusca and Brusca 1990).

Isopoda

Isopods in the LWR generally occur in water no deeper than 1 m. They are found under rocks, vegetation, and debris where they scavenge for food, preying on items such as dead and injured aquatic animals and aquatic vegetation.

Trichoptera

Caddis fly larvae are often found in shallow-water habitats where there is an adequate supply of oxygen. They can occur on all types of substrate, including rock, gravel, sand, mud, debris, and vegetation. There are three families of caddis flies in the LWR: Polycentropodidae, Hydropsychidae, and Leptoceridae. Polycentropodidae and Hydropsychidae are net filter feeders. They collect prey items by constructing a fine net that strains particulate material from the water. They feed either by eating the entire net and its contents or by removing the particulate matter they have collected from the nets. Leptoceridae are grazers. They feed on algae, fungi, detritus, and small invertebrates found on the river bottom.

Ephemeroptera
Mayflies are aquatic as juveniles and terrestrial as adults. Mayfly nymphs in the LWR are opportunistic feeders, consuming primarily aquatic plants and detritus. There are two genera of epibenthic Ephemeroptera in the LWR. *Baetis* nymphs tend to be free-ranging. When at rest they attach themselves to pebbles on the river bottom. *Stenonema* nymphs cling to rocks and other substrates and are found in highest abundance in crevices and under rocks (Pennak 1978). Burrowing mayfly nymphs, e.g., *Hexagenia* spp., are typically found in sandy or silty sediments (Hilsenhoff 2001). Mayfly nymphs are an important food source for many fishes (Brusca and Brusca 1990).

Eucopepoda
Eucopepods found in the LWR are classified in the suborder Calanoida. These copepods filter-feed on plankton and can be found in both littoral and benthic regions of rivers (Pennak 1978). Calanoids can comprise a major part of fish diets.

Heteroptera
The primary heteropterans in this system are the Corixidae, commonly known as water boatmen. These species can move throughout the water column and even fly to other areas in response to overcrowding, high temperatures, or unfavorable conditions. They spend most of their time anchored to the river bottom where they gather food by sweeping flocculent material into their mouths. They feed primarily on debris, algae, Protozoa, and microscopic Metazoa. Nymphs and adults may spend winters hibernating in the substrate, although they can also be active during the cold season (Pennak 1978).

Other Invertebrate Taxa
Annelids (Nereidae and Hirudinidae families) and Platyhelminthes (Tricladida family) are also found in the LWR epibenthic community. Most of the freshwater species in the family Hirudinidae (leeches) are common inhabitants of ponds, marshes, lakes and slow streams. Leeches prefer protected shallows, where there is little wave action and plants, stones, and debris provide protection. The great majority of specimens are collected in water depths of 0-2 m (Pennak 1978). Leeches prefer substrates to which they can adhere and consequently are uncommon on pure mud or clay bottoms. Nereidae are hunting predators, feeding mostly on small invertebrates. They are predominantly epibenthic, preferring protected habitats in mussel communities, algae, crevices, and under rocks (Brusca and Brusca 1990).

Animals in the phylum Platyhelminthes are free-living and parasitic flatworms. They are particularly successful as parasites and commensals. Most are carnivorous predators or scavengers, feeding on available animal matter (mostly small, living invertebrates). A few are herbivorous, feeding on macroalgae; some switch from herbivory to carnivory as they mature. Freshwater flatworms are found virtually everywhere, usually on or closely related to a substrate. Most

species are photonegative and are found under objects during the daytime. Flatworms thrive on any kind of substrate where there is an appropriate food supply (Pennak 1978).

Three species of freshwater mussels may occur in the LWR infaunal community. They are the California floater (*Anodonta californiensis*), Willamette floater (*Anodonta wahlametensis*), and western ridgemussel (*Gonidea angulata)* (Frest and Johannes 1995; Ingram 1948). The California floater and Willamette floater live buried in the soft substrates of large streams and lakes. They prefer relatively slow currents and are filter-feeders, as are the other freshwater mussel species (Frest and Johannes 1995). Ingram (1948) states that the California floater and Willamette floater were present at the mouth of the Willamette River; however, benthic invertebrate surveys conducted in the LWR during the last seven years have not found freshwater mussels (Tetra Tech 1995; Dames & Moore 1998; Landau 2000; Frest and Johannes 1995).

Fingernail clams (Sphaeriidae) are the only native clams reported in the LWR. Tetra Tech (1995) collected Sphaeriidae from the LWR in 1993 and 1994 at two sites located at RM1 and RM 25.5, with an average of 11.1 individuals per sample at RM 1 and 72.1 individuals per sample at RM 25.5. Fingernail clams can reach high densities, up to 10,000 individuals/m^2 in large rivers and can be the major food source for benthivorous fish and wildlife (Jahn and Anderson 1986).

2.3.2 Fish Species

Ellis (2000) conducted a comprehensive review of published and unpublished literature containing information pertinent to fish use of Portland Harbor. This review was conducted through searching ODFW, Oregon Department of Environmental Quality (ODEQ), Columbia River Intertribal Fish Commission, Bonneville Power Administration, U.S. Army Corps of Engineers, and the Northwest Power Planning holdings, published scientific journal articles, agency and private research reports, permit applications, biological assessments and biological opinions, and meetings with agency biologists familiar with the work that has been conducted on the river. In total, 36 documents were reviewed. Based on this review, 64 fish species that have been reported to occur or potentially occur in the LWR, were identified and are presented in Table 2-2. In addition to these reports, ODFW has completed the first year of a four-year study that addresses the diversity and abundance of fish in the LWR, their habitat use, migration patterns and rates, and food habits. Data from the first year of this study (North et al. 2001) are reviewed in Section 2.3.2.2.

Farr and Ward's (1993) sampling of the LWR from RM 0 through RM 17 in 1987 and 1988 using six different sampling methods provides the most recent and complete accounting of the fish of the LWR. In this study, 39 species of fish from 17 families were captured. Nineteen of these species from 7 families were exotic

species. Species not reported in previous studies included mountain whitefish (*Prosopium williamsoni*), redside shiner (*Richarsonius balteatus*), longnose dace (*Phinichthys cataractae*), mountain sucker (*Catostomus playrhynchus*), channel catfish (*Ictalurus punctatus*), three-spined stickleback (*Gasterosteus aculeatus*), sand roller (*Percopsis transmontana*), banded killifish (*Fundulus diaphanus*), smallmouth bass (*Micropterus dolomieui*), pumpkinseed sunfish (*Lepomis gibbosus*), walleye (*Stizostedion vitreum*), and starry flounder (*Platichthys stellatus*). They reported two additional fishes captured by anglers, pirapatinga (*Piaractus brachypomus*) and hybrid bass. The diversity of species from this study was higher than any previous study, possibly due to the wide variety of sampling methods and sampling over a longer timeframe. Several fish species that were not captured in this study but have been reported to be present in the LWR include the Pacific brook lamprey (*Lampreta pacifica*), speckled dace (*Rhinichthys osculus*), and tench (*Tinca tinca*), and several other fishes are suspected to occur due to their presence in adjacent waterways (Bond 1973; Wydoski and Whitney 1979).

Since the Farr and Ward (1993) study, several studies have sampled fish species over extended periods of time at specific locations within the harbor (Fishman 1999; Beak 2000). However, no additional fish species have been documented.

2.3.2.1 Fish Habitat Association

Several studies have addressed habitat association of both resident and migratory fish species in the LWR. Farr and Ward (1993) characterized the fish community in terms of bank preference up to RM 17 from 1987 to 1990. Results from this study suggested that non-indigenous species are more associated with moderately developed banks than indigenous species (Table 2-3). Migratory fishes, generally salmonids and American shad (*Alosa sapidissima*), are more evenly distributed between developed and undeveloped shorelines within Portland Harbor (Farr and Ward 1993).

Habitat use by juvenile salmonids in the LWR has been addressed in several studies. Ward et al. (1994) found no pattern to the horizontal distribution (distance from shore) of yearling chinook salmon (*Oncorhynchus tshawytscha*) or juvenile steelhead (*Oncorhynchus mykiss gairdneri)* in Portland Harbor. Sub-yearling chinook salmon were found closer to shore at developed sites than at undeveloped sites.

In 2000, ODFW mapped the banks of the LWR up to Willamette Falls (RM 26) and sampled the fish community using several different gear types to determine habitat preference (North et al. 2001). Mean electrofishing catch rates of juvenile salmonids, in the first year of this four year study, were highest at beach and rock sites in the LWR (North et al. 2001). However, these results were not significantly different from those in other areas, and data from radiotelemetry of

subyearling and yearling chinook suggested that rock outcrops were the most preferred habitat (North et al. 2001). Electrofishing catch rates of minnows, suckers, and sunfish were highest adjacent to riprapped banks (North et al. 2001). Additional data in the next three years of this four-year study will provide more information on the habitat associations of resident and migratory fish species in the LWR.

2.3.2.2 Resident and Migratory Fish Species

This section describes resident and migratory fish species that are known to be present, or that could occur based on life history characteristics in the LWR (Altman et al. 1997; Hughes and Gammon 1987; Friesen and Ward 1996; Farr and Ward 1992; Tetra Tech 1995; Beak 2000; Wydoski and Whitney 1979). Fish species were separated into feeding guilds based on the feeding preference of each species as an adult. The four feeding guilds are defined as omnivore/ herbivore (feeds on vegetation and invertebrates or solely vegetation); invertivore (feeds primarily on invertebrates including insects and benthic organisms); piscivore (feeds mostly on fish); and detritivore (feeds mostly on detritus). The diets of fish species in the ISA are somewhat flexible, with a great deal of overlap in diet among groups. For example, a study of piscivorous fish diets in Portland Harbor revealed that piscivorous fish are at least occasionally eating mainly insects and crayfish (Fishman 1999). Similar flexibility is expected in fishes from the other feeding groups. The abundance, feeding guild, habitat, food preferences, lifespan, and age of reproductive maturity of each fish species reported or expected to be found in the LWR, based on collection in the LWR or adjacent water bodies, are presented in Table 2-2.

The majority of fish species found in the LWR are resident species; thus, all life stages may be present within the LWR. These fishes may move upstream and downstream or offshore and inshore in response to water temperatures, food availability, and river flow, but do not have seasonal mass migrations for spawning or feeding. In addition, several species of migratory fishes use the LWR for juvenile rearing and as a migration corridor for both adult and juvenile fishes (Table 2-2). Although spawning habitat for many of these resident and migratory species may occur in the LWR, no studies to date have documented specific spawning locations for any fish species within the LWR.

Omnivores /Herbivores

Thirteen omnivorous fish may occur in the LWR (Table 2-2). The largescale sucker (*Catostomus macrocheilus*), white sturgeon (*Acipenser transmontana*), common carp (*Cyprinus carpio*), brown bullhead (*Ameiurus nebulosus*), and yellow bullhead (*Ameiurus natalis*) are a few examples of common omnivorous species. All of these species are residents of the LWR with the exception of white sturgeon, which is considered semi-anadromous. In addition, all of the omnivorous species are predominantly bottom-feeders.

The largescale sucker, a member of the Catostomidae family, is native to the LWR. It has a long life span (up to 15 yr) and reaches reproductive maturity at age 3-5 yr (males) and 4-6 yr (females) (Wydoski and Whitney 1979). The largescale sucker generally inhabits large riverine and estuarine waters; however, it prefers to remain close to the bottom in shallow waters both as a juvenile and as an adult. It consumes insect larvae as a juvenile, and diatoms, detritus, crustaceans, and snails as an adult (CBFWA 1996). This native fish is known to consume large amounts of sediment during feeding as an adult (CBFWA 1996). The largescale sucker is common throughout the LWR (Beak 2000; Farr and Ward 1992; Hughes and Gammon 1987; Tetra Tech 1995). The general habitat of this species is included in Figure 2-6.

The white sturgeon is another common omnivore in the LWR and although semi-anadromous, is present both as an adult and as a juvenile. Sturgeon rely on large, complex river systems for many of their life stages and can feed opportunistically on prey ranging from benthos to large fish (Beamesderfer and Farr 1997). They can have very large home ranges; one study of Columbia River white sturgeon noted the recapture of a marked Columbia River sturgeon in Puget Sound (Devore and Grimes 1993). Juvenile white sturgeon are slow to mature, reaching reproductive maturity at 9 yr for males and 13 yr for females (McCabe and Tracy 1993). In addition, white sturgeon is a native species with a very long lifespan (some more than 100 yr) and is highly sought after by anglers (Dees 1961). Farr and Ward (1992) found that white sturgeon were more abundant in undeveloped areas than developed areas.

Another sturgeon species, the green sturgeon (*Acipenser medirostris*), is similar to the white sturgeon in life history characteristics. This species remains close to marine waters, but frequently migrates to the lower Columbia River estuary (Beamesderfer 1997).

The common carp is an exotic species to the LWR with a long lifespan (more than 20 yr). Juvenile carp are primarily pelagic feeders; however, the adult fish are largely benthic feeders and consume copepods along with algae and plant fragments (Wydoski and Whitney 1979). The common carp is a common resident species (Hughes and Gammon 1987) and has been found to be evenly distributed throughout the LWR, with populations increasing as the water temperature increases (Farr and Ward 1992; Tetra Tech 1995).

Brown bullhead and yellow bullhead are two members of the Ictaluridae family present in the LWR. Both of these species are residents and were introduced to the LWR. These species are both bottom feeders with similar life spans (approximately 5 yr) and habitat preferences. However, the preferred range of depth of yellow bullhead (0-10 m) is shallower than that of brown bullhead (0-40 m) (Scott and Crossman 1973). In addition, brown bullhead are tolerant of low dissolved oxygen levels and high temperatures, whereas yellow bullhead

prefer clear water of streams or ponds with aquatic vegetation (Wydoski and Whitney 1979). Yellow bullhead have been the most common catch from this family in several studies (Hughes and Gammon 1987; Farr and Ward 1992; Beak 2000); however, yellow bullhead catch numbers were relatively low in other studies (4 fish in Beak [2000], 1 fish in Hughes and Gammon [1987]). In addition, only a few brown bullhead were caught by Farr and Ward (1992).

The eulachon (*Thaleichthys pacificus*) is a native pelagic species that may be present in LWR during a short period of the year. Eulachon inhabit predominately marine waters, migrating to estuaries and coastal rivers to spawn. It is estimated that eulachon spend less than six weeks in freshwater a year.

Other omnivores that are possibly present in the LWR include the fathead minnow (*Pimephales promelas*), oriental weatherfish (*Misgurnus anguillicaudatus*), pumpkinseed sunfish, bluegill (*Lepomis macrochirus*), black bullhead (*Ameiurus melas*), and goldfish (*Carassius auratus*) (Table 2-2). All of these species have been introduced to the LWR. Pumpkinseed prefer quiet vegetated pools in low-velocity areas of rivers (Wydoski and Whitney 1979). Bluegill have similar habitat preferences as the pumpkinseed, preferring low gradient, low velocity areas with abundant pools and aquatic vegetation (Stuber et al. 1982a). Pumpkinseed and bluegill are both benthopelagic species from the Centrarchidae family and are not as common as other members of this family (black and white crappie, smallmouth and largemouth bass), but have been caught in several studies (Farr and Ward 1992; Tetra Tech 1995; Beak 2000).

The goldfish is a benthic feeder with a long life span (up to 25 yr) from the Cyprinidae family and prefers low-velocity, stagnant water of ponds, lakes, and slow-moving rivers (Wydoski and Whitney 1979). Local goldfish populations are subject to frequent fluctuations due to the release of aquarium goldfish into local rivers and ponds (Wydoski and Whitney 1979).

The black bullhead is also a benthic feeder whose presence is rare in the LWR and can live up to 10 yr (Scott and Crossman 1973). Black bullhead prefer soft substrate habitat in pools, backwater and slow current areas in small to large rivers, impoundments, oxbows and ponds.

The oriental weatherfish prefers shallow waters (0-5 m) and muddy substrates (Page and Burr 1991). The fathead minnow prefers pools of headwaters, creeks, and small rivers and can tolerate low dissolved oxygen levels and high water temperatures (Page and Burr 1991). Oriental weatherfish and fathead minnow have not been documented in any of the studies to date.

Only two fish species are classified as herbivores in the LWR: the chiselmouth (*Arocheilus alutaceus*) and the mountain sucker (Table 2-2). Both of these fish are native to the region and resident species.

The chiselmouth is a member of the Cyprinidae family. Chiselmouth can live up to 6 yr and usually reach maturity at age 3-4 yr (Wydoski and Whitney 1979). The chiselmouth is a benthic feeder and consumes a diet of diatoms and algae as an adult, and insects and algae as a juvenile (Wydoski and Whitney 1979). This fish inhabits moderate-to-fast moving pools, creeks, rivers, and lake margins over sandy or gravel substrate (Page and Burr 1991; Wydoski and Whitney 1979). Several fish studies have captured chiselmouth in the LWR (Hughes and Gammon 1987; Farr and Ward 1992; Tetra Tech 1995; Beak 2000).

The mountain sucker is a member of the Catostomidae family and shares similar life history characteristics with the chiselmouth. The mountain sucker inhabits shallow waters of mountain streams over sandy to rocky substrate (Wydoski and Whitney 1979; Scott and Crossman 1973). As adults, mountain suckers prefer diatoms, algae, insects, and plants (Wydoski and Whitney 1979). Studies conducted by Farr and Ward (1992) and Beak (2000) both reported capturing mountain sucker in the LWR. Tetra Tech (1995) collected mountain sucker upstream from Willamette Falls.

Invertivores (benthopelagic)
Several species of benthopelagic invertivorous fish (primarily feeding on invertebrates) may occur in the LWR (Table 2-2). The peamouth (*Mylocheilus caurinus*), redside shiner, and American shad are a few common benthopelagic invertivores occurring in the LWR. All of these species are residents except the American shad, which is anadromous.

The peamouth is a member of the Cyprinidae family and is native to the LWR. It predominantly feeds on benthic invertebrates, crustaceans, and small fish as an adult and can live up to 13 yr (Wydoski and Whitney 1979). The peamouth prefers shallow areas of lakes and slow-moving rivers, remaining nearshore during winter months and moving to deeper waters in the summer months (Wydoski and Whitney 1979). The peamouth has been caught in several studies in the LWR (Farr and Ward 1992; Tetra Tech 1995; Beak 2000).

The redside shiner is a member of the Cyprinidae family and a native resident of the LWR with a short life span (less than 5 yr). The redside shiner prefers to eat zooplankton and algae as a juvenile, and as an adult consumes aquatic and terrestrial insects, zooplankton, and fish eggs. It resides in shallow areas of ponds, lakes, and streams, and prefers gravel-bottomed streams for spawning (Wydoski and Whitney 1979). Farr and Ward (1992) reported catching redside shiner throughout the LWR, but not with the high frequency of other members of the Cyprinidae family.

The American shad is an introduced member of the Clupeidae family. The American shad is anadromous and a repeat spawner, migrating to freshwater after spending 2-6 yr in the ocean (Stier and Crance 1985). The shad is long-lived (approximately 11 yr) and reaches reproductive maturity at 4 yr for males and 5 yr

for females (Stier and Crance 1985). It prefers to spawn in broad flats or shallow water of large rivers, and juvenile shad remain in fresh water for their first summer, moving to marine waters in the fall (Stier and Crance 1985). While in freshwater, juveniles consume insects, crustaceans, zooplankton and benthic invertebrates (Wydoski and Whitney 1979). Several studies have observed both adult and juvenile American shad in the LWR (Farr and Ward 1992; Tetra Tech 1995; Beak 2000). Farr and Ward (1992) reported capturing adult and juvenile shad in their May and June collections.

Other benthopelagic invertivores that may be present in the LWR through their introduction to the region include the mosquitofish (*Gambusia affinis*), the banded killifish, the brook trout (*Salvelinus fontinalis*), and the lake trout (*Salvelinus namaycush).*

The mosquitofish and the banded killifish are resident species and both inhabit shallow water of ponds or backwaters with aquatic vegetation present. The mosquitofish has a very short lifespan (approximately 1 yr). Both species consume benthic invertebrates and insects (Wydoski and Whitney 1979; Page and Burr 1991). Banded killifish were observed in studies conducted by Farr and Ward (1992) and Beak (2000).

Brook trout and lake trout are both salmonids. Brook trout is a benthopelagic feeder, consuming fish, insect larvae, shrimp and snails. It has a lifespan of approximately 4 yr and inhabits cold, headwater ponds and spring-fed streams (Wydoski and Whitney 1979). The lake trout has a longer lifespan (approximately 10 yr) and prefers deep waters of lakes and streams (Marcus et al. 1984).

Invertivores (benthic)

Several benthic invertivores reside in the LWR, including seven sculpin species (*Cottus* spp.), starry flounder, redear sunfish (*Lepomis microphus*), channel catfish, warmouth (*Lepomis gulosus*), and threespine stickleback (Table 2-2). All of these species are residents and are introduced except the sculpin, the starry flounder, and the threespine stickleback, which are native.

The prickly sculpin (*Cottus asper*) is one of seven members of the Cottidae family present in the LWR. The prickly sculpin is short-lived (approximately 4-5 yr) and reaches maturity in 2-4 yr (Wydoski and Whitney 1979). As a juvenile, it feeds in the pelagic zone for the first 30 days, consuming mostly plankton and aquatic insect larvae. The prickly sculpin is a benthic feeder as an adult and consumes crustaceans, aquatic insect larvae, fish, and mollusks (Wydoski and Whitney 1979). It prefers shallow water with sand, gravel, or rubble bottoms and abundant aquatic vegetation (Wydoski and Whitney 1979). It is also tolerant of salinity. Several studies suggested that the prickly sculpin is the most common sculpin in the LWR (Hughes and Gammon 1987; Farr and Ward 1992; Tetra Tech 1995). General sculpin habitat is shown in Figure 2-7.

Other sculpins reported to occur in the Willamette River are the reticulate sculpin (*Cottus perplexus*), mottled sculpin (*C. bairdi*), paiute sculpin (*C. beldingi*), shorthead sculpin (*C. confuscus*), riffle sculpin (*C. gulosus*), and torrent sculpin (*C. rhotheus*) (Hughes and Gammon 1987; Farr and Ward 1992; Tetra Tech 1995). These species are similar in life span (approximately 5-7 yr) and prefer to consume aquatic insects, crustaceans, snails, and fish eggs as adults and aquatic insect larvae as juveniles (Wydoski and Whitney 1979). The reticulate sculpin is reported to have the longest life span (up to 7 yr). It prefers pools and riffles of small streams, and can burrow up to 36 cm into gravel to forage (Wydoski and Whitney 1979). The mottled sculpin, paiute sculpin, shorthead sculpin, and riffle sculpin prefer moderate- to fast-moving, shallow water with rubble or gravel substrates (Wydoski and Whitney 1979).

The starry flounder inhabits shallow to deep estuarine waters, although it can travel far upstream rivers for foraging (Orcutt 1950). It is a benthic feeder and consumes crabs, mollusks, and small fish (Orcutt 1950). Starry flounder were observed in studies conducted by Tetra Tech (1995), Farr and Ward (1992) and Beak (2000).

Redear sunfish is in the Centrarchidae family and is introduced to the LWR. The redear sunfish lives up to 8 yr. Both juveniles and adults are bottom feeders, consuming bottom insects, crustaceans, algae, snails and insect larvae (Twomey et al. 1984). The preferred habitat of the redear sunfish is warm, slow-moving water with little turbidity, although adults can also be found in deeper, open waters (Twomey et al. 1984). The redear sunfish has not been documented in any of the studies of the LWR.

The channel catfish is in the Ictaluridae family and was introduced to the region. This species can live over 14 yr (Wydoski and Whitney 1979), and juveniles take a relatively long time to reach reproductive maturity (approximately 6-7 yr) (McMahon and Terrell 1982). The channel catfish prefers warm water with moderate to swift currents; it forages in shallow water among vegetation, and takes cover in deeper waters (Wydoski and Whitney 1979). Juveniles forage for aquatic insect larvae and plankton, whereas adults consume more crayfish, fish, fish eggs, and aquatic insects (Scott and Crossman 1973; Wydoski and Whitney 1979). Farr and Ward (1992) collected one channel catfish in their 1987–1990 study.

The warmouth is a member of the Centrarchidae family and is also exotic to the region. It has a lifespan of about 7 yr (Wydoski and Whitney 1979) and reaches reproductive maturity at 2 yr (McMahon et al. 1984a). The warmouth prefers backwater habitats with slow-moving water and dense vegetation and is known to be adversely affected by channelization (McMahon et al. 1984a). Juvenile warmouth feed on protozoa, bacteria, and zooplankton, and adults feed on aquatic

insect larvae, crayfish, and small fish (Wydoski and Whitney 1979). Farr and Ward (1992) collected warmouth in their 1987-1990 study.

The threespine stickleback is a member of the Gasterosteidae family and is native to the LWR. The threespine stickleback can live in both freshwater and marine systems, but spawns in freshwater habitats. It is a benthic feeder in fresh water, and consumes small crustaceans, insects, and fish eggs (Wydoski and Whitney 1979). The threespine stickleback is short-lived (up to 3 yr) and is found close to the bottom of streams and lakes near aquatic vegetation (Wydoski and Whitney 1979). The threespine stickleback has been observed in the LWR in several studies (Farr and Ward 1992; Tetra Tech 1995; Beak 2000).

Other benthic invertivores that may be present in the LWR include Oregon chub (*Oregonichthys crameri*), longnose dace, leopard dace (*Rhinichthys falcatus*), speckled dace, white catfish (*Ameiurus catus*), tench, green sunfish (*Lepomis cyanellus*), and sand roller.

The Oregon chub, longnose dace, leopard dace, speckled dace, and the tench are in the Cyprinidae family and are all native to the region except the tench. The Oregon chub is endemic to the Willamette Basin (Altman et al. 1997) and is classified as a federally endangered species. According to historic records, Oregon chub have never been recorded north of the Clackamas River and are unlikely to be found in the ISA. They are traditionally found in backwater areas with plentiful aquatic vegetation, little or no flow, and silty organic substrate such as flooded marshes, beaver ponds, or oxbos lakes (Scheerer 1999). The exotic tench prefers warm lakes and pools with mud bottom and abundant weeds, and feeds mostly on algae as a juvenile and on bottom invertebrates and aquatic insects as an adult (Wydoski and Whitney 1979). The three dace species prefer flowing pools and rocky riffles (Page and Burr 1991; Wydoski and Whitney 1979). Longnose and leopard dace live approximately 5 yr, whereas the speckled dace has a lifespan of approximately 3 yr (Wydoski and Whitney 1979). As adults, all three species consume insects, algae, fish eggs, and plant material, whereas juveniles prefer plankton and aquatic insects (Wydoski and Whitney 1979). Farr and Ward (1992) collected one longnose dace in their 1987–1990 LWR study, and Hughes and Gammon (1987) and Tetra Tech (1995) caught all three dace species upstream from Willamette Falls.

The white catfish has habitat and food requirements similar to the channel catfish; however, the white catfish prefers pools and backwater habitats and can tolerate brackish water (Turner 1966a). The green sunfish and the sand roller also prefer habitat with abundant pools and vegetative or woody debris cover (Stuber et al. 1982b; Wydoski and Whitney 1979). All of these species are benthic feeders and feed on crustaceans, larval insects, and some fish (Wydoski and Whitney 1979). Farr and Ward (1992) reported collecting sand rollers in the LWR. Beak (2000) observed sand rollers in the LWR.

Invertivores (salmonid): Ten species of salmonids are known to occur in this region: chinook salmon (*Oncorhynchus tshawytscha)*, steelhead trout (*O. mykiss gairdneri)*, rainbow trout (*O. mykiss*), chum salmon (*O. keta*), coho salmon (*O. kisutch*), sockeye salmon (*O. nerka nerka*), kokanee (*O. nerka kennerlyi*), coastal cutthroat trout (*O. clarki clarki*), brown trout (*Salmo trutta*), and mountain whitefish (*Prosopium williamsoni*) (Table 2-2). In general, many of these species are anadromous, spawning in freshwater and then spending part of their lifecycle in saltwater before returning again to freshwater. Rainbow trout, kokanee, mountain whitefish, and brown trout are resident species, and are not anadromous. Sockeye salmon, kokanee, and brown trout are exotic to the region; the rest of the salmonids are native. The larger salmon species may be piscivorous as adults in the ocean, but these species are grouped with invertivores because their juvenile stages prey primarily on invertebrates during their residence in rivers. Piscivorous adult salmon returning upriver during their spring migrations feed relatively little.

There are two life history patterns that chinook salmon follow in the Willamette River, a stream type and an ocean type. The stream type generally comprise the spring runs and spend one or more yr in fresh water before migrating to the ocean. The ocean type generally comprise the summer and fall runs and usually migrate to the ocean about three months after emergence (Healy 1991). Chinook spawn in gravel runs, and their eggs require high oxygen concentrations. Juveniles reside in marginal areas of rivers and find cover near woody debris and tree roots (Healy 1991). While in fresh water, juvenile chinook salmon feed on aquatic insect larvae and terrestrial insects (Wydoski and Whitney 1979; Healy 1991).

Steelhead trout share similar life history traits with chinook. Winter runs of steelhead enter fresh water in March or April and spawn in May and June (NMFS 1996). The majority of steelhead in Washington and Oregon smolt after two years in freshwater; however, some juveniles can spend up to seven years in fresh water before migrating to the ocean (NMFS 1996). Steelhead are iteroparous, being able to spawn multiple times, although most steelhead in this region spawn only once (NMFS 1996). Juvenile steelhead feed on aquatic insects and insect larvae while in fresh water (Wydoski and Whitney 1979).

Rainbow trout, the freshwater resident form of steelhead trout, has a lifespan of 3–8 yr. It consumes aquatic insects and insect larvae, worms, and fish eggs as a juvenile, and aquatic insects and fish as an adult (Wydoski and Whitney 1979; Raleigh et al. 1984). Rainbow trout inhabit clear, cold water of stream riffles and pools, with abundant vegetation present (Raleigh et al. 1984).

Chum salmon are semelparous, spawning only once, and anadromous (Salo 1991). Spawning habitat for chum salmon is usually located in the lowermost reaches of rivers and streams, in close proximity to marine waters. After emergence, fry do not remain in fresh water, but immediately begin to migrate to

estuarine waters. Migration usually takes approximately 30 days in short streams (Salo 1991).

Coho salmon are also semelparous and anadromous (Sandercock 1991). Coho prefer to spawn in gravel located at the head of stream riffles (Wydoski and Whitney 1979; Sandercock 1991). After emergence, fry remain in freshwater habitat for 1–2 yr before migrating to marine waters. Juvenile coho inhabit shallow waters (10–20 ft) in backwater areas, side channels, and small creeks with overhanging vegetation (Sandercock 1991). Like other salmonid species, juvenile coho are insectivores and consume mostly insects, insect larvae, worms, and fish eggs (Wydoski and Whitney 1979).

Sockeye salmon spawn in gravel riffles of streams and tributaries to lakes. Upon emergence, juvenile sockeye spend 1–2 yr in freshwater habitats, usually the pelagic zone of lakes (Wydoski and Whitney 1979). Juvenile sockeye consume zooplankton while in fresh water. Kokanee are the resident form of sockeye salmon and share similar food and habitat preferences. After emergence, juvenile kokanee migrate to lake environs to mature and reside as adults in the pelagic zone of the lake (Wydoski and Whitney 1979).

Coastal cutthroat trout have variable life history patterns. Some are anadromous, migrating to marine waters and returning to freshwater to spawn; some are potamodromous, spending most of their lives in streams and lakes and migrating to tributaries to spawn; and some are nonmigratory, remaining in small streams and headwater tributaries (Trotter 1997). Coastal cutthroat trout are known to spawn in the smallest headwater streams (Wydoski and Whitney 1979). Upon emergence, juveniles prefer low-velocity backwater areas until large enough to move into riffles and overwinter in pools with logs and vegetation for cover (Trotter 1997). Anadromous juveniles remain in fresh water habitats for 2–4 yr before migrating to marine waters. While in fresh water, juveniles are pelagic feeders and consume fish, insect larvae, and sand shrimp (Trotter 1997).

Brown trout are tolerant of high turbidity, low oxygen levels, and warm temperatures, and tend to fare well in recently disturbed areas, out-competing other trout species (Wydoski and Whitney 1979). This species tends to rely on deep pools for cover during the day. As juveniles, brown trout prefer insects such as mayflies and stoneflies, crustaceans, and shrimp; as adults, brown trout consume fish, crustaceans, and aquatic insect larvae (Wydoski and Whitney 1979). Brown trout reach reproductive maturity in 3-5 yr (Raleigh et al. 1986).

The mountain whitefish is a native salmonid and prefers riffle areas and large pools of cold streams (Wydoski and Whitney 1979). This species feeds on crustaceans, larval insects, and some fish (Wydoski and Whitney 1979). Farr and Ward (1992) reported collecting a few mountain whitefish in the LWR. Studies conducted by Hughes and Gammon (1987) and Tetra Tech (1995) captured mountain whitefish in areas above Willamette Falls.

The LWR is considered critical habitat for several of these salmonid species (Table 2-2). Chinook salmon, steelhead, and coho salmon appear to use this area for juvenile rearing and adult holding more extensively than other salmonid species (Ward 2001; Foster 2001a). Chinook were the most prevalent species caught using both electrofishing and beach seine gear in the 2001 ODFW study. In the beach seine catch, sub-yearling chinook was the highest catch overall (94.7%), followed by coho (0.6%), steelhead (0.0%), and unidentified salmonids (4.7%). Electrofishing catch was comprised of chinook (47.1%), coho (11.5%), steelhead (3.0%), and unidentified salmonids (38.4%) (North et al. 2001). It appears that some seasonal variation in relative abundance occurs among these species: the relative abundance from most to least fish caught per unit effort by beach seine in the LWR, was coho, chinook, steelhead in spring; chinook, coho, steelhead in summer; and chinook, steelhead, coho in fall (North et al. 2001). This information contrasts with what was previously believed based on Portland General Electric out-migrant counts at Willamette Falls and at the Clackamas hydroelectric dam, which found these salmonid species to be abundant only for a short period of time (Domina 1997). This discrepancy is probably due to the different locations sampled and different methods used to observe the fish.

Salmonids, both adult and juvenile, are common in the LWR during various times of the year. Timing of downstream movements of juvenile salmonids has been documented by monitoring yearling chinook movement patterns downstream to Willamette Falls (Schreck et al. 1994), seasonal fish trapping at Willamette Falls (Massey 1967; Domina 1997), and sequential seasonal sampling within the harbor (Beak 2000; Fishman 1999; Farr and Ward 1993; Ward and Farr 1989, 1990; Ward and Knutsen 1991; Ward et al. 1988; Ward et al. 1994). Juvenile salmon can be found in the LWR year-round (various life stages), but peak periods of downstream movement appear to be March through mid-June and November.

Based on telemetry data, juvenile chinook salmon appear to have a longer residence time in Portland Harbor than steelhead or coho salmon (Ward et al. 1992, North et al. 2001). Average migration rates were 15.5 km/d, 13.8 km/d, 11.0 km/d, and 7.2 km/d for steelhead, coho, yearling chinook, and subyearling chinook respectively (North et al. 2001). Migration rates for juvenile chinook salmon through the LWR from Willamette Falls to the mouth of the Columbia River ranged from two days to two months, based on calendar year 2001 ODFW studies (North et al. 2001). Beach seining data collected in 2001 shows that the migration rate of sub-yearling fall chinook salmon is slower than that of yearling spring chinook salmon. Preliminary radio telemetry studies found that the range of residence times for sub-yearling fall chinook was 1.2 to 6.8 days from RM 9.5 to RM 3.5 and 1.6 to 26.8 days from RM 18.5 to RM 3.5 (Ellis 2001). Residence time of smaller juvenile salmon (less than 108 mm) has not been measured and may vary somewhat from those reported here. Periods of adult salmonid migration through Portland Harbor are not as well documented as downstream

movements (Ellis 2001). Timing of salmonid migration through the LWR is shown in Figure 2-4.

Piscivores: Northern pikeminnow (*Ptychocheilus oregonensis*), smallmouth bass (*Micropterus dolomieui)*, largemouth bass (*Micropterus salmoides*), black crappie (*Pomoxis nigromaculatus*), white crappie (*Pomoxis annularis)*, walleye (*Stizostedion vitrem*), yellow perch (*Perca flavescens*), and bull trout (*Salvelinus confluentus*) are piscivorous fish species known to inhabit the region (Table 2-2). Both smallmouth and largemouth bass are introduced species, and northern pikeminnow and bull trout are native. Bull trout is classified as a federally threatened species. All four species are residents.

The northern pikeminnow is a member of the Cyprinidae family. It has a long life span, up to 19 yr, and reaches reproductive maturity at 3 yr (males) and 4 yr (females) (Wydoski and Whitney 1979). Northern pikeminnow is benthopelagic and inhabits large riverine systems, remaining nearshore in summer and occupying deeper waters in the winter (Wydoski and Whitney 1979). Juvenile northern pikeminnow forage for aquatic and terrestrial insects and small fish, whereas adults consume predominantly fish and some insects (Jeppson and Platts 1959; Buchanan et al. 1981). Northern pikeminnow was the most abundant catch out of six common species in the LWR in a study conducted by Ward and Nigro (1992). Farr and Ward (1992), Tetra Tech (1995), and Beak (2000) also captured northern pikeminnow.

Smallmouth bass, largemouth bass, and black and white crappie are members of the Centrarchidae family. All four species are benthopelagic, consuming fish, crayfish and other crustaceans, mollusks, and worms as adults and insect larvae and zooplankton as juveniles (Wydoski and Whitney 1979; Turner 1966b; George and Hadley 1979). The largemouth bass has a longer life span (12–16 yr) than smallmouth bass (approximately 10 yr), but both species mature around the same age (1–4 yr) (Wydoski and Whitney 1979). Smallmouth bass prefer riverine systems with a moderate current and rocky substrate (Wydoski and Whitney 1979), and reportedly use riprap for cover (Farr and Ward 1992). Largemouth bass inhabit warm shallow waters with abundant plants and woody debris available for cover (Wydoski and Whitney 1979). Largemouth and smallmouth bass are reported to be common throughout the LWR (Ward and Nigro 1992; Farr and Ward 1992; Beak 2000). Tetra Tech (1995) reported smallmouth bass to be the most abundant catch of the centrarchid species.

The black crappie is an introduced resident of the LWR. The black crappie has a relatively long life span (approximately 13 yr), becoming reproductively mature at 2–3 yr (Wydoski and Whitney 1979). As a juvenile, the black crappie prefers plankton, crustaceans, and larvae, and consumes fish as it matures (Scott and Crossman 1973), and commonly forages in open, deep waters (Edwards et al. 1982a). Black crappie prefer areas of low velocity and turbidity with abundant

vegetative cover, nesting in soft mud (Edwards et al. 1982a). Several studies have shown that black crappie is an abundant centrarchid species in the LWR (Ward and Nigro 1992; Farr and Ward 1992; Beak 2000).

White crappie is another introduced fish to the LWR. The white crappie lives 7–9 yr and reaches reproductive maturity at 1–3 yr (Edwards et al. 1982b). Juvenile white crappie prefer zooplankton, aquatic insects, and algae, whereas adults consume fish, insects, fish eggs, and crustaceans (Muoneke et al. 1992; Edwards et al. 1982b). The white crappie inhabits low-gradient, low-turbidity, slow-moving riverine systems with abundant vegetative cover and shallow areas for nesting (Edwards et al. 1982b). Several studies have observed white crappie throughout the LWR (Ward and Nigro 1992; Farr and Ward 1992; Beak 2000).

The walleye is another introduced resident of the LWR with a long life span (17 yr), becoming reproductively mature at 2–4 yr for males and 3–8 yr for females (McMahon et al. 1984b). A member of the Percidae family, the juvenile walleye prefers a diet of zooplankton and aquatic insects, and consumes fish and crustaceans as an adult (McMahon et al. 1984b; Wydoski and Whitney 1979). Walleye require moderate to large riverine systems with abundant shallow vegetated areas for all life stages and prefer to spawn in rocky areas in rivers or below falls (McMahon et al. 1984b; Scott and Crossman 1973; Wydoski and Whitney 1979). Walleye have been captured in several studies in the LWR (Hughes and Gammon 1987; Tetra Tech 1995; Beak 2000), and Farr and Ward (1992) suggested that walleye prefer less developed areas of the LWR.

The yellow perch is in the Percidae family and is exotic to the LWR. Yellow perch can live up to 9–10 yr, but most live to 7 yr and reach maturity at 2-3 yr (males) and 3–4 yr (females) (Krieger et al. 1983). The yellow perch prefers shoreline habitat with pools and vegetation present in freshwater systems, although it can tolerate brackish water (Krieger et al. 1983). Some local populations are reported to have a small home range and do not travel far (Wydoski and Whitney 1979). Juvenile yellow perch consume insect larvae and zooplankton, and adults consume fish, crayfish, fish eggs, and aquatic insects (Krieger et al. 1983; Wydoski and Whitney 1979). Yellow perch appear to be common throughout the LWR (Hughes and Gammon 1987; Tetra Tech 1995; Beak 2000) and evenly distributed among developed and undeveloped sites (Farr and Ward 1992).

The bull trout is a salmonid and is reported to be rarely anadromous (Page and Burr 1991). The bull trout is benthopelagic and consumes mostly fish and zooplankton. It inhabits deep pools in large, cold rivers (Page and Burr 1991).

Detritivores: Four species of detrivorous lamprey are native to the Willamette River: the Pacific lamprey (*Lampreta tridentata*), the river lamprey (*Lampreta ayresi)*, the western brook lamprey (*Lampreta richardsoni)*, and the Pacific brook lamprey (Table 2-2). The Pacific brook and western brook lampreys are resident

species, whereas the Pacific lamprey and river lamprey are anadromous and migrate to the ocean as adults.

The Pacific lamprey and river lamprey share many similar life history traits. Both are filter-feeders as juveniles, consuming phytoplankton and detritus while burrowed in the freshwater sediment (Kostow 2002; Moore and Mallatt 1980). The Pacific lamprey has a longer life span (up to 12 yr) than the river lamprey (up to 8 yr) and also takes longer to mature (5-7 yr and 4-6 yr, respectively) (Kostow 2002). Farr and Ward (1992) and Beak (2000) reported collecting a few Pacific lamprey in the LWR.

The two resident lamprey, western brook and Pacific brook, are similar to the anadromous species in that juveniles remain burrowed in mud until maturity, feeding on diatoms and detritus (Kostow 2002). Both the western brook and Pacific brook lamprey live less than 6 yr and reach maturity in 4-6 yr. As adults, these two species remain in fresh water, migrating downstream from the spawning grounds. However, unlike the anadromous species, which become ectoparasitic as adults, the two resident species do not feed as adults (Kostow 2002). As soon as they become adults, they spawn and die. Friesen and Ward (1996) reported collecting western brook lamprey in streams of the Tualatin Basin in the Willamette River basin. General lamprey habitat for the ISA is shown in Figure 2-6.

2.3.3 Birds

Numerous species of aquatic or semi-aquatic birds use the Willamette River in the ISA. Table 2-4 presents the aquatic and semi-aquatic bird species that may breed along the LWR, and Table 2-5 presents a list of bird species that may overwinter or only partially utilize the LWR.

Of the fifteen sites in the ISA with significant habitat identified by Adolfson et al. (2000), the Oaks Bottom Complex contains the greatest abundance and diversity of birds. Within this site is the Oaks Bottom Wildlife Refuge, a diverse habitat closely associated with Ross Island. More than 200 bird species have been reported in this area, including nesting raptors and river birds such as green-backed herons, northern shovelers, pintails, mallards, wood ducks, coots, wigeons, gulls, and cormorants (Adolfson et al. 2000).

This section discusses birds that may reside in the ISA according to four feeding guilds that are based on common feeding strategies and diet composition (Table 2-4). These guilds are:

- Herbivores (birds feeding predominantly on plant material)

- Diving carnivores and omnivores (birds that usually swim on the surface and feed on invertebrates or mix of invertebrates, fish, and occasionally plants)
- Sediment-probing invertivores and omnivores (birds probing in the sediments for invertebrates in shallow water and along the shoreline)
- Piscivores (birds feeding almost exclusively on fish).

2.3.3.1 Herbivorous Birds

Two common herbivores may use the ISA: Canada geese (*Branta canadensis*) and mallards (*Anas platyrhynchos*). Canada geese are common in the vicinity of the ISA throughout the year (Puchy and Marshall 1993). Some are present year-round while others merely overwinter in the area. Canada geese typically nest on the ground near open water, often in vegetated marshes (Csuti et al. 1997). These geese preferentially feed on the shoots of terrestrial and aquatic plants but will also eat aquatic invertebrates (Ehrlich et al. 1988). Mallards are also very common in the area. Some are present in the summer during breeding season, while others overwinter along the Willamette River (Puchy and Marshall 1993). Mallards are "dabbling ducks" that forage in open water areas on aquatic plants (Csuti et al. 1997), and nest on the ground near water (Ehrlich et al. 1988).

2.3.3.2 Carnivorous and Omnivorous Birds

Within the group of carnivorous and omnivorous birds, three species feed more heavily on plants (omnivores) and four rely primarily on invertebrate prey and small fish (carnivores). The omnivores are cinnamon teal (*Anas cyanoptera*), wood duck (*Aix sponsa*), and American coot (*Fulica americana*). The cinnamon teal is a fairly common breeding duck found throughout Oregon (Puchy and Marshall 1993). They typically overwinter south of Oregon, but some are known to remain throughout the year (Csuti et al. 1997). Cinnamon teals are described as dabbling ducks and forage near vegetative cover along shorelines on a mix of aquatic plants and aquatic invertebrates such as mollusks, midges, and larvae (Ehrlich et al. 1988). They typically nest on the ground in marshes, meadows, or other low vegetation habitats near open water (Puchy and Marshall 1993).

The wood duck is relatively uncommon in the Willamette Valley but some are year-round residents (Puchy and Marshall 1993). They are described as perching ducks and, as their name suggests, they prefer to nest in woodland habitats, often in trees and snags near water (Ehrlich et al. 1988). They feed in shallow water, mainly foraging on seeds and aquatic plants, but they are also known to eat aquatic insects (Csuti et al. 1997).

Unlike the other two omnivores, the American coot is a rail rather than a duck. It is locally abundant in the Willamette Valley and is usually a year-round resident

(Puchy and Marshall 1993). American coots build floating nests usually under vegetative cover; therefore, marshes are a common nesting location (Ehrlich et al. 1988). They are described as a diving species (as opposed to dabbling avian species that feed in shallower water) and feed mostly on aquatic plants, but also eat aquatic insects, crustaceans, worms and other invertebrates especially when they are young (Csuti et al. 1997).

The four species of diving carnivores that may use the ISA are the American dipper (*Cinclus mexicanus*), common merganser (*Mergus merganser*), hooded merganser (*Lophodytes cucullatus*), and pied-billed grebe (*Podilymbus podiceps*). American dippers are mostly year-round residents (Puchy and Marshall 1993). They generally prefer smaller, fast-flowing streams, but are occasionally found along larger rivers, ponds, and lakes (Csuti et al. 1997). They usually nest in stream banks or cliffs along flowing water, and feed mostly on aquatic insects and larvae (Ehrlich et al. 1988).

Common and hooded mergansers are both locally common breeders in the Willamette Valley with some year-round residents (Csuti et al. 1997; Nebeker 2001; Davis 2002). Both prefer to nest in tree cavities in close proximity to open water (Kitchen and Hunt 1969; Ehrlich et al. 1988). Common mergansers feed primarily by diving for whatever small fish are abundant, but they will also eat aquatic invertebrates, especially as hatchlings (Csuti et al. 1997). Hooded mergansers are smaller, and therefore eat more aquatic invertebrates than do common mergansers (Csuti et al. 1997). They are known to feed on crustaceans, aquatic insects, and small fish (Bendell and McNicol 1995).

Pied-billed grebes are range from uncommon-to-common breeders in the Willamette Valley, but many individuals overwinter in the area (Puchy and Marshall 1993; Csuti et al. 1997). They forage in open water for aquatic insects, crayfish, small fish, and other aquatic invertebrates (Csuti et al. 1997). Pied-billed grebes typically build floating nests in quiet waters, usually under the cover of emergent vegetation (Ehrlich et al. 1988).

2.3.3.3 Sediment-probing Invertivorous and Omnivorous Birds

Spotted sandpipers (*Actitis macularia*) are locally common breeders in the Willamette Valley and some are present year-round (Puchy and Marshall 1993). They build ground nests amid herbaceous vegetation and usually feed nearby along shallow gravel shorelines and beaches (Ehrlich et al. 1988). They feed on insects and benthic invertebrates such as crustaceans, mollusks, and worms (Csuti et al. 1997). Some sandpipers are known to ingest relatively large amounts of sediment while feeding (Beyer et al. 1994). Spotted sandpiper habitat is shown in Figure 2-9.

The common snipe (*Gallinago gallinago*) is a common breeder in the Willamette Valley and most are present year-round (Puchy and Marshall 1993). They usually nest on the ground in grassy areas near water (Ehrlich et al. 1988). Common snipes feed by probing into saturated soils in wetlands and very shallow water, feeding largely on insect larvae and worms.

Killdeer (*Charadrius vociferus*) are locally abundant in the Willamette Valley and most are year-round residents (Puchy and Marshall 1993). They feed mostly on flying insects, such as beetles, dragonflies, and grasshoppers, but may also eat crayfish and other benthic invertebrates (Csuti et al. 1997). Killdeer nest on the ground in a variety of habitats near open water (Ehrlich et al. 1988).

Soras (*Porzana carolina*) are common breeders along the Willamette, but are usually present during the summer only (Puchy and Marshall 1993). They build floating nests in emergent vegetation along lakes and streams and are more omnivorous than the other species in this guild (Csuti et al. 1997). They feed on seeds, insects, and aquatic invertebrates (Ehrlich et al. 1988).

Finally, the Virginia rail (*Rallus limicola*) is a locally common breeder in the Willamette Valley and some are year-round residents (Puchy and Marshall 1993). They nest on the ground, usually in marshes with cover from emergent vegetation (Ehrlich et al. 1988). Virginia rails' diets consist of insects, aquatic invertebrates, and some seeds (Csuti et al. 1997).

2.3.3.4 Piscivorous Birds

Few species from this guild feed solely on fish, but fish make up the majority of the diets for all eight species of piscivorous birds discussed below. Osprey (*Pandion haliaetus*) tend to feed solely on fish. Several breeding pairs are present in the ISA from March until September (Henny 2002). In addition to the five pairs nesting between RM 0 and 7.1, osprey also nest in Oaks Bottom Wildlife Refuge at RM 15.4 (Henny 2002). Each fall, they migrate south to western Mexico and Central America (Martell et al. 2001). They generally feed on slow-moving prey that swim near the water surface (Csuti et al. 1997).

Belted kingfishers (*Ceryle alcyon*) also tend to feed solely on fish. They are uncommon breeders in the Willamette Valley, but tend to be year-round residents (Puchy and Marshall 1993). They usually nest in horizontal burrows dug into sandy stream and river banks (Ehrlich et al. 1988). Kingfishers feed anywhere they can find small fish (3-4 in.); they may also eat crayfish, amphibians, and insects (Csuti et al. 1997).

American bittern (*Botaurus lentiginosus*) are uncommon breeders in the Willamette Valley but are present year-round (Puchy and Marshall 1993). They have a more varied diet than most other species in this guild as they feed on fish,

amphibians, crayfish, and insects (Csuti et al. 1997). American bitterns build ground nests amid emergent vegetation, usually in marshes (Ehrlich et al. 1988).

Double-crested cormorants (*Phalacrocorax auritus*) are common breeding birds along the coast and the lower Columbia River, and it is possible that some breed in the vicinity of the LWR (Puchy and Marshall 1993; Csuti et al. 1997). They are present year-round and many overwinter in the area (Puchy and Marshall 1993). Double-crested cormorants nest in cliffs, trees, and marshes near open water (Csuti et al. 1997). They feed mostly on fish by diving in relatively deep water; they sometimes also feed on aquatic invertebrates such as crayfish and mollusks (Ehrlich et al. 1988).

The green heron (also called the green-backed heron) (*Butorides virescens*) is an uncommon year-round resident in the LWR (Puchy and Marshall 1993). They usually nest in trees in riparian woodlands, often in willows (Csuti et al. 1997). Green herons also have a varied diet consisting mainly of small fish and aquatic invertebrates such as crustaceans and snails. They will also take frogs and terrestrial invertebrates (Ehrlich et al. 1988).

The great blue heron (*Ardea herodias*) is more common and widespread than the green heron and is resident year-round in the LWR (Puchy and Marshall 1993). Ross Island is the site of an active heronry containing up to 30 nests. They are colonial nesters and usually build their nests in trees near water. They can utilize many different habitats and often travel great distances (Csuti et al. 1997). Great blue herons feed mainly on fish, but can also take crustaceans, amphibians, and some upland vertebrates (Ehrlich et al. 1988).

Finally, bald eagles (*Haliaeetus leucocephalus*) are known to nest up and down the Willamette River. The closest known nest is on Ross Island at RM 15, while two old nests are located on Sauvie Island (Isaacs and Anthony 2001). Eagles are year-round residents in western Oregon, with some eagles from further north overwintering in the area (Puchy and Marshall 1993). They nest in treetops or cliffs near large bodies of water (Csuti et al. 1997). Bald eagles feed mainly on fish but are also opportunistic, as they will scavenge on mammals and birds (Ehrlich et al. 1988).

2.3.4 Mammals

Aquatic or semi-aquatic mammals using the LWR include beaver (*Castor canadensis*), muskrat (*Ondatra zibethicus*), raccoon (*Procyon lotor*), river otter (*Lutra canadensis*), mink (*Mustela vison*), nutria (*Myocastor coypus*), and California sea lion (*Zalophus californianus*) (Table 2-6). Nutria was introduced to the area and is considered a nuisance species. Potential foraging areas for beaver, muskrat, raccoon, river otter, mink, and nutria are present at many of the 15 habitat sites identified as part of the Adolfson et al. (2000) natural resource

inventory. California sea lions may use the ISA, primarily from March to mid-May, to forage on runs of spring chinook and summer and winter steelhead (Foster 2001b). California sea lions are protected under the Marine Mammals Act; however, they are considered a nuisance in the LWR because they prey on salmonids. They are known to congregate at the Willamette Falls fish ladder and may use Portland Harbor only for migrating upstream to their preferred feeding areas.

Beaver and nutria are herbivores, although nutria may occasionally eat mollusks. Muskrats are aquatic mammals that dig burrows in banks and feed on vegetation, but may also consume crayfish, fish, turtles, snails, and salamanders (Csuti et al. 1997). Mink and river otter feed on fish, frogs, crayfish, and small mammals and birds (Csuti et al. 1997). Raccoons are omnivorous, ingesting small mammals, fish, amphibians, birds, aquatic invertebrates, fruits, berries, nuts, and seeds (Csuti et al. 1997). Potential mink habitat in the ISA is shown in Figure 2-10.

2.3.5 Amphibians and Reptiles

Conditions within the ISA are likely to provide a limited amount of suitable habitat for amphibians and reptiles. Amphibians and reptiles require off-channel, low-flow aquatic habitat with a substantial presence of riparian vegetation. They can utilize either permanent or ephemeral aquatic habitat, provided the hydro-period is long enough to allow eggs to hatch and larvae to develop. Emergent vegetation is required during the breeding season for ovipositing of eggs. Areas that also contain tree-dominated riparian vegetation provide the most suitable habitat (Hayes 2002). Amphibians generally avoid large lakes and rivers due to predation by large fish (Corkran 2002). Potential habitat for amphibians is shown for the ISA in Figure 2-11. Habitat requirements for reptiles are not met within the ISA, although the painted turtle (Chrysemys picta) has been observed in nearby ponds and wetlands.

There is a paucity of scientific information concerning the occurrence of amphibians and reptiles in the LWR. Table 2-7 lists the amphibians and reptiles that may occur in or near the ISA as well as their associated life history characteristics. Reptile species that are possibly present at or near the ISA are the painted turtle (*Chrysemys picta*) and the Western pond turtle (*Clemmys marmorata marmorata*). Breeding populations of painted turtles have been documented in wetland habitats with some access to the LWR (Adolfson et al. 2000), but these species generally prefer the more quiet backwaters of lakes, ponds, and marshes. Amphibians using the aquatic environment for portions of their life history that may be present in the vicinity of the ISA include northern red-legged frog (*Rana aurora aurora*), northwest salamander (*Ambystoma gracile*), long-toed salamander (*Ambystoma macrodactylum*), rough skin newt (*Taricha granulosa)*, Western toad *(Bufo boreas*), Pacific chorus frog (*Pseudacris regilla*), Cope's giant salamander (*Dicamptodon copei*), Pacific giant salamander

(*Dicamptodon tenebrosus*), tailed frog (*Ascaphus truei*), and the bullfrog (*Rana catesbeiana*). The Pacific chorus frog and the long-toed salamander are the most likely amphibian species found in the area (Hayes 2002). The northern red-legged frog, tailed frog, and the northwestern pond turtle are federal species of concern and state-listed sensitive species.

The aquatic portion of amphibian diets may include aquatic plants, detritus, small invertebrates, tadpoles, fish eggs, zooplankton, and small fish. Amphibian adults may prey on terrestrial insects, earthworms, and in some species small birds and mammals (Csuti et al. 1997). Juvenile amphibians rely more heavily on the aquatic environment for their diet and development than do adults. Reptiles have a similar aquatic diet as amphibians, including aquatic plants, mollusks, crayfish, fish and tadpoles. Additionally, reptiles may feed on earthworms and terrestrial insects.

2.3.6 Aquatic Plants

The current conditions of the LWR prevent the successful establishment of a dense, submerged and emergent plant community along the river banks. Turbidity is too high in the LWR for the establishment and growth of many plant species (Sytsma 2002). In addition, riprap and other bank stabilization efforts have resulted in little area for plant establishment on the banks and shoreline areas. Riprap also separates the shoreline plant community from upland plant communities. The disturbance of bank stabilization and channelization efforts often promotes the successful invasion of exotic plant species such as Himalayan blackberry (*Rubus discolor*) and reed canary grass (*Phalaris arundinaceae*). These exotic, pioneer species flourish in disturbed areas and further prevent native plant species from establishing along the banks of the LWR.

Currently, no comprehensive vegetation surveys have been conducted to quantify and describe the plant community in the LWR. However, Adolfson et al. (2000) recently conducted an inventory of fish and wildlife habitat along the shoreline of the LWR. This inventory resulted in general descriptions of plant community types occurring along the LWR and identified 10 distinct habitat classes: bottomland forest, foothill savanna, conifer forest, scrub, meadow, shrub, emergent wetland, beach, rock outcrop, open water, and unvegetated/disturbed. Although all of these plant communities occur in the vicinity of the LWR, bottomland forest, emergent wetlands, rock outcrop, beach, and open water communities are likely the most common community types occurring along the shoreline within the ISA. The following is a brief description of the plant species commonly found within these communities.

Black cottonwood (*Populus balsamifera*) is usually a dominant species in bottomland forest communities, along with Pacific willow (*Salix lucida*), red osier dogwood (*Cornus sericea*), snowberry (*Symphoricarpos alba*), Oregon ash

(*Fraxinus latifolia*), and Himalayan blackberry (Adolfson et al. 2000). Historically, this plant community was an important component of the Willamette River floodplain system (Sedell and Froggatt 1984), and exists today at a small percentage of its former extent (Adolfson et al. 2000).

Emergent wetlands make up a small percentage of habitat type on the shoreline of the LWR. This community type exists in a few small remnant patches in areas adjacent to the shoreline. These areas are usually dominated by reed canary grass with Douglas spiraea (*Spiraea douglasii*), red osier dogwood, and other sedge and rush species (Adolfson et al. 2000).

Basalt rock outcrops are not common throughout the LWR, perhaps due to the local geology and bank stabilization and channelization efforts in the area. Where they exist, these areas provide substrate for plant communities consisting of ferns, mosses, liverworts, and lichens (Adolfson et al. 2000).

Beach habitats throughout the LWR typically consist of narrow shoreline areas, with sand substrate, and are dominated by a variety of annual grasses and perennial shrubs. Willow communities often establish in these areas and can include Pacific willow, Columbia River willow (*Salix fluviatilis*), and Piper's willow (*Salix piperii*) (Adolfson et al. 2000).

Open water habitats occur throughout the LWR in tributaries, sloughs, and side channels and are often dominated by aquatic plant species from bottomland forest, emergent wetland, and scrub/shrub communities (Adolfson et al. 2000).

2.4 SPECIAL-STATUS SPECIES

Special-status species include federal and state proposed and candidate species, federal species of concern, and state sensitive species. Table 2-8 identifies the special-status species likely to occur in the ISA.

2.4.1 Invertebrates

The Columbia pebblesnail (also known as the Columbia spire snail) is a freshwater mollusk that may occur in the LWR. They are listed as a species of concern by the U.S. Fish and Wildlife Service (USFWS).

2.4.2 Fish

Of the seven salmonid species reported to use the LWR, five are listed as threatened or proposed threatened (Table 2-8). Coastal cutthroat trout, steelhead, and chum and chinook salmon are also all considered sensitive species by ODFW. Pacific lamprey and river lamprey are recognized as species of concern at the

federal level (USFWS), and Pacific lamprey is recognized as a sensitive species at the state level (ODFW). Pacific lamprey is an anadromous species that occurs in Portland Harbor. Pacific lamprey populations have significantly declined in the last 30 to 50 years. At the Bonneville Dam on the Columbia River, Pacific lamprey have declined from peak returns of about 380,000 in the 1930s and 1940 down to returns of about 10,000 recently. Reasons for declines are unclear, but lamprey ammocoetes require spawning habitats similar to those for Pacific salmon, and declines may be related to dams and habitat degradation (Kostow 2002). Little is known about the presence of river lamprey in the Lower Columbia Basin and the Willamette River. River lamprey have not been observed in these areas in recent years, but they are a rare species and difficult to find in fresh water. They have been collected in the Lower Columbia River in the vicinity of the LWR, but their presence in the LWR is unknown (Kostow 2002).

2.4.3 Birds

The status of sensitive aquatic or semi-aquatic bird species is listed in Table 2-8. Aleutian Canada geese (*Branta canadensis leucopareia*) are rare but may be observed occasionally along the LWR in winter and are considered a threatened species (USFWS). Both Aleutian Canada geese and the American peregrine falcon (*Falco peregrinus annatum*) are protected as state endangered species (ODFW). Black terns (*Childonias niger*), a federal listed species of concern, are generally rare in the area, but were common during the summer of 2001 due to the drought in the eastern part of the state (Nebeker 2001). Bald eagles are known to use habitat along the Willamette River and are recognized as a threatened species both by USFWS and ODFW. Harlequin duck (*Histrionicus histrionicus*) is considered a federal species of concern, but is uncommon in the Lower Willamette Valley. On rare occasions these ducks may be observed migrating through the area, but would not use the area as a foraging ground (Nebeker 2001). Any of these birds observed in the area have home ranges that extend well beyond the ISA.

Breeding populations of several species that are present in the LWR only during the winter have been given special status by ODFW or are considered sensitive by the Oregon Natural Heritage Program (ONHP). These species include Barrow's goldeneye (*Bucephala islandica*), bufflehead (*Bucephala albeola*), horned grebe (*Podiceps auritus*), red-necked grebe (*Podiceps grisegena*), long-billed curlew (*Numenius americanus*), and greater sandhill crane (*Grus canadensis*) (ONHP 2001).

2.4.4 Amphibians and Reptiles

Western toad, Cope's giant salamander, tailed frog, northern red-legged frog, northwestern pond turtle, and painted turtle are all considered sensitive species by

ODFW. In addition, northwestern pond turtle, tailed frog, and red-legged frog are listed as species of concern by USFWS.

2.4.5 Aquatic Plants

Nine wetland plants that occur in the Willamette Valley and may occur in the ISA are special-status species (Table 2-8). Howell's bentgrass (*Agrostis howellii*), white-topped aster (*Aster curtus*), wayside aster (*Aster vialis*), Peacock larkspur (*Delphinium pavonaceum*), and Hitchcock's blue-eyed grass (*Sisyrinchium hitchcockii*) are all species of concern by USFWS. Howellia (*Howellia aquatilis*) and Nelson's sidalcea (*Sidalcea nelsonia*) are federally threatened species, and the Willamette daisy (*Erigeron decumbens*), Bradshaw's lomatium (*Lomatium bradshawii*) are protected federal endangered species. All of these plant species have threatened or endangered state status as well, with the exception of Howell's bentgrass, howellia and Hitchcock's blue-eyed grass.

Additional habitats may be developed along the river banks as part of future restoration projects. Future enhancement will be taken into account under future use of the area.

2.5 IDENTIFICATION OF REPRESENTATIVE SPECIES

A systematic process was followed to select representative species. Representative species were selected for fish, birds and mammals.

Based on the available information for the resources and on EPA guidance (EPA 1997, 1998) for fish, birds, and mammals, representative species were selected based on the following steps:

- Key direct and indirect exposure routes were identified.
- Groups of organisms that may be exposed via these pathways were identified.
- Species from within these groups of organisms were then selected based on:
  - Their societal and cultural significance (i.e., species valued by society or that have special regulatory status—threatened or endangered)
  - Their ecological significance (i.e., species that serve a unique ecological function)
  - Their level of exposure to likely COPCs at the site (i.e., site usage)

- Their relative ability to bioaccumulate likely COPCs at the site
- Their sensitivity to likely COPCs at the site
- Availability of sufficient data on behaviors that determine exposure and potential sensitivity of the species to COPCs to allow meaningful assessment of risks.

In Sections 2.3 and 2.4, fish, birds, and mammals confirmed as or likely to be present in the ISA were discussed as a function of their feeding guild, ecological significance, and societal significance. This information was used to determine which species could be exposed to contaminants in the ISA. Final selection of receptors was based on the sensitivity and relative ability of the species to bioaccumulate COPCs, based on available bioaccumulation and toxicity studies, including historical site data and available information on site usage which affects exposure. By selecting the most sensitive species, other less sensitive species that experience similar exposure conditions, will also be protected. Species that occupy the LWR during a large part of the year or during sensitive periods, such as nesting, were preferentially selected as receptors.

Finally, data availability regarding both exposure and effects was assessed. Species for which there are related site-specific data, such as COPC concentrations in food, site usage, and feeding, and toxicological data, such as toxicity reference values (TRVs), were preferred. A TRV is a value (e.g., dose, medium concentration, or tissue residue) that represents a toxicity threshold and can be defined by either no-effect data or low-effect data or both. For some species, toxicological information from surrogate species will be required because species-specific data are not available.

This section presents a discussion of species selected as receptors (i.e., the representative species). A representative species was chosen from each of the feeding guilds for fish, birds, and mammals.

2.5.1 Aquatic Plants

Various wetland plant species were identified in the Aquatic Plant and Amphibian/Reptile Reconnaissance Survey (see Attachment B.2). Native wetland plant species were identified, including common wetland asters (*Aster* spp.), sedges (*Carex* spp.), horsetail (*Equisetum avense*), rushes (*Juncus* spp.), smartweed (*Polygonum* spp.), black cottonwood (*Populus balsamifera*), Columbia river willow (*Salix fluviatilis*), Douglas' spiraea and cattail (*Typha latifolia*). Fifteen non-native species were also found and no submerged aquatic plants were found (See Attachment B.2). Wapato (*Sagittaria latifolia*) is a wetland plant of

particular interest to Native Americans. Aquatic plants will be assessed by evaluating multiple species, dependent on the scientific information available.

2.5.2 Benthic Invertebrates

2.5.2.1 Epibenthic and Infaunal Invertebrates

Lower-trophic-level benthic invertebrates are generally evaluated as a community in ERAs. Benthic invertebrates in the ISA are in direct contact with sediment and therefore have a high exposure potential. They are present in the ecosystem year-round. Benthic invertebrates are an important food source for other invertebrates, fish, birds, and mammals, and provide essential nutrient cycling to the LWR ecosystem. Both infaunal and epibenthic macroinvertebrates often comprise a significant portion of the heterotrophic biomass in a river system (Jahn and Anderson 1986), and therefore serve as a principal food resource for higher trophic-level consumers (i.e., fish and wildlife). Macroinvertebrates also control energy flow by acting as principal processors of organic matter (Merritt et al. 1984). In large, deep rivers, such as the LWR, particles suspended in the water column are a significant source of organic matter for the ecosystem. Bivalves are important filter feeders that capture this energy source and serve as potential food resources for higher trophic-level consumers. In addition, benthic organisms have been shown to be susceptible to sediment-associated chemicals and data are available to assess their exposure and predict potential effects.

The potential effects to shellfish will be assessed separately from the epibenthic and infaunal invertebrate evaluation. The assessment will be performed on the population level.

2.5.2.2 Epibenthic Macrofauna

In addition to the community assessment, crayfish were selected as an important prey species. The effects to crayfish will be assessed by comparing whole body concentrations with tissue TRVs. Crayfish have small home ranges, and therefore may be susceptible to localized concentrations of chemicals. They are also highly exposed because of direct contact with sediment and have a relatively long life span, up to eight yr, compared to other invertebrates (Hobbs 2001). Some toxicological data are available to evaluate potential effects.

2.5.3 Fish Species

Representative species of fish were selected based on the criteria presented in Section 2.5. First, all fish that may occur in the LWR were identified through literature reviews (Table 2-2). Fish were then classified into four feeding guilds: omnivores/herbivores (eating vegetation, or vegetation and invertebrates),

invertivores (primarily eating invertebrates), piscivores (primarily eating fishes), and detritivores (primarily eating detritus).

Information on origin (native versus introduced), abundance, feeding guild, prey items, home range, location in water column, preferred habitat, spawning time, and lifespan was compiled for each fish (Table 2-2). Using this information and the criteria presented above, representative species of fish that are likely to be more highly exposed to COPCs in the ISA were selected for each feeding guild. These representative species were chosen from each feeding guild to represent the fish community as a whole, and the risk evaluation for these species should be representative of risks to all fish species in the ISA. The choice of representative species from each of these feeding groups is discussed in the sections below.

2.5.3.1 Omnivores/herbivores

Omnivorous and herbivorous fish in the LWR are exposed to chemicals primarily through their diet and incidental ingestion of sediments (Section 2.6). The common omnivores in the ISA are largescale sucker, common carp, and white sturgeon (Table 2-2). These species are benthic-feeders that ingest sediment along with a variety of animal, plant, and detrital material. All of these species are long-lived, with life expectancies of 15, 20, and 100 yr for largescale sucker, carp, and white sturgeon, respectively. Largescale sucker is one of the most abundant species in the LWR. Farr and Ward (1993) reported that they were common in all habitats in the LWR. However, largescale sucker have a large home range that may extend outside of the LWR into the adjacent segments of the Clackamas and Columbia Rivers, and largescale sucker have not been observed to spawn in the ISA. They spawn in sand or gravel shoals in cold water lakes or streams at temperatures of 7.8 to 8.9°C (Scott and Crossman 1973).

White sturgeon are also common in the LWR and were captured by Farr and Ward (1993) throughout the LWR. White sturgeon were captured most frequently near sandy beach shorelines with no structures (Farr and Ward 1993). White sturgeon in the LWR are considered to be part of the lower Columbia River population. White sturgeon are migratory and may spend significant portions of their lives outside the ISA (Devore and Grimes 1993). Tagged Columbia River white sturgeon have been reported as far away as Puget Sound (Devore and Grimes 1993). White sturgeon have not been reported to spawn in the ISA. They spawn in cobble habitat that is not present in the ISA. They may spawn upstream of Portland Harbor below Willamette Falls. Eggs and larval stages of white sturgeon have been found dozens of miles downstream from spawning locations (Devore and Grimes 1993). Thus, early life-stages of white sturgeon are likely to be present in the ISA if spawning takes place below Willamette Falls. White sturgeon are extremely long-lived and slow to mature. They are anadromous and rear in freshwater for up to 11 yr.

Carp are a benthopelagic species frequently associated with bottom sediments. Farr and Ward (1993) report that carp are common in the LWR, though not as common as largescale sucker or white sturgeon. Carp in the LWR did not appear to be associated with any particular habitat (Farr and Ward 1993). Carp have not been reported to spawn in the LWR. They prefer to spawn in backwater areas at temperatures greater than 17°C with some vegetation present (Scott and Crossman 1973).

Based on the criteria above, largescale sucker and common carp are suitable representative species, though largescale sucker is preferred because it is more highly associated with the benthic environment. White sturgeon is not a good representative of omnivorous or herbivorous fish within the ISA because of its large home range. Mark and recapture studies with white sturgeon have documented migrations of greater than 500 miles (Chadwick 1959; Kohlhurst et al. 1991; Devore and Grimes 1993). Therefore, there is great uncertainty regarding their exposure to chemicals outside the ISA. Largescale sucker is selected rather than carp to represent omnivorous and herbivorous fish in the ISA because of their close association with sediments. Some uncertainty exists in selecting this species because they have a home range extending beyond the ISA. However, the maximum documented movement of largescale sucker in the Columbia River was an order of magnitude less (~40 mi) than for white sturgeon (Dauble 1986) (Figure 2-5). Largescale sucker have a higher trophic status than the only two herbivorous fish (chiselmouth and mountain suckers), and thus should have higher exposure to biomagnifying chemicals. Because the herbivorous fish are not known to be more sensitive, the more highly exposed largescale sucker is an appropriate representative species. The uncertainty associated with largescale sucker representing the white sturgeon, a longer-lived species, as a member of this feeding guild will be discussed in risk characterization.

2.5.3.2 Invertivores

Many species of invertivorous fish inhabit the LWR (Table 2-2). Carnivorous fish are potentially exposed to biomagnifying chemicals through their prey, and to chemicals through direct and indirect exposure to water and sediments. Within this feeding guild, two resident fish species were selected, along with an anadromous salmonid species. Of all the fish species that occur in the ISA, invertivorous salmonids are perhaps most highly valued by society. Pacific salmon contribute to recreational and commercial fisheries, and are important in both spiritual and practical terms as food and fishery to the Native American tribes of the area. Of the Pacific salmon, several species that occur in the ISA are listed under the Endangered Species Act (ESA) (Table 2-8).

Resident invertivorous fish common in the ISA include yellow perch, peamouth, threespine stickleback, reticulate sculpin, and prickly sculpin. Other invertivorous

fish in the LWR (e.g., shad) are migratory or uncommon and thus do not represent this feeding guild well. As resident species, all life stages of these species are potentially exposed to chemicals in the ISA. Peamouth are a benthopelagic species that preys on both benthic and pelagic prey, whereas sculpin is a benthic species that feeds on benthic prey. The home range for the peamouth is unknown, but it is likely to be larger than that of sculpin, which are generally territorial species. Therefore, sculpin exposure is likely to be reflective of chemical concentrations near the site where fish are captured, whereas peamouth are likely to integrate exposure over a larger area. Peamouth, with a maximum lifespan of approximately 13 yr, are longer-lived than sculpin, which have a lifespan of approximately 4–7 yr. Based on their ecology, both peamouth and sculpin species may be representative of invertivorous fish in the LWR.

Sculpin were selected to represent invertivorous fish because of their close association with sediments and their small home range. The species of sculpin has not been chosen because they are difficult to distinguish; however, they all have similar feeding behavior and home ranges. As resident invertivores, all life stages of sculpin are present and exposed to chemicals in the ISA. The peamouth was also selected to represent invertivorous fish because it is a resident species with a home range potentially much larger than the sculpin, and therefore representative of exposure over a wider area in the ISA.

Both juvenile and adult life stages of several Pacific salmon, including chinook salmon, migrate through the ISA. However, adult life stages of these salmonids are exposed to chemicals in their oceanic habitat; thus, the source of chemical burdens in adult fishes found in the ISA would be difficult to ascertain. Adult life stages of most anadromous species have substantially reduced feeding during their upstream migrations, so exposure to chemicals in the ISA through this pathway is likely to be relatively low. These factors make adult salmonids an inappropriate choice for a representative species. Additionally, juveniles are generally believed to be more susceptible to toxic substances than adults.

Juvenile salmonid residence time in the LWR and ISA is a matter of ongoing investigation, and there is uncertainty in the year-to-year variation between size and age cohorts for each of the various species. However, of the juvenile Pacific salmonids, juvenile chinook salmon appear to have the longest residence in the ISA (Ward and Nigro 1992, North et al. 2001) (Figure 2-4), giving them the greatest potential exposure to chemicals. Abundant toxicological data from studies conducted with salmonid species are available to evaluate potential effects for this species. Based on the above information, juvenile chinook salmon were selected to represent juvenile salmonids in the ISA. However, some salmonids (e.g., spring chinook) may spend more time in the ISA than juvenile fall chinook. Neither spring nor fall chinook can be distinguished during sampling. Therefore, it is uncertain which seasonal chinook tissue will be collected for use in the risk assessment. As described above, peamouth inhabit similar habitats and have diets

similar to juvenile salmonids utilizing the ISA. Therefore, peamouth will provide a conservative estimate of exposure for those juvenile chinook with greater residence time in the ISA. General juvenile chinook habitat is shown in Figure 2-6.

2.5.3.3 Piscivores

Several species of piscivorous fish have been observed in the LWR (Table 2-2). Northern pikeminnow, smallmouth bass, largemouth bass, bull trout, black crappie, white crappie, and walleye are common piscivores in the LWR. As top predators, all of these fish play a key role in the dynamics of the aquatic community. Because of their high trophic status, these fish have high potential exposure to biomagnifying chemicals such as polychlorinated biphenyls (PCBs), DDTs, and mercury. Of the piscivores listed in Table 2-2, northern pikeminnow is the only native species.

Habitat associations for piscivores in the LWR vary between species in ways that may affect their exposure to chemicals. Northern pikeminnow, black crappie, and white crappie are more common in the LWR than the other piscivorous fish. The northern pikeminnow is common in all habitats in Portland Harbor, especially near undeveloped natural beaches (Farr and Ward 1993). Black crappie and white crappie, though common in all habitats, are most common near developed sites, especially near quiescent rip-rapped areas (Farr and Ward 1993). Black crappie, white crappie, smallmouth bass, and largemouth bass are closely related species, all of the family Centrarchidae. These centrarchids are all believed to have home ranges that are small relative to the ISA. Northern pikeminnow have varying home ranges. In a mark-recapture study, North et al. (2001) found that most northern pikeminnow were recaptured within 1.4 km of their release site; however, one fish was captured 21 km from the release site, and several fish were not recaptured and may have moved long distances or been eaten by predators (Figure 2-5).

The diets of piscivorous fishes in the LWR have been shown to be similar (Fishman 1999). All of the piscivorous fish in the LWR are benthopelagic species, so none are likely to have greater direct sediment exposure. Northern pikeminnow have a longer expected lifespan (19 yr) than walleye (17 yr), largemouth bass (16 yr), black crappie (13 yr), smallmouth bass (10 yr), or white crappie (6–7 yr). Sufficient tissue data were not available to compare relative bioaccumulation directly (Section 3). Also, few toxicological data are available for piscivorous fish species present in the LWR. Therefore, the relative sensitivity of piscivorous fish species could not be used as a factor for selection of a receptor for this guild. The northern pikeminnow was selected as representative of piscivorous fish because it is relatively long-lived and is a top predator. Smallmouth bass were also selected as representative of piscivorous fish because

of their smaller home range and similarity to other centrarchid piscivores in the LWR.

2.5.3.4 Detritivores

Lamprey ammocoetes are unique to the fish community in Portland Harbor because they live burrowed in the sediment and filter their food from sediment, ingesting sediments in the process. These are the only detritivorous fish present in the LWR. Lamprey ammocoetes reside in freshwater for up to 6 yr and potentially have extensive exposure. However, lamprey ammocoetes are reported to move progressively downstream as they mature, so exposure in the ISA is likely to be less than the maximum possible in fresh water. Pacific lamprey are also a species of concern under the ESA and an Oregon State sensitive species. Pacific lamprey are valued by Native American tribes in the region for ceremonial purposes. Additionally, toxicity data are available for lamprey because several chemicals have been tested as lampricides for use in the Great Lakes, where sea lamprey from the Atlantic Ocean are an introduced pest species.

The occurrence of lamprey ammocoetes in the ISA is largely unknown; however, they were reported to be present near RM 11 from an electrofishing survey (Fishman 1999). Three species of lamprey other than Pacific lamprey may occur in the ISA, but their presence has not been well documented (Table 2-2). Therefore, Pacific lamprey ammocoetes were selected to serve as a representative for detritivorous fish in the LWR. Extensive sampling efforts to capture this receptor within the ISA occurred in 2002, but few were captured (Attachment B.3). These results indicate that use of the ISA by lamprey ammocoetes may be more limited than expected. The opportunity to sample additional lamprey ammocoetes will be evaluated and if deemed not feasibly other fish tissue data will be used as surrogates in the evaluation of potential effects to lamprey.

Adult lamprey travel through the ISA while migrating to upstream spawning areas. Growth of adult lamprey occurs primarily during parasitic feeding on other fish in the ocean or estuary. Adult lamprey do not feed in fresh water. Therefore, their exposure through the dietary pathway while in the ISA is insignificant. The passage time of adult lamprey in the ISA is unknown.

2.5.3.5 Summary

Seven fish species were selected as receptors from the four feeding guilds of the LWR. They are largescale sucker, sculpin, peamouth, juvenile chinook salmon, northern pikeminnow, smallmouth bass, and Pacific lamprey. Collectively, these fishes represent the exposure pathways that are most likely to be significant for fish species, and they represent the range of life stages and habitat used by fishes in the ISA. Altogether, chemical risk analyses of these receptors will be protective of other fish species in the ISA. Fish in early life stages may be

affected by COPCs differently from the adult stages discussed above. Methods for assessing risks to juvenile and other early-life-stage fish will be discussed in Section 5.0 of this appendix.

2.5.4 Amphibians and Reptiles

Amphibians will be evaluated at the population level and will act as a surrogate representing the reptile population. Amphibians will be a surrogate species to evaluate reptiles because little toxicity data are available on reptiles and exposure of amphibians to COPCs is greater. The suitability of using amphibians as surrogate for reptiles will be assessed by performing a comparative evaluation of toxicity based on a literature search, if appropriate reptile habitat is found in the ISA. Amphibians and reptiles will be assessed by evaluating multiple species, dependent on the scientific information available.

2.5.5 Birds

To choose avian representative species, birds at the site were evaluated using the criteria in Section 2.5, dividing them into four primary feeding guilds: herbivores (eating primarily vegetation), sediment-probing invertivores/omnivores (feeding on invertebrates), diving carnivores/omnivores (feeding on small fish, crayfish, and invertebrates), and piscivores (eating primarily fish). This section discusses the selection of representative bird species.

2.5.5.1 Herbivores

Herbivorous birds in the vicinity of the ISA that consume mostly aquatic vegetation as well as some aquatic organisms include geese, swans, American coot, and various diving and dabbling ducks. A representative from this group will not be assessed because they feed at the base of food web and thus are less exposed to contaminants than the receptors from the other feeding guilds. In addition, aquatic vegetation is limited in the ISA, so feeding probably occurs primarily in areas not associated with harbor contamination. Although dabbling ducks may ingest sediment while feeding, they are not likely to ingest as much as sandpipers. Spotted sandpiper was selected as a receptor (Section 2.5.5.3), so protection of this species will also be protective of dabbling ducks thereby acting as a surrogate for this feeding guild. The similarity of the spotted sandpiper's and dabbling ducks' exposure units will be evaluated through a comparison of the area usage within the ISA by the two species. The wintering population of Aleutian Canada goose is listed as threatened by the USFWS and endangered by ODFW (ONHP 2001), and may be present in the vicinity of the ISA, but is rarely observed (Nebeker 2001). Canada geese eat primarily grain and foliage in the winter (Ehrlich et al. 1988), reducing their exposure to contaminated sediment from the ISA. Herbivorous birds have limited exposure to contaminants in the

LWR and estimated total exposure for sediment-probing invertivores is assumed be a conservative estimate of total exposure to herbivorous birds.

2.5.5.2 Diving Carnivore/Omnivore

Diving birds in the study area that ingest primarily invertebrates and small fish include bufflehead, hooded merganser, goldeneye, grebes, Bonaparte's gull, California gull, and scaup. None of these species are identified as threatened or endangered. Any of these species would be good representative species for the diving birds. The hooded merganser was chosen as the representative species because it utilizes most of the aquatic habitat in the LWR to forage for crustaceans, mollusks, aquatic insects, and fish.

2.5.5.3 Sediment-probing Invertivore/Omnivore

Sediment-probing birds consume mostly sediment-associated invertebrates and may incidentally ingest a relatively large amount of sediments. In the vicinity of the ISA, these birds include sandpipers, killdeer, sora, yellowlegs, marbled godwit, long-billed curlew, Wilson's phalarope, dowitchers, common snipe, and Virginia rail. Spotted sandpiper, killdeer, sora, Virginia rail, and common snipe are species that breed in the vicinity of the ISA. Breeding populations of the long-billed curlew, which are not present in the Willamette Valley, are considered vulnerable by ODFW (ONHP 2001). None of the probing birds is listed as threatened or endangered, and species-specific laboratory toxicological data are not available for any of these species. Of the bird species evaluated for consumption of soil and sediment by EPA (1993), sandpipers were found to have the highest sediment ingestion rate. Therefore, spotted sandpiper was chosen as a representative species based on sediment exposure and presence of breeding population. Because exposure of the spotted sandpiper to sediment is expected to be relatively high, the spotted sandpiper is considered a conservative representative of omnivorous and herbivorous birds.

2.5.5.4 Piscivores

Piscivorous birds feeding from the Willamette River in the vicinity of the ISA include ospreys, cormorants, herons, terns, eagles, kingfishers, American white pelicans, and western gulls. Of these birds, the osprey and the bald eagle were chosen as representative species of piscivores at the site. The bald eagle is listed as a threatened species under the ESA and is also protected by the Bald Eagle Protection Act, and both the osprey and bald eagle are protected under the Migratory Bird treaty Act. Osprey and bald eagle nests have been observed at or close to the site, indicating that sensitive, developmental life stages of these species are potentially exposed to chemicals in the ISA. Most of the osprey's prey are fish, and bald eagles are assumed to consume primarily fish in the LWR. Consumption of secondary aquatic consumers, such as invertivorous fishes, gives

bald eagle and osprey the highest potential exposure to biomagnifying chemicals. Chemical exposure in the ISA for these two species is likely to be different because the bald eagle is present year-round and osprey is a migratory species, present only from spring through fall.

Other piscivores considered for inclusion as representative species were the cormorant, great blue heron, and kingfisher, based on their presence at the site, breeding habitat, special regulatory status, or societal importance. The cormorant feeds on bottom fish, and thus may have potentially high exposure. However, the osprey and bald eagle consume secondary consumers and have more societal value, rendering them better representative species. The great blue heron nests on Ross Island, but the site affiliation may not be as strong as for the osprey because great blue heron may feed on upland species. Osprey and bald eagles are likely the most highly exposed to site-related chemicals, and protection of ospreys and eagles would therefore also protect other piscivorous birds.

2.5.5.5 Summary

Four birds were selected as representative species from three of the four feeding guilds of the LWR. They are spotted sandpiper, hooded merganser, osprey, and bald eagle. Collectively, these birds represent the exposure pathways that are most likely to be significant for bird species, and they represent the range of life stages and habitat used by birds in the ISA. Altogether, risk assessment of these receptors will be protective of other bird species in the ISA.

2.5.6 Mammals

The key exposure route for aquatic or semi-aquatic mammals is likely to be consumption of prey associated with sediment in the ISA. The mammalian species that may use the ISA and have the greatest percentage of aquatic prey in their diets are mink, river otter, raccoon, and California sea lion. None of these species is listed as threatened, endangered, or sensitive. Raccoons are omnivores that ingest significant amounts of vegetation along with a broad range of other food items. The California sea lion is generally considered a nuisance species in the Willamette River because of its predation on salmonids, and is likely to use the site only for migrating to Willamette Falls to forage at the fish ladder.

Mink were chosen as the representative species to represent wildlife consuming aquatic prey. Mink are not common in the ISA; however, mink are known to be extremely sensitive to PCBs and therefore may be sensitive to other contaminants. In addition, substantial toxicity data exists for this mammal species. By protecting mink, other less sensitive mammals such as the river otter will be protected.

2.6 POTENTIAL EXPOSURE PATHWAYS

This section describes the potential chemical exposure pathways to species in the ISA and discusses which pathways will be evaluated for the various representative species in the ecological risk assessment. Representative species can be exposed to chemicals in water or sediment in the ISA either directly through contact with or ingestion of sediments or surface water or indirectly through the food chain. The CSM (Figure 2-12) illustrates the pathways that chemicals may follow from primary sources to the ecological species. Exposure pathways were designated as follows:

- **Complete and Major**: Pathway is complete and expected to be a significant contributor to total exposure. This pathway will be quantitatively assessed when possible in the PRE and the BERA.
- **Complete and Minor**: The pathway is complete and expected to be a minor component of total exposure. In relation to other complete pathways, chemical exposure is expected to be minimal. This pathway will not be quantitatively evaluated in the PRE and the BERA unless sufficient data are available, but will be discussed qualitatively to a level of certainty dependent on available studies. If the data are insufficient, additional information will be gathered through an interim sampling process and the risk evaluated if the pathway is believed to potentially contribute to overall risk significantly.
- **Complete and Uncertain**: The pathway is complete but of undetermined significance. If there is a lack of sufficient toxicological data, this pathway will not be quantitatively evaluated in the PRE and BERA, but will be discussed qualitatively to a level of certainty dependent on available studies. However, if the uncertainty is due to lack of site-specific data, appropriate information will be collected and a determination made whether the pathway is major or minor. If sufficient toxicological data exist, the pathway will be evaluated using multiple lines of evidence including sediment chemistry, bioassays and an evaluation of groundwater contribution.
- **Incomplete**: The pathway is incomplete; therefore, it will not be evaluated in the PRE or BERA.

The rationale for each exposure pathway designation by receptor is discussed in the remainder of this section.

2.6.1 Aquatic Receptors

2.6.1.1 Aquatic Plants

The Aquatic Plant and Amphibian/Reptile Reconnaissance Survey (see Attachment B.2) confirmed the presence of aquatic plants in the ISA. Exposure pathways considered complete and major to aquatic plants are direct contact with surface water and sediment (Figure 2-12). Because aquatic plants actively and passively transfer chemicals from surface water and sediments, these contact pathways are considered the only complete pathways of exposure to this receptor community in the ISA.

2.6.1.2 Benthic Invertebrates

Infaunal and epifaunal invertebrates

Infaunal and epifaunal benthic invertebrates are generally in direct contact with sediment and surface waters. Therefore, direct sediment and water contact are considered complete and major pathways of exposure (Figure 2-12). Surface water ingestion is considered a complete and minor pathway of exposure for infaunal and epifaunal invertebrates. In addition, benthic invertebrates are known to routinely ingest sediment, and therefore this pathway is considered complete and major. A significant portion of benthic invertebrate diet consists of other benthic organisms, algae, and detritus. Therefore, biota ingestion for infaunal and epifaunal organisms is considered a complete and major pathway of exposure.

Benthic infauna may be exposed to chemicals associated with groundwater infiltration into sediments. This exposure may not be reflected in sediment concentrations for volatile organic compounds and some metals that do not partition into sediments. The importance of this pathway in the ISA cannot be determined at this time due to lack of information on groundwater hydrology within the ISA. Therefore, this pathway is considered complete and uncertain. The groundwater pathway will be assessed if the results of the groundwater evaluation indicate the existence of areas where porewater chemistry may be influenced by groundwater input creating a complete pathway to benthic infauna (see Section 7.5 of the Programmatic RI/FS Work Plan for groundwater evaluation process). The porewater pathway is considered complete and the significance is uncertain at this time for benthic infauna. For all other receptors, this pathway is considered incomplete.

Mollusks

Direct sediment, porewater, and surface water contact are considered complete and major pathways of exposure for mollusks (Figure 5-3). Sediment ingestion is also considered a complete and major pathway of exposure for mollusks because they are known to routinely ingest sediment. Incidental water ingestion is considered a complete and minor pathway. Biota ingestion is considered a complete and major pathway because mollusks' diets can consist of other benthic organisms and detritus.

Epibenthic Macrofauna
Crayfish are in direct contact with surface water, and this pathway is considered complete and major. Crayfish are also in direct contact with sediment. Thus, sediment contact is considered a complete and major pathway for crayfish. Crayfish ingest sediment both directly and indirectly, therefore this pathway is considered complete and major. Surface water ingestion is considered a complete and minor pathway of exposure. Finally, crayfish diets consist of other benthic organisms, detritus, and dead fish. Therefore, biota ingestion is considered a complete and major pathway of exposure.

2.6.1.3 Fish
Omnivore/Herbivore-largescale sucker
Largescale suckers live in close association with sediment and benthic invertebrates which are a primary component of this species' diet. As such, direct contact with sediment, sediment ingestion, and ingestion of benthic biota are considered to be complete and major pathways of exposure for this species and will be evaluated (Figure 2-12). In addition, largescale suckers are in direct contact with surface water, thus, this pathway is considered a complete and major pathway of exposure for this receptor. Incidental ingestion of water may occur for the largescale sucker, like all the fish species, however, this pathway is considered complete and minor. Largescale sucker habitat is shown in Figure 2-6.

Invertivore--sculpin species
Benthic invertivorous fish, such as sculpin species, are in direct contact with surface waters and sediments. Therefore, direct sediment and water contact are considered complete and major pathways of exposure for sculpin (Figure 2-12). Water ingestion is considered a complete and minor pathway. Since sculpin are benthic feeders and consume sediment-ingesting prey such as epibenthic invertebrates, sediment and biota ingestion are also considered complete and major pathways of exposure.

Invertivore—peamouth
Peamouth are in constant contact with surface water and this pathway is considered complete and major. Ingestion of surface water is a complete and minor pathway. The diet of the peamouth consists of benthic invertebrates, crustaceans and small fish which bioaccumulate chemicals. Therefore, the ingestion of biota is a complete and major pathway. While feeding, peamouth may ingest sediment directly through the mouth or indirectly through prey. The amount of sediment ingested with prey could be significant when feeding on benthic organisms. However, fish are also a portion of the peamouth diet and would constitute a minor mass of sediment. Therefore, the sediment ingestion pathway is considered complete and uncertain. Peamouth are benthopelagic species and direct contact with sediment will occur when feeding on benthic prey. However, benthic species comprise only a part of the peamouth diet and

peamouth spend a significant portion of time in the pelagic zone. Therefore, direct contact with sediment is considered a complete and minor pathway.

Invertivore-juvenile chinook salmon
Juvenile chinook salmon are in constant contact with surface water. Therefore, surface water contact is considered complete and major pathway of exposure (Figure 2-12). Epibenthic invertebrates are generally a primary component of the juvenile chinook salmon diet. Therefore, ingestion of benthic biota is considered a complete and major exposure pathway. Juvenile chinook salmon may directly ingest sediment while feeding and indirectly through consumption of prey containing sediment. However, no sediment ingestion studies are available to determine its contribution to total exposure for any contaminants. Therefore, the sediment ingestion pathway is considered complete and uncertain. Direct contact between juvenile chinook salmon and sediments, and ingestion of surface water are assumed to be a complete and minor pathways.

Piscivore-smallmouth bass
The diet of piscivores such as smallmouth bass is predominantly fish, crayfish, and occasional other prey items (e.g., water column invertebrates, drift organisms). Therefore, ingestion of biota is considered a complete pathway of exposure (Figure 2-12). The ingestion of water is considered a complete and minor pathway of exposure. Smallmouth bass are in constant contact with water. Thus, direct contact with surface water is a complete and major pathway of exposure.

Smallmouth bass consume benthic prey so they are likely to incidentally consume some sediment; however, sediment ingestion is considered to be a minor pathway of exposure in comparison to the prey ingestion pathway. Though they may occasionally come into contact with sediments when foraging, they are not likely to have substantial direct contact with sediments because smallmouth bass are benthopelagic species. Therefore, direct sediment contact is considered a complete and minor pathway. Smallmouth bass habitat is shown in Figure 2-6.

Piscivore-northern pikeminnow
Northern pikeminnow are in constant contact with surface water and this pathway of exposure is considered complete and major. Juvenile northern pikeminnow feed on both insects and small fish, and adult northern pikeminnow consume primarily fish. Thus, ingestion of biota is considered a complete and major pathway of exposure. Northern pikeminnow, like smallmouth bass, are a benthopelagic species and are occasionally in direct contact with the sediment and may ingest some sediment directly and indirectly from their prey. Ingestion of surface water and sediment, and direct contact with sediment are all considered complete yet minor exposure pathways.

Detritivore-Pacific lamprey ammocoetes
Pacific lamprey ammocoetes live in direct contact with sediment and often filter food (e.g., detritus, diatoms) directly from sediment. Therefore, direct sediment contact and ingestion of sediments and biota are considered to be complete and major pathways of exposure for Pacific lamprey ammocoetes and will be evaluated in the PRE (Figure 2-12). In addition, Pacific lamprey ammocoetes are in direct contact with surface water; thus, surface water contact is also considered a complete and major pathway of exposure for this species. Ingestion of surface water is a complete and minor pathway.

2.6.1.4 Amphibians and Reptiles
The Aquatic Plant and Amphibian/Reptile Reconnaissance Survey (see Attachment B.2) confirmed the presence of amphibians in the ISA. Although reptiles were not observed in the qualitative two-day survey, the ISA likely provides suitable yet limited habitat for reptiles. Therefore reptiles and amphibians will all be assessed in the BERA. Direct contact with the surface water pathway is considered a complete and major pathway for amphibians. For reptiles direct contact with surface water is considered a complete and uncertain pathway. Because direct contact with sediment varies depending on the species and life stage, direct contact with the sediment pathway is considered complete and uncertain pathway for amphibians and reptiles. Some data are available regarding relative amounts of sediment ingested directly or indirectly by reptiles from Beyer et al. (1994) indicating that sediment is a small proportion of their total diet, approximately 4–6 % of total food ingestion. However, no comparable data are available for amphibians, which may consume more sediment. Therefore, the sediment ingestion pathway is considered complete and uncertain. The food ingestion pathway is considered complete and major for both amphibians and reptiles because some species prey on benthic invertebrates. Surface water ingestion is considered a complete but relatively minor pathway for amphibians and reptiles (Figure 2-12).

2.6.2 Wildlife Receptors

A CSM for wildlife species is presented in Figure 2-12. Pathway designations are described below.

2.6.2.1 Birds
Surface water exposure by swimming and ingestion are considered complete and minor for all birds because water ingestion does not contribute measurably to total exposure for any contaminant when included in calculation of the risk estimate and water contact is limited by insulating feathers. The insignificance of surface water exposure to birds is due in large part to the relative insolubility of many COPCs.

Diving Carnivore—hooded merganser
Hooded mergansers primarily consume benthic invertebrates and small fish. Therefore, ingestion of biota is considered a complete and major pathway of exposure (Figure 2-12). In addition, hooded mergansers are likely to ingest sediments incidentally while foraging and indirectly through their prey. Thus, sediment ingestion is considered a complete and major pathway. Surface water contact and ingestion and direct sediment contact are considered incidental occurrences and complete but relatively minor pathways of exposure.

Sediment-probing Invertivore—spotted sandpiper
Spotted sandpipers primarily consume benthic invertebrates; thus, ingestion of benthic biota is considered a complete and major pathway of exposure and will be evaluated in the PRE (Figure 2-12). In addition, spotted sandpipers are likely to consume sediments during feeding. Thus, sediment ingestion is considered a complete and major pathway of exposure. Surface water contact and ingestion are considered complete but relatively minor pathways. Because spotted sandpipers forage extensively on beaches they are likely to be in direct contact with sediments. Direct contact exposure studies have not been conducted with shorebirds; therefore, the contribution to total exposure from direct contact is uncertain. Although assumed to be a complete pathway, without sufficient toxicological data this pathway will not be quantitatively assessed in the PRE or BERA.

Piscivore—osprey and bald eagle
Piscivorous birds, such as osprey and bald eagle, primarily consume fish from the water column. Therefore, ingestion of fish and other biota is considered a complete and major pathway of exposure for these species and will be evaluated in the PRE and BERA (Figure 2-12). Bald eagles frequently consume beached fish carcasses and may incidentally consume sediments as a result. Thus, sediment ingestion is considered a complete and minor pathway of exposure for bald eagle. Since surface water contact and ingestion and direct sediment contact are likely to be minimal, these pathways are considered to be complete but minor pathways.

2.6.2.2 Mammals
Carnivore—mink
Carnivorous mammals consume a wide range of prey, but primarily consume aquatic prey such as fish and macroinvertebrates (e.g. crayfish); therefore, ingestion of fish and other biota is considered a complete and major pathway of exposure and will be evaluated in the PRE and BERA (Figure 2-12). Mink may ingest sediments while foraging, burrowing or digging into the sediment and while grooming their fur. Thus, sediment ingestion is considered a complete and major pathway of exposure for carnivorous mammals. Surface water contact and ingestion are considered complete but relatively minor pathways. Surface water contact by swimming and ingestion are considered complete and minor because

water ingestion does not contribute measurably to total exposure for any contaminant when included in calculation of the risk estimate and water contact is limited by the insulating fur coat. The insignificance of surface water exposure to mammals is due in large part to the relative insolubility of many COPCs. Direct sediment contact may contribute to total exposure through transdermal absorption. However, given the insulating properties of the fur of mink and other aquatic carnivorous mammals that may use the ISA, direct contact would be limited to the paws. Thus, this pathway is considered complete and minor. Because assessment methods for skin contact are unavailable, the contact pathways will be qualitatively assessed in the PRE and BERA.

Data will be provided by the Round 1 and later sampling programs to characterize the ecological risks associated with exposure to chemicals in sediments, water, and tissues. This information will be used to update the ecological CSM as it becomes available.

3.0 EXISTING DATA

This section summarizes the existing water, sediment,, invertebrate, tissue and toxicity testing data for samples collected within the ISA since 1990. All data were subject to a quality assurance/quality control (QA/QC) review. A complete discussion of the QA/QC review process as well as the results of the review is presented in Section 4 and Table 4-1 in the Programmatic Work Plan and Appendix F.

3.1 DATA QUALITY ASSESSMENT

Data quality and potential usability were evaluated according to criteria developed to place data into two categories (Work Plan Appendix F). Category 1 data have acceptable QA/QC, whereas Category 2 data have an unknown, incomplete, or unsatisfactory QA/QC status. Criteria for categorizing data were selected to identify basic data qualities, not to limit data to specific program uses. Criteria were developed for the following factors: traceability, comparability, sample integrity, potential measurement bias, accuracy, and precision. Placement of data into Category 1 required that all of the acceptance criteria were known or documented. If any of the factors were unmeasured or unreported, data were placed into Category 2. If the acceptance criteria for any of the factors were not satisfied, data were generally qualified and determined to have limited usefulness. Performance outside acceptance criteria did not necessarily require placement of data into Category 2.

3.2 SURFACE WATER DATA

A limited number of surface water samples have been collected and analyzed for metals or organic compounds since 1990 (Table 3-1). Data are available from a 1999 ODEQ study for Phase 3 of the McCormick & Baxter Remedial Investigation (RI), and from a 1995 study by Woodward-Clyde for the Rhone-Poulenc St. Helens Road facility. The ODEQ data are considered both Category 1 and 2 data, and the Woodward-Clyde data are Category 2. The number of samples in which each analyte was measured ranged from 4 to 11. In addition to these two investigations, surface water samples have been collected at two stations within the ISA by ODEQ as part of their ambient monitoring program, but were analyzed for trace elements only. These data are considered Category 2 because of inadequate information for data verification. Results of historic surface water sampling are provided in Table 3-2.

3.3 SEDIMENT DATA

Numerous sediment chemistry investigations have been conducted in the ISA. Sediment sampling density is the highest between RM 4 and RM 9, where facilities are undergoing remedial or other types of investigations. Table 3-3 lists investigations conducted within the ISA since 1990, along with the category of data quality. Based on the evaluation of the bathymetric survey data, the surface sediment layer at the 0-to-1-ft depth interval appears to capture the majority (97% offshore and 87% nearshore) of the elevation shifts in the riverbed. This information, combined with the fact that the biotic zone of sediments is commonly defined as 0–30 cm, supports a working definition of surface sediments for ecological risk assessment purposes as 0–1-ft. For comparison purposes, the historic sediment chemistry data is presented to full sampling depth, 0–4 ft (Category 1 and 2) and to 1 ft depth in Tables 3-4a through 3-4d for Category 1 and all historical data. Results of historic sediment sampling are presented in Section 4 of the RI/FS work plan.

3.4 INVERTEBRATE DATA

Limited site-specific data exist on the epibenthic and infaunal invertebrate communities. Since 1990 one survey of the epibenthic community (Landau 2000) and three surveys of the infaunal communities have been conducted (Tetra Tech, 1994; Dames & Moore, 1998; Landau, 2000). In 2002, LWG surveyed the infaunal communities at 22 locations and the epibenthic communities at ten locations within the ISA as part of the Round 1 assessment. The community data will not be assessed quantitatively, but will be used in the overall risk assessment as background information.

3.5 TISSUE DATA

Five studies have been conducted within the ISA since 1990 that collected fish or crayfish for chemical analysis, as summarized in Table 3-5. Several species of fish were collected, including black crappie, common carp, smallmouth bass, largemouth bass, northern pikeminnow, and largescale sucker. Table 3-6 presents detected concentrations of chemicals in fish tissue.

Thomas and Anthony (1997) measured chemicals in great blue heron eggs and their prey within the lower Columbia River basin. They examined three nest locations along the lower Columbia and two on the Willamette: one on Ross Island and one about 20 miles further upstream in Molalla State Park. In both 1994 and 1995, five eggs were chosen randomly from each site and were analyzed for DDT, DDE, PCBs, mercury, dioxins, and furans. Table 3-7 summarizes the ranges of concentrations in great blue heron eggs collected from nests on Ross Island.

Uncertainties are associated with QA/QC in all tissue studies. In general, QA/QC documentation (e.g. matrix spikes, surrogate recoveries etc.) was not available for tissue chemistry data sets. Thus all sets were assigned to Category 2 (e.g. uncertainties, unknown, suspect quality) and the data are considered useful for screening purposes only. For additional details regarding uncertainties associated with QA/QC in tissue studies see Section 4 and Table 4-1 in the Programatic Work Plan and Appendix F.

3.6 TOXICITY TESTING

Fifteen laboratory toxicity studies using benthic invertebrates have been conducted with sediment collected in the ISA since 1990. These data were generally collected for dredged material characterizations, remedial investigations, and site investigations conducted at Portland Harbor facilities. Table 3-8 summarizes the bioassay tests completed in the ISA, providing information about date of study, purpose, tests completed, number of samples, results, and data quality category. Figure 3-1 shows the location and results of each station.

In 1998, the U.S. Army Corps of Engineers, EPA, Washington State Department of Ecology, ODEQ, and Washington State Department of Natural Resources prepared the Dredged Material Evaluation Framework for the Lower Columbia River Management Area (LCRMA 1998) to provide guidelines for dredged material sampling and testing. Generally, two tests have been used to assess the suitability of dredged material, the amphipod (*Hyalella azteca*) 10-day survival, and the midge insect larvae (*Chironomus tentans*) 10-day survival and growth tests. In studies completed prior to LCRMA 1998 guidelines, bioassays were performed using *Hyalella azteca* and *Daphnia magna.* A few studies used the Microtox bioluminescence test, which is not commonly used in regulatory programs.

3.6.1 Interpretive Criteria

Amphipod and midge bioassay results were compared to LCRMA guidelines. When multiple bioassays are conducted, bioassay interpretive criteria are defined as "one-hit" and "two hit" failures. For the amphipod bioassay, a one-hit failure occurs when mean test mortality is greater than 15% when compared to mean mortality of the reference sample and statistically different from the reference ($p \leq 0.05$). For the midge survival bioassay, a 1-hit failure occurs when mean test mortality is greater than 20% when compared to mean mortality of the reference sample, and is statistically different from the reference ($p \leq 0.05$). For the midge growth bioassay, a one-hit failure occurs when the mean growth rate is less than 60% of mean growth rate of the reference sample and statistically different from

the reference ($p \leq 0.05$). When any two of the three bioassay tests fails the one-hit rule, the test sample fails the two-hit rule (LCRMA 1998).

Microtox data were interpreted according to Washington State Sediment Management Standards (Chapter 173-204 WAC). A test sample fails if mean percent light reduction is greater then 20% when compared to the mean percent light reduction of the reference sample, and is statistically significantly different from the reference ($p \leq 0.05$).

3.6.2 Test Results

Results of the bioassay data are provided in Table 3-8. Organism effects, expressed as percent mortality (or survival), and measured growth as biomass varied widely between projects and often within project areas. Results showing significant adverse effects are generally associated with high chemical concentrations. Terminal 4 Slip 3 samples that failed criteria occur in the eastern half of Slip 3, in a location having elevated PAH concentrations (Hart Crowser 1999). At McCormick and Baxter, PTI (1992) noted that the sediments causing the greatest adverse effects were in the vicinity of the creosote dock and upstream of the creosote dock along the shoreline. In 1999, at the same site, investigators noted a strong statistical relationship between LPAH concentrations and *Hyalella* mortality (Ecology and Environment 2001). In a dredged material characterization performed at Tosco, significant mortalities were noted in one composite sample but not the other. The reason for the observed toxicity was not known (Exponent 1999). Exceedances of LRCMA criteria occur at the northeastern end of Terminal 4, Slip 3, McCormick & Baxter, Swan Island Lagoon, Portland Shipyard, the Pipeline Terminals, and the shoreline across from Terminals 1 and 2 (Cargill and Goldendale Alumina). It should also be noted that test samples located within these same areas passed LRCMA criteria.

3.7 SUMMARY

Overall, the existing data collected within the ISA that qualify as Category 1 data are principally associated with sediment chemistry and toxicity studies using benthic organisms. Almost all other types of environmental data collected have been determined to be Category 2 data, and therefore may be of limited use in the PRE and the BERA.

4.0 COPC SELECTION PROCESS

At the request of regulatory agencies, a very large number of chemicals were identified for analysis in RI and FS samples. The large analyte list was due, in part, to the diversity of *potential* contaminants among the many distinct sources in the Portland Harbor. However, it is likely that only a small portion of the analytes will be important "risk drivers," and/or important in risk management decisions. The analytes will be evaluated both as harbor-wide and site-specific risk drivers. Furthermore, most individual sites along the ISA are associated with a limited scope of potential contaminants. It is impractical to expend LWG and government resources on analyzing risk from all analytes. Therefore, a process is needed to narrow the scope of COPCs for which detailed risk analysis is to be conducted.

Following the completion of the Round 1 field sampling events, a preliminary list of COPCs will be selected for fish tissue and possibly wildlife that do not ingest sediment (or ingest minimal amounts). It should be noted that toxicity data for many COPCs may be inadequate to make useful judgments of risk. Analytes for which no toxicity values are obtained will be retained as COPCs for the risk assessment but will not be quantitatively assessed. These compounds will be discussed in the uncertainty section of the BERA. The potential effects of excluding such compounds on risk characterization conclusions will be discussed.

COPCs will not be developed for the benthic invertebrate community, amphibians, reptiles, some of the wildlife species, or aquatic plants based on the PRE either because data gaps critical to the evaluation of these receptor groups will remain at the time of the PRE, or because the group will be evaluated qualitatively due to lack of toxicity data. The final BERA will assess all receptors and provide a final identification of COPCs and COCs. The BERA will include all the data collected by the LWG during Rounds 1 and 2 (and any subsequent rounds needed). The COPCs presented in the BERA will be for all pathways and receptors that have toxicity information available. The COPCs presented in the BERA will be used to develop a final list of chemicals of concern (COC) based on probable risk, using area-weighted averages and other spatial tools and knowledge of receptor foraging characteristics. If needed, information will be collected on area-specific foraging characteristics. A fish food web model may also be used to help identify COPCs and COCs in pathways that contribute to unacceptable risk. Data gaps following Round 2 may be identified; these data gaps will be filled in subsequent rounds and the Draft BERA will be updated.

COPC identification will be presented in a technical memorandum prior to the PRE. The methods for COPC identification will rely on maximum concentrations of site media. The specific methods for each assessment endpoint are presented below.

4.1 AQUATIC PLANTS

Risk to aquatic plants will not be assessed quantitatively. A qualitative assessment will be included in the risk characterization that will consider all detected analytes in sediment and surface water as COPCs.

4.2 BENTHIC INVERTEBRATES

COPCs for sediment will not be derived for benthic invertebrates from the PRE. A quantitative assessment approach has been developed using a Sediment Quality Value Quotient approach and the details are presented in Attachment B.4.

Maximum surface water analyte concentrations will be compared to the corresponding chronic ambient water quality criteria (AWQC) values or other effects-based toxicity values for sensitive species to identify COPCs for aquatic invertebrates, including mollusks and crayfish. A literature search will be conducted to locate appropriate toxicity values for analytes that do not have corresponding AWQC values. Analytes measured in surface water at concentrations greater than the corresponding AWQC or other relevant toxicity value will be retained as aqueous COPCs for aquatic invertebrates. Aqueous COPCs will be developed only after surface water data collection is completed (and the groundwater pathway has been evaluated).

In the PRE, maximum crayfish and clam tissue concentrations for each analyte will be compared to the respective tissue residue effects concentrations for crayfish and clams. Analytes with tissue concentrations above the corresponding residue effects concentrations will be retained as tissue COPCs for aquatic invertebrates. Due to the limited shellfish and clam tissue data and difficulties collecting additional data it may not be possible to reduce the COPC list at this time with these data.

4.3 FISH

Aqueous and sediment COPCs will be developed for fish in separate steps. To determine aqueous COPCs for fish in the ISA, maximum surface water analyte concentrations will be compared to corresponding chronic AWQC or other chronic toxicity values. A literature search will be conducted to locate appropriate toxicity reference values (TRV) (both no effects and effects concentrations) for measured analytes that do not have corresponding AWQC values. Analytes measured at concentrations greater than the corresponding AWQC or TRV value will be retained as COPCs for fish.

Maximum whole body fish tissue concentrations for each bioaccumulative analyte will be compared to corresponding fish tissue TRVs for non-metabolized COPCs.

Dietary-based TRVs will be compared to a daily dose estimate for metabolized COPCs. Analytes for which receptor tissue residue concentrations or dietary-dose estimates exceed their corresponding TRV values will be retained as COPCs for fish. Additional tissue data may be needed for the COPC elimination process for those species that were not collected in Round 1 (or if additional areas are selected for fish species that were collected).

4.4 AMPHIBIANS AND REPTILES

Amphibian and reptile COPCs will be determined by comparing relevant media maximum concentrations to appropriate TRVs or AWQCs. When available, data on the most sensitive life stage will be used in the evaluation. Analytes exceeding TRVs or AWQCs will be retained as COPCs.

4.5 WILDLIFE

Wildlife COPCs will be determined by comparing dietary dose TRVs to estimated daily doses for each of the specific wildlife receptors. All Round 1 data will be used in the calculations. If historical tissue data can be upgraded to Category 1 data, they will also be included in the calculations. The methods for calculating doses for wildlife receptors are presented in detail in Section 5.3. Conservative assumptions, such as 100 percent site use, will be used in estimating total exposure for the purposes of identifying COPCs. Analytes for which daily dose estimates exceed their corresponding TRV values will be retained as COPCs for that receptor. Maximum concentrations will be used to identify COPCs.

5.0 ANALYSIS AND RISK ESTIMATION PLAN

This analysis plan presents the approach to exposure characterization, effects characterization, and risk estimation for each assessment endpoint and describes data needed to assess each endpoint using these methods. In the exposure characterization, measures that will be used to estimate exposure of receptors to COPCs in the ISA from all the complete pathways identified in the problem formulation and their spatial and temporal extent are described. The effects characterization describes chemical-specific effects related to the assessment endpoints (e.g., through stressor-response profiles) and examines how the response changes with chemical concentration. Risk characterization is where information from the exposure and effects characterizations is integrated into an estimate of risk and the likelihood of adverse ecological effects is described. The methods for the risk estimation step vary by assessment endpoint and are included in this section. The approach for the latter step, risk description, is identical across assessment endpoints and is presented in the next section. Identification of data needs, which are based on the available information summarized in the problem formulation (Section 2) and the types of data required to complete the risk assessment, are summarized for each assessment endpoint. These data needs are summarized in the DQO process presented in Tables 5-1 through 5-5 (also found in the Programmatic Work Plan Section 7).

In this section, the exposure point concentration (EPC) and hazard quotient calculations common to all assessment endpoints, except No. 1, are described. The approach of comparing EPCs to effect concentrations in a quotient is recommended by EPA guidance (EPA 1998). The exposure point concentration is a calculated value intended to represent exposure from a medium to the receptor and the hazard quotient approach is one of the common methods of risk estimation used in the PRE and BERA. Following this, additional unique method details and a summary of the exposure and effects characterization approach are presented for each assessment endpoint. Note that the usefulness and feasibility of applying probabilistic risk assessment (PRA) techniques in the BERA to reduce uncertainties will be discussed with EPA and its partners. If a PRA approach is used to reduce uncertainties, a technical memorandum or work plan will be developed, based on EPA guidance, on the PRA approach and agreed to with EPA and EPA's partners prior to conducting this approach.

Assumptions regarding exposure conditions for each assessment endpoint will need to be defined before completion of the PRE. These specific assumptions will be developed through discussions with EPA and its partners and will be presented within the PRE or a technical memorandum prior to the PRE. Similarly, refined exposure assumptions will be presented in the draft and final BERA.

5.1 EXPOSURE POINT CONCENTRATIONS

EPCs will be calculated to quantitatively estimate exposure for all receptors except aquatic plants. The exposure point concentration represents the concentrations of COPCs in sediment, aqueous solutions, and prey items to which receptors may be exposed. A "high-end" exposure point concentration (EPA 1998), a conservative estimate of exposure, will be applied in the PRE by using the maximum concentration and by calculating the 95 percent upper confidence limit on the mean (95% UCL) of the relevant data. The data used will consist of those collected during Round 1 and historic data that have passed QA/QC criteria. For datasets where the 95% UCL exceeds the maximum detected concentration or sample sizes are less than ten, the maximum detected concentration will be used as the EPC (EPA 1992b). As noted above, one purpose of the PRE is to use conservative assumptions to help identify COPC/receptor pairs for which additional data and/or more detailed analysis is necessary in the BERA to make decisions regarding acceptable risk. In the BERA, a measure of central tendency will be calculated in addition to the upper-bound estimates of exposure and risk. For organisms that are immobile the exposure point concentration will be the maximum and the 95% UCL. Exposure for each receptor will be assessed for the ISA as a whole using EPCs based on receptor-specific foraging areas. Prior to the assessment the specific area of the ISA and the specific sediment samples selected to represent a receptor will be identified in cooperation with EPA. In addition, to determine key exposure pathways for identified sources and the contribution of individual sources to overall site exposure, another iteration of EPC calculations will be conducted based on a more localized spatial unit centered around identified sources. The spatial unit for this iteration will not be based on the foraging range of the receptor, but will focus on the spatial boundaries for each source. Prior to calculating the EPC for specific receptors the specific calculation method(s) will be selected in cooperation with EPA.

Using common goodness-of-fit tests and other statistical measures of testing data distributions, concentration datasets will be tested for normality. The 95% UCL will be calculated for normally distributed datasets as follows (EPA 1992b):

$$UCL = m + t\left(\frac{s}{\sqrt{n)}}\right) \qquad \textbf{Equation 1}$$

Where:

UCL = Upper Confidence Limit
m = mean of the untransformed data
s = standard deviation of the untransformed data
t = student t-statistic (i.e., for alpha < 0.05)
n = number of samples

For lognormal datasets the following equation will be used (from EPA 1992):

$$UCL = e^{(m+0.5s^2+sH/\sqrt{n-1})}$$ **Equation 2**

Where:

UCL = Upper Confidence Limit
e = constant (base of the natural log, equal to 2.718)
m = mean of the natural log transformed data
s = standard deviation of the transformed data
H = H-statistic
N = number of samples

For nonparametric datasets, various methods such as bootstrapping techniques are available that do not require assumptions about distributions of the dataset.

5.2 THE HAZARD QUOTIENT APPROACH

The risk estimation is the process of integrating exposure and effects (EPA 1998). The hazard quotient method, comparing the exposure estimate to some kind of toxicity reference value (e.g., on a tissue residue, dietary dose, or media concentration–based value) will be used to estimate exposure through one or more pathways for all receptors except infaunal and epibenthic invertebrates, which are assessed using a sediment quality value approach. The following equation is used to estimate hazard quotients:

$$HQ = ED \text{ or } C/TRV$$ **Equation 3**

Where:

HQ = ecological hazard quotient (unitless)
ED = exposure dose (e.g., mg/kg bw-day dw, mg/kg sediment dw))
C = media concentration (mg/kg or mg/L)
TRV = toxicity reference value (same units as ED or C)

No-effect HQs that exceed 1.0 suggest that adverse effects are possible at the individual level. In these cases, the estimated exposure exceeds the highest dose at which no statistically significant effects were observed. Lowest-observed-adverse-effect HQs will also be calculated to examine potential population-level effects. HQs will be considered along with the associated uncertainty in the exposure and effects data to determine if a given COPC presents sufficient risk for a given measure of effect for each representative species.

Where possible, exposure-response functions will also be presented.

5.3 ANALYSIS PLAN BY ASSESSMENT ENDPOINT

The following section presents the analysis plan, organized by assessment endpoint. Within each assessment endpoint, the process for ***characterization of exposure*** is discussed first. Following this discussion, there is a discussion for how the ***characterization of effects*** will be completed. Following the characterization of exposure, the process for addressing variability and secondary stressors is outlined for the ***identification of ecosystem and receptor characteristics***. Four examples of secondary stressors that may influence receptor populations in the LWR are listed in Table 5-6.

Assessment Endpoint No. 1: Survival, growth, and reproduction of aquatic plant populations

Potential exposure of the aquatic plants in the ISA to COPCs will be evaluated qualitatively. Very few chemicals accumulate in plants; therefore, estimating exposure is probably more meaningful by examining water and sediment concentrations than plant tissue residues. However, there is very little information regarding the effects of COPCs in sediment or water on aquatic plants. A literature review of studies that examine toxicity and adverse effects of COPC exposure to aquatic plants will be conducted. The results of this review will be summarized in the effects characterization.

Sediment criteria for plants are not available, although there are some available for soil. However, application of soil criteria is inappropriate because plant toxicity varies significantly with physical conditions, such as pH and organic content of soil, and there is no information on relative toxicity of aquatic plants compared to terrestrial plants. The uncertainty associated with this evaluation is very large and would not offer a meaningful assessment of risk to aquatic plants. Therefore, the potential for adverse effects to aquatic plants from exposure to COPCs will be discussed qualitatively in the risk characterization of the PRE and the BERA based on the site-specific and literature-derived information gathered to characterize exposure and effects. No data collection needs were identified for these risk assessment methods in the DQO process.

Other, non-chemical factors can influence the behavior and location of receptors of concern and may affect the exposure of a receptor to COPCs. These factors can include habitat alterations, changes in water quality, increased predation or competition for resources due to introduced species, and increased susceptibility to diseases or pathogens. Examples of habitat modification within the LWR include loss of riparian vegetation, physical habitat alteration, reduction in habitat diversity and complexity due to channelization and bank revetments, and increased habitat fragmentation and loss of connectivity to other aquatic and upland habitats (Adolfson et al. 2000). Loss of riparian vegetation also results in less shading which can lead to increased water temperatures and decreased dissolved oxygen concentrations. Changes in flow rate and increases in nutrient

loading can further degrade water quality. Exotic fish, mammal, amphibian, and plant species in the LWR can impact receptor populations by altering habitat structure, increasing competition for food and habitat, and increasing predation (Altman et al. 1997). These factors, in combination with the health and predisposition of the receptor population, can increase or decrease the receptor's susceptibility to disease, and thus increase mortality (Arkoosh et al. 1998). The impacts of these factors on the receptor populations will be qualitatively reviewed to determine whether they will influence the exposure of receptor populations. This discussion will be included in the risk characterization.

Assessment Endpoint No. 2: Survival, growth, and reproduction of benthic invertebrate populations

The benthic invertebrates will be assessed using multiple lines of evidence that address different exposure pathways. These methods are described below and summarized in Figure 5-1.

Epibenthic and infaunal invertebrates will be assessed using two approaches. The first approach addresses direct exposure to chemicals adsorbed to sediment. This is a multi-step approach that begins by using existing sediment quality values and chemical data to rank sediment stations in the ISA over a concentration gradient. Bioassays will then be conducted at stations representing this gradient. Sediment chemistry and bioassay results will be used to develop a predictive model of chemistry-to-effects to assess risk from bulk sediment at other site locations. A detailed description of this approach is included as Attachment B.4.

The second approach is the hazard quotient approach. To estimate exposure from bioaccumulative compounds, tissue residue concentrations will be compared to toxicity values in a hazard quotient approach (see Equation 3). Attempts to collect invertebrate tissue samples in Round 1 met with mixed success. Grab samples from bulk sediments resulted in inadequate tissue mass for analysis. Clam tissue samples were obtained in sufficient mass, but from only a few locations. Mollusk tissue TRVs are available to estimate effects for some COPCs (e.g., EVS Solutions 1999) and will be applied in a hazard quotient approach. If possible additional clam tissue samples will be collected in subsequent sampling rounds. Additional tissue samples may be collected for other invertebrates, based on discussion with EPA and the results of Round 1 and 2 sampling.

Similarly, risks to epibenthic macrofauna will be assessed by comparing crayfish tissue residue concentrations to TRVs in a hazard quotient approach. Crayfish are an important prey species and may potentially pass bioaccumulated contaminants on to higher trophic level organisms. Effects of COPC exposure to epibenthic macrofauna will be estimated using available tissue residue TRVs for decapods from the literature. Linear regression analysis will be conducted to examine the relationship of tissue concentrations in crayfish with co-located sediment concentrations. The objective is to examine the predictive power of sediment

concentrations to estimate tissue concentrations. If a statistically strong relationship is observed, this regression relationship will be used to predict crayfish tissue concentrations in areas of the ISA where sediment data are available but tissue data are lacking. This approach, which will be developed in detail with EPA and its partners, will not be applied if the regression analyses results show a weak relationship between sediment and tissue concentrations If no correlation is seen between the tissue and sediment chemistry, various hypotheses will be evaluated and additional sampling may be conducted. For example, a surrogate organism with a higher correlation between tissue and sediment may be selected for additional sampling and analysis.To assess risks from the surface water pathways, surface water chemistry data will be compared to EPA chronic AWQC for aquatic life in a hazard quotient approach or other relevant toxicity value.

The results of the groundwater study conducted as part of the Round 1 analysis will be evaluated in order to determine if there is potential for exposure of infaunal invertebrates to groundwater chemicals as they enter the porewater of the biologically active zone. A tiered approach for identifying significant contributions to risk to benthic infauna will be used. Decisions and data uses to be employed are:

- Determine what scale of investigation is important for assessing ecological risks in sediment and porewater from groundwater chemicals of interest (COIs).

- Identify locations where significant COI concentrations are present in upland groundwater and where known or probable pathways to the river exist.

- Identify locations where whole sediment chemistry data may not adequately reflect risks to benthos from potential groundwater sources. This identification would be based on areas where groundwater COIs identified during Step 1 could be present at concentrations that present an unacceptable risk.

- Identify locations where groundwater data are lacking and where additional sampling may be needed to support risk-based evaluations. The site will then be referred to DEQ for groundwater investigation and this analysis will later be performed on the results of the subsequent data collection activities. Alternatively, site-specific collection of data on COI concentrations in porewater or sediment, and/or bioassay testing may be conducted.

If contaminants in porewater are identified as potentially impacting benthic organisms, a benthic risk assessment for the groundwater/surface water interface

pathway may be completed as part of the baseline risk assessment. Based on chemistry results, dose-response toxicity tests will be completed on benthic organisms to determine whether a predictive site-specific relationship can be developed between the chemistry and toxicity data.

As described under Assessment Endpoint No. 1, the potential effects of non-chemical factors on the receptor populations (i.e. habitat alterations, changes in physical characteristics of water quality, increased predation, and increased occurrences of diseases or pathogens) will be qualitatively reviewed to determine whether they influence the exposure of receptor populations. This discussion will be included in the risk characterization.

A preliminary ecotoxicological profile for benthic invertebrates has been constructed that summarizes the toxicity of the major COPC chemical groups (Attachment B.5).

Considering the risk assessment approach for this assessment endpoint and available historical data, the following data needs were identified. Data collection activities were conducted in 2002 or will be conducted in future sampling events to fulfill these needs.

- Multiplates were placed in the ISA during the spring and summer of 2002 to determine epibenthic community structure. Insufficient tissue volume was collected to enable chemical analysis. See Attachment B.1 for summary of taxa.
- Benthic infaunal grab samples were collected in Round 1 to better understand infaunal community structure. Insufficient tissue mass was obtained for chemical analysis. Analysis included taxonomic identification and enumeration. Data were being analyzed at the time of Work Plan preparation.
- Crayfish were collected in Round 1 with collocated surface sediment samples and chemically analyzed to assess risks to epibenthic macrofauna.
- A reconnaissance survey was conducted in Round 1 to determine locations of clam communities. A small number of samples (2) of adequate mass were collected with co-located surface sediment samples and chemically analyzed to assess risks to clams and the benthic community.
- Surface sediment grab samples co-located with tissue and benthic infaunal samples were collected at biota collection locations in Round 1 and chemically analyzed to assess risks to benthic organisms, and to assess relationships

between sediment and tissue COPC levels. Additional sediment grab samples will be collected in Round 2 to support the benthic assessment.

- Surface water samples will be collected in Round 2 and chemically analyzed to identify potential adverse effects to aquatic invertebrates.
- Based on the results of the RI/FS Round 1 groundwater evaluation, potentially complete pathways from porewater to aquatic receptors will be identified.

Assessment Endpoint No. 3: Survival, growth, and reproduction of fish

Risks to fish receptors will be assessed using multiple lines of evidence. Total exposure from non-metabolized chemicals will be assessed by comparing whole-body-tissue residue data to TRVs using a hazard quotient approach (see calculation above). For chemicals metabolized by fish, this approach will be modified by comparing estimated dietary concentrations to TRVs. If a metabolized chemical is also found in the fish tissue a TRV approach may be used. The direct toxicity of surface water will be assessed by comparing surface water concentrations to chronic AWQC or other relevant toxicity values using the hazard quotient approach. If there is sufficient literature data available, TRVs will be developed for all pathways (e.g. uptake from water column, dietary exposure, direct exposure to sediment) and the resulting information will be used in a weight of evidence analysis. A more detailed description of these methods follows. The whole approach, including the time order of steps, is summarized in Figure 5-2.

Exposure of fish will be assessed using methods similar to those employed in the COPC screen for fish (Section 4.3). However, in the exposure assessment, where appropriate, more realistic assumptions of chemical exposure will be employed (e.g., use of 95th UCL on the mean). Chemical concentrations in whole body tissues of the representative species for each feeding guild[1] will be analyzed to determine exposure concentrations. Chemical concentrations in food will be calculated from concentrations in each component of the fish species' diet and each component's fraction of the diet. For example, the concentration in food for a representative species that might ingest fish, amphipods, and incidental sediment will be estimated as follows:

[1] Omnivore/omnivore—largescale sucker; invertivore—juvenile chinook salmon, sculpin, and peamouth; Piscivore—smallmouth bass and northern pikeminnow; and detritivore—Pacific lamprey ammocoete. Additional whole body tissue residue data for several fish species will be available from the human health risk assessment. These data will supplement the exposure estimates for the appropriate feeding guilds in the ERA.

$$C_{food} = (C_f \times F_f) + (C_a \times F_a) + (C_s \times F_s) \qquad \textbf{Equation 4}$$

Where:

C_{food} = concentration in prey items plus sediment (mg COPC/kg food and sediment dw)
C_f = concentration in fish tissue (mg COPC/kg tissue dw)
C_a = concentration in benthic invertebrate tissue (mg COPC/kg tissue dw)
C_s = concentration in sediment (mg COPC/kg sediment dw)
F_f = fraction of the wildlife species diet that is fish (kg fish/kg food)
F_a = fraction of the wildlife species diet that is benthic invertebrates (kg benthic invertebrates/kg food)
F_s = fraction of the wildlife species diet that is sediment (kg sediment/kg food)

For chemicals that are metabolized or otherwise regulated by the fish (such as PAHs and certain metals), a tissue residue approach is not as appropriate (McCarty and MacKay 1993). For COPCs of this type, a dietary approach is preferable. The dietary exposure approach requires an approximation of the COPC concentration in the prey of a representative receptor species. Analysis of whole-body composite samples of receptor tissues will be used to determine exposure. Total exposure from prey ingestion would be estimated as follows:

$$TDE = (P_1 \times IR \times C_1) + (P_2 \times IR \times C_2) + ...(P_x \times IR \times C_x) \qquad \textbf{Equation 5}$$

Where:

TDE = total dietary exposure (mg/day)
Px = Proportion of prey item x in diet (unitless)
IR = total food ingestion rate (kg/day)
Cx = Concentration of COPC in prey item x (mg/kg)

Where appropriate, sediment ingestion will be incorporated into this exposure model as a percent of total food ingestion.

Whole body residue-based and dietary-based TRVs for fish receptors will be developed from the scientific literature. The details of TRV derivation and selection are presented in Attachment B.6. The literature search for fish tissue residue and dietary TRVs will include searching for studies on early-life stages of fish.

Linear regression analysis will be conducted to examine the relationship of tissue concentrations in sculpin with co-located sediment concentrations. The objective is to examine the predictive power of sediment concentrations to estimate tissue concentrations. If a statistically strong relationship is observed, this regression

relation will be used to predict sculpin tissue concentrations in areas of the ISA where tissue data is lacking. This approach, which will be developed in detail with EPA and its partners, will not be applied if the regression analyses results show a weak relationship between sediment and tissue concentrations. If this approach cannot be used for sculpin, application of a mass balance mechanistic food web model will be investigated, such as one of those reviewed in Attachment B.7, for estimating sculpin tissue concentrations in areas missing tissue data. Application of this approach would only be necessary for the sculpin because the other fish used as prey items in the risk assessment have larger foraging ranges and would be represented by the collected tissue samples.

A weight-of-evidence approach will be used to assess risk to all fish receptors. All life stages of fish receptors will be considered if they occur within the ISA. The lines of evidence will be 1) AWQC compared to surface water concentrations, 2) the adult TRV assessment and 3) available knowledge regarding the relative sensitivities of juveniles compared to adults. This approach will be developed in detail with EPA and its partners.

Lipophilic contaminants (e.g., PCBs, DDTs) are stored in lipid tissue if not immediately metabolized in the body. Therefore, whole body concentrations are often correlated with lipid content of the organism. For this reason, lipid normalization of whole-body concentrations in fish will be conducted for lipophilic COPCs that are assessed using a tissue residue approach (i.e., non-metabolized chemicals). Body residue TRVs are not typically lipid-normalized and require that an estimate of lipid content be generated in order to determine a hazard quotient. Lipid content analytical methods are not standardized, and therefore results can vary significantly between methods. Also, lipid content can vary between individuals of the same species. Therefore, the uncertainty associated with lipid-normalization of data from various sources can be high. To capture the impact of lipid normalization and its associated uncertainty, both lipid-normalized and non-lipid-normalized hazard quotients will be developed for lipophilic COPCs. Where lipid-normalized TRVs are not available, they will be estimated by examining the scientific literature to determine the natural variability of percent lipids in the fish species for which the TRV was developed. When variability in percent lipids is low (less than ±10% of mean), the mean percent lipid for that species will be used to normalize TRVs. Where variability is high (greater than ±10% of mean), the TRV normalization will be bracketed using a range of lipid content for that species. Both lipid-normalized and non-normalized tissue concentrations will be used to characterize exposure.

Fish sampling during Round 1 provided an opportunity for the LWG to qualitatively examine a small number of stomachs from receptor species with the objective of characterizing the type of benthic invertebrates that are or are not consumed by these fishes. Stomachs for all receptor species except juvenile chinook salmon and Pacific lamprey were sampled. The notable observations

from this stomach screening included: the high frequency of bryozoans in all fish stomachs, sediment only in fish stomachs containing filamentous algae, and the presence of crayfish in smallmouth bass stomachs. A summary of this qualitative examination is presented in Attachment B.8. The results of this stomach screening will not be used for any quantitative purpose in the PRE or BERA.

As described under Assessment Endpoint No. 1, the potential effects of non-chemical factors on the receptor populations will be qualitatively reviewed to determine whether they will influence the exposure of receptor populations. This discussion will be presented in the form of a stressor-response profile applicable to the appropriate level of biological organization and included in the risk characterization.

A preliminary ecotoxicological profile for fish has been constructed summarizing the toxicity of the major COPC chemical groups (Attachment B.5).

Based on these risk assessment methods and the site-specific historical data, data needs were established for the ERA. Data collection activities were conducted in 2002 or will be conducted in future sampling events to fulfill these needs.

- Fish tissue samples were collected from the ISA and analyzed. Fish tissue collected includes juvenile chinook salmon, largescale sucker, sculpin, smallmouth bass, peamouth, and northern pikeminnow.
- Sediment samples were collected co-located with benthic invertebrate and sculpin tissue stations and analyzed to assess risks from the dietary pathway. More surface sediment samples will be collected during Round 2 to fill in any data gaps.
- Benthic invertebrate community samples were targeted for COPC analysis but insufficient volume was obtained. Crayfish and clam tissue samples were collected and analyzed to provide exposure estimates for higher trophic level species from ingestion of invertebrate prey
- Surface water samples will be collected and analyzed in Round 2 to identify potential adverse effects from surface water pathways.

Assessment Endpoint No. 4: Survival, growth, and reproduction of amphibians and reptiles

Exposure estimates for amphibians will be estimated as EPCs if an appropriate quantitative risk assessment method is applied (pending discussions with EPA and its partners). If toxicity values are required to assess risk to amphibians, toxicity

studies for all life stages of amphibians available from the scientific literature will be reviewed. Because the toxicity data available for amphibians are primarily based on surface water exposure, surface water chemistry data will be needed. To determine potential risk to amphibian and reptilian populations, surface water will be collected in habitat areas where the presence of amphibians or reptiles would be expected.

As described under Assessment Endpoint No. 1, the potential effects of non-chemical factors on the receptor populations will be qualitatively reviewed to determine whether they are likely to influence the exposure of receptor populations. This discussion will be included in the risk characterization.

Assessment Endpoint No. 5 and 6: Survival, growth, and reproduction of birds and mammals

Risk to birds and mammals will be assessed by estimating daily exposure from food and sediment ingestions pathways and comparing this to a dietary-based TRV. This approach is summarized, including the sequence of steps, in Figure 5-3 and described in detail below.

Exposure of wildlife will be determined by calculating daily doses of each COPC to each representative species. Two exposure pathways will be evaluated: ingestion of prey and incidental ingestion of sediment. Other pathways considered in the CSM are considered minor and insignificant. Risks to wildlife from direct (or dermal) contact with sediment are considered minor relative to those from ingestion (EPA 2000). Likewise, direct contact with water is generally a minor contributor to the overall risk estimate for wildlife. Therefore, the exposure dose will be based on ingestion of prey items and sediment.

The exposure dose estimates will be calculated using the following equation:

$$\text{ExposureDose} = \frac{\left(\left[DFC \times C_{food}\right] + \left[DFC \times SIR \times C_{sedt}\right]\right) \times SUF}{BW} \qquad \textbf{Equation 3}$$

Where:

Exposure Dose	=	COPC mass ingested per day via food and sediment (mg COPC/kg body weight/day dw)
DFC	=	daily food consumption rate (kg food and sediment /day dw)
C_{food}	=	concentration in prey items and sediment (mg COPC/kg food and sediment dw)
SIR	=	sediment ingestion rate (% of DFC)
SUF	=	site use factor (unitless)
BW	=	wildlife species body weight (kg ww)

The site use factor (SUF) is the fraction of time that a receptor spends foraging at the site compared to other areas. Foraging ranges, daily food consumption rates, and body weights of representative species will be obtained from EPA's Wildlife Exposure Factors Handbook (EPA 1993), Atlas of Oregon Wildlife (Csuti et al 1997) and other local sources of information or published scientific literature. Regionally relevant sources will be preferred. Conservative assumptions, such as 100% site use, will be used in the PRE to fully bracket the risk estimate. These conservative assumptions will be replaced with more realistic, site-specific assumptions in the BERA (EPA 1998).

Chemical concentrations in prey will be calculated from concentrations in each component of the wildlife species' diet and each component's fraction of the diet. For example, the concentration in food for a representative species that might ingest fish, amphipods, and incidental sediment will be estimated as follows:

$$C_{food} = (C_f \times F_f) + (C_a \times F_a) + (C_s \times F_s) \qquad \textbf{Equation 4}$$

Where:

C_{food} = concentration in prey items plus sediment (mg COPC/kg food and sediment dw)
C_f = concentration in fish tissue (mg COPC/kg tissue dw)
F_f = fraction of the wildlife species diet that is fish (kg fish/kg food)
C_a = concentration in benthic invertebrate tissue (mg COPC/kg tissue dw)
F_a = fraction of the wildlife species diet that is benthic invertebrates (kg benthic invertebrates/kg food)
C_s = concentration in sediment (mg COPC/kg sediment dw)
F_s = fraction of the wildlife species diet that is sediment (kg sediment/kg food)

Concentrations of chemicals in food items and sediment consumed by each representative species will be determined using data from biota and sediment collected from receptors' feeding habitats at the site. The feeding habitat for spotted sandpiper or shorebirds is defined as open sediment (e.g., beach) areas. Hooded merganser habitat is considered nearshore waters (i.e. outside of channel) anywhere in the ISA. Hooded merganser habitat is shown in Figure 2-8. Feeding habitat for osprey, bald eagle and mink is not limited and is defined as anywhere in the ISA. Data from sediment samples collected as part of the RI/FS from representative species feeding habitats will be used to estimate sediment exposure. Dietary components for each representative species will be obtained from EPA's Wildlife Exposure Factors Handbook (EPA 1993), Atlas of Oregon Wildlife (Csuti et al 1997) and other local sources of information or published scientific literature. Regionally relevant sources will be preferred.

TRVs for wildlife receptors will be developed from the scientific literature. The details of TRV derivation and selection are presented in Attachment B.9. As described under Assessment Endpoint No. 1, the potential effects of non-chemical factors on the receptor populations will be qualitatively reviewed to determine whether they will influence the exposure of receptor populations. This discussion will be included in the risk characterization.

A preliminary ecotoxicological profile for birds and mammals has been constructed that summarizes the toxicity of the major COPC chemical groups (Attachment B.5).

Considering the risk assessment approach for these assessment endpoints and site-specific historical data, data needed to complete the ecological risk assessment are chemical concentrations in prey items and sediment in foraging areas. Fish and invertebrate tissue and surface sediment samples were collected during 2002 in bird and mammal foraging areas. Additional sediment samples will be collected as needed in Round 2 to complete representation of exposure areas in the ISA.

5.4 DATA GAP IDENTIFICATION AND COLLECTION OF ADDITIONAL DATA

Data needs identified in the previous sections will be satisfied over multiple rounds of sampling. The objectives for Round 1 data collection were to collect benthic community samples (diversity and chemistry), co-located sediment, crayfish, and clam tissue for chemistry, tissue samples for all the fish receptor species for chemistry, and conduct surveys for amphibians, reptiles and aquatic plants. Existing information regarding sources and known and new information about receptor habitat were used to design the sampling event. The details concerning sampling station locations, numbers of samples that were to be collected and other pertinent information about the collection and analysis of samples are presented in the Round 1 FSP.

The historical data (Category 1 and 2) combined with the Round 1 data will be used to scope the next sampling round. Round 2 sampling will target stations for bioassays (see Attachment B.4), additional *Corbicula* clam tissue samples, surface water chemistry, any additional sediment chemistry data gaps related to ecological risk assessment, and any other site data needed to parameterize the food web model (see Attachment B.7 for food web model approach). The data gaps that remain after Round 1 will be targeted in the Round 2 FSP. The PRE and draft BERA will include data gap evaluations.

6.0 RISK DESCRIPTION

For chemicals where exposure and effects data are available in more than one medium or more than one assessment method is used, a lines of evidence approach will be used to estimate the likelihood of adverse effects from all potential and assessable pathways. Where more than one medium is relevant to the exposure estimation, exposure will first be calculated independently for each medium then summed for comparison to a TRV and calculation of a hazard quotient. Then, the contribution of each exposure pathway to the hazard quotient will be characterized. Where more than one assessment method is applied, the results of each risk estimation and the associated uncertainty will be examined as pieces of evidence that support or do not support the test hypotheses. Lines of evidence analysis will be based on considerations similar to those from Suter (1993), as summarized below:

Relevance—Evidence more directly related to the assessment endpoint will be given more weight. Considerations include mode of exposure, exposure media, duration of exposure, and relationship between test species and assessment endpoint.

Exposure-response—A line of evidence that demonstrates a relationship between the magnitude of exposure and the effect will be given more weight than one that does not.

Temporal scope—A line of evidence will be given more weight if the data encompass the relevant range of temporal variability in conditions.

Spatial scope—A line of evidence will be given more weight if the data adequately represent the area to be assessed, including directly contaminated areas, indirectly contaminated areas, and indirectly affected areas. For example, tissue residues of wide-ranging[2] organisms such as white sturgeon may be less reflective of exposure within the ISA than water or prey concentrations.

Quality—The quality of the data will be evaluated in terms of the protocols for sampling, analysis, and testing; the expertise of the individuals involved in the data collection; the adequacy of the quality control during sampling, sample processing, analysis, recording of results; and any other issues that are known to affect the quality of the data for purposes of risk assessment.

Quantity—The adequacy of the data will be evaluated in terms of the number of observations taken. Results based on small sample sizes are given less weight than those based on large sample sizes.

[2] Home ranges greater than the ISA.

Uncertainty—A line of evidence that estimates the assessment endpoint with low uncertainty will be given more weight. Uncertainty in a risk estimate is in part a function of the data quality and quantity, discussed above. In most cases, however, the major source of uncertainty is the extrapolation from the measures of effect and the assessment endpoint. In addition, the extrapolation from the measures of exposure of the endpoint entities may be large due to considerations such as bioavailability and temporal dynamics.

The results, showing the lines of evidence, will be presented in the PRE and will be used to identify data gaps for the BERA. The final results will be presented in the BERA. The ecological significance of the adverse effects will also be discussed. The testable hypotheses will be evaluated in terms of the risk characterization. The BERA will identify chemicals of concern that will be evaluated in the feasibility study.

7.0 UNCERTAINTY ANALYSIS

Uncertainty analysis is an important step of the ERA process. Uncertainty analysis increases the confidence of an ERA by explicitly describing the magnitude and direction of uncertainties (EPA 1998). There are inherent uncertainties throughout the ERA process that must be identified and evaluated for their impacts on risk estimation.

Uncertainties will be identified in three primary areas: knowledge of the site, the parameters used to evaluate risk, and the models used to represent and estimate risk. For example, information may be lacking about receptors at the site, and this knowledge gap would represent an uncertainty. Parameters such as sediment chemical concentrations are inherently variable, and this uncertainty will be considered in the determination of sample sizes and location. Models, which are simplified representations of physical and biological processes that may be too complicated to express in any other way, may be oversimplified or fail to capture important aspects of the processes under investigation. Such uncertainties, along with their implications for the final risk estimate for the study area, will be identified as they are encountered, discussed, and reviewed in context of the risk characterization.

There are multiple methods described in EPA guidance for analyzing uncertainties. The simplest method is to incorporate various exposure and effects scenarios in the risk estimation process that capture the range of uncertainties in assumptions. The risk estimates can be expressed as point estimates with statistical measures of uncertainty (e.g., confidence limits, percentiles). Another method to analyze uncertainty is sensitivity analysis, where parameter values are iteratively varied to examine the effect of the parameter on the risk estimate. Simulation software can be used to conduct Monte Carlo analysis for the purpose of examining uncertainty. This probabilistic approach is commonly applied and EPA supplies guidance regarding the application of probabilistic techniques to ERA. For the Portland Harbor ERA, one or more of these methods will be applied in the uncertainty analyses. LWG will discuss these options will EPA and its partners.

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LWG
LOWER WILLAMETTE GROUP

Portland Harbor RI/FS
Round 1 Work Plan

APPENDIX B:
ECOLOGICAL RISK ASSESSMENT APPROACH
TABLES

REVISED DRAFT FINAL
November 13, 2003

Prepared for:
The Lower Willamette Group

Prepared by:
Windward Environmental LLC

List of Tables for Appendix B

Table 2-1.	*Benthic macroinvertebrates found in the lower Willamette River*	*1*
Table 2-2.	*Fish of the Lower Willamette River*	*6*
Table 2-3.	*Habitat associations of fish in Portland Harbor*	*16*
Table 2-4.	*Potentially resident birds breeding along the lower Willamette River*	*16*
Table 2-5.	*Birds seasonally occurring in or minimally associated with aquatic habitat in the ISA*	*19*
Table 2-6.	*Mammals potentially utilizing the lower Willamette River*	*22*
Table 2-7.	*Amphibians and reptiles possibly occurring in or near the ISA*	*22*
Table 2-8.	*Species of special interest in the ISA*	*25*
Table 3-1.	*Surface water surveys within the ISA*	*26*
Table 3-2.	*Concentrations of chemicals detected in surface water samples collected from the ISA*	*26*
Table 3-3.	*Sediment surveys within the ISA*	*28*
Table 3-4a.	*Category 1 concentrations of chemicals detected in 0-4 ft sediment samples collected from the ISA*	*30*
Table 3-4b.	*Category 1and 2 concentrations of chemicals detected in 0-4ft sediment samples collected from the ISA*	*34*
Table 3-4c.	*Category 1 concentrations of chemicals detected in 0-1 ft sediment samples collected from the ISA*	*38*
Table 3-4d.	*Category 1and 2 concentrations of chemicals detected in 0-1 ft sediment samples collected from the ISA*	*42*
Table 3-5.	*Fish tissue surveys conducted in the ISA*	*46*
Table 3-6.	*Concentrations of chemicals detected in fish tissue samples collected from within the ISA*	*47*
Table 3-7.	*Concentration ranges of chemicals in great blue heron egg tissues from Ross Island in 1994 and 1995*	*52*
Table 3-8.	*Bioassay data from environmental investigations in the ISA*	*53*
Table 5-1.	*The DQO process for the ecological risk evaluation: Amphibians, reptiles and plants*	*55*
Table 5-2.	*The DQO Process for the ecological risk evaluation: Benthic invertebrate communities*	*56*
Table 5-3.	*The DQO process for the ecological risk evaluation: Fish*	*58*
Table 5-4.	*The DQO process for the ecological risk evaluation: Birds*	*59*
Table 5-5.	*The DQO process for the ecological risk evaluation - Mammals*	*61*
Table 5-6.	*Limited list of secondary stressors that may influence receptor populations within the LWR*	*62*

Table 2-1. Benthic macroinvertebrates found in the lower Willamette River

Phylum	Class	Order	Family	Genus/Species	Common Name	Habitat
Platyhelminthes						
		Turbellaria				
			Tricladida			Epibenthic
Nematoda						Infauna
Annelida						
	Oligochaeta					
		Haplotaxida				
			Tubificidae	*Brachiura sowerbyi*		Infauna
			Naididae			Infauna
		Lumbriculida				
			Lumbricidae			Infauna
	Hirudinea					
		Rhynchobdellida				
			Glossiphoniidae			
				Helobdella sp.	Freshwater leech	Epibenthic
		Gnathobdellida				
			Hirudinidae	Leeches		Epibenthic
	Polychaeta					
		Phyllodocida				
			Nereidae	*Nereis limnicola*		Epibenthic
		Sabellida				
			Sabellidae			
				Manayunkia sp.	Featherduster worm	Infauna

Phylum	Class	Order	Family	Genus/Species	Common Name	Habitat
Mollusca						
	Gastropoda					
		Mesogastropoda				
			Hydrobiidae	*Fluminicola virens*	Olympia pebblesnail	Epibenthic
				Amnicola sp.	Columbia dusky snail	Epibenthic
				Fluminicola fuscus	Columbia pebblesnail	Epibenthic
			Pleuroceridae	*Juga plicifera*	Pleated juga	Epibenthic
				Juga sp.		Epibenthic
		Basommatophora				
			Lancidae	*Fisherola nuttalli*	Giant Columbia River limpet	Epibenthic
			Physidae	*Physella columbiana*	Rotund physa	Epibenthic
	Bivalvia			*Juga hemphilli hemphilli*	Barren juga	Epibenthic
		Veneroida				
			Corbiculidae	*Corbicula fluminea*	Asiatic clam	Epibenthic
		Myoida	Sphaeriidae	*Sphaerium* sp.	Fingernail clam	Epibenthic
		Unioncida	Unionidae	*Anodonta californiensis*	California floater	Infauna
				Anadonta wahlametensis	Willamette floater	Infauna
				Gonidea angulata	Western ridgemussel	Infauna
			Margaretiferidae	*Margaritifera falcata*	Western pearlshell	Epibenthic
Arthropoda						
	Crustacea					
		Eucopepoda				
		Ostracoda				

PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	COMMON NAME	HABITAT
		Isopoda				
			Asellidae	*Asellus* sp.		Epibenthic
		Amphipoda				
			Corophiidae	*Corophium* sp.		Epibenthic
			Gammaridae	*Gammarus* sp.		Epibenthic
		Decapoda				
			Asticidae	*Pacifastacus leniusculus or P. trowbridgii*	Western freshwater crayfish	Epibenthic
			Palaemonidae	*Exopalaemon modestus*	Siberian prawn	Epibenthic
	Insecta					Epibenthic
		Ephemeroptera				
			Ephemeridae	*Hexagenia limbata limbata*	Burrowing mayfly	Infauna
			Baetidae	*Baetis insignificans*	Mayfly species	Epibenthic
				Baetis tricaudatus	Mayfly species	Epibenthic
			Heptagenidae	*Stenonema* sp.	Mayfly species	Epibenthic
			Leptophlebiidae			
		Diptera				
			Chaoboridae	*Chaoborus* sp.	Phantom midges	Epibenthic
			Empididae	*Empidae* sp.		Epibenthic
			Simuliidae	*Simulium* sp.	Black flies	Epibenthic
			Ceratopogonidae			
			Chironomidae	*Chironomus* sp.	Midges	Infauna/ Epibenthic
				Cricotopus sp.	Midges	
				Cryptochironomus sp.	Midges	

PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	COMMON NAME	HABITAT
				Cryptotendipes sp.	Midges	
				Dicrotendipes sp.	Midges	
				Dienotendipes sp.	Midges	
				Einfeldia sp.	Midges	
				Endochironomus sp.	Midges	
				Eukiefferiella sp.	Midges	
				Glyptotendipes sp.	Midges	
				Harnischia sp.	Midges	
				Heterotrissocladius sp.	Midges	
				Macropelopia sp.	Midges	
				Monodiamesa sp.	Midges	
				Orthocladius complex	Midges	
				Paralauterbomiella sp.	Midges	
				Phaenopsectra sp.	Midges	
				Polypedilum sp.	Midges	
				Procladius sp.	Midges	
				Saetheria sp.	Midges	
				Stictochironomus sp.	Midges	
				Synendotendipes sp.	Midges	
				Tanytarsus sp.	Midges	
				Thienemannimyia gr. sp.	Midges	
		Heteroptera				
			Corixidae	*Corixa* sp	Water boatmen	Epibenthic
		Trichoptera				
			Polycentropodidae			

PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	COMMON NAME	HABITAT
				Polycentropus sp.	Caddisfly	Epibenthic
			Hydropsychidae			
				Cheumatopsyche sp.	Net spinning caddisfly	Epibenthic
			Leptoceridae			
				Oecetis sp.	Tan long-horned sedge	Epibenthic
			Glossosomatidae			
				Protoptila sp.	Caddisfly	Epibenthic
				Glossoma sp.	Caddisfly	Epibenthic
		Coleoptera				
			Elmidae			
				Dubiraphia sp.	Riffle beetle	Epibenthic
		Megaloptera				
			Sialidae			
				Sialis sp.	Alderfly	Epibenthic
		Lepidoptera				
			Pyralidae			
				Parargyractis sp.	Aquatic lepidoptera	Epibenthic

Sources: Hjort et al. (1984); Ward et al. (1988); Tetra Tech (1995); Landau (2000); Dames and Moore (1998)

Table 2-2. Fish of the Lower Willamette River

Species	Scientific Name	Origin[A]	Abundance in LWR[B]	Resident or Migratory[C]	Feeding Guild[D]	Location in water column[C]	Prey items for Adults	Prey items for Juveniles	Habitat preferences	Life span & age of maturity[C]
Chiselmouth	*Acrocheilus alutaceus*	Native	Present	R	herbivore	benthic	diatoms and algae (43)	insects, diatoms (43)	moderately to fast flowing pools, creeks, and small to medium rivers (28,43); sand and gravel substrate; also in margins of lakes (28).	6 yr lifespan (max); mature at 3 yr (males) and 4 yr (females).
Mountain sucker	*Catostomus platyrhynchus*	Native	Present	R	herbivore	benthic	diatoms, filamentous algae, insects, plants (35,43)	ND	shallow waters of mountain streams; sand, gravel, or boulder substrate (35,43).	Lifespan 9 yr (40); mature at 2 yr (males) and 3 yr (females)
Eulachon	*Thaleichthys pacificus*	Native	Present	M	omnivore	pelagic (8)	plankton, shrimp, only at sea (32,43)	ND	predominantly marine habitat, migrates to estuaries and coastal rivers to spawn, spends <6 weeks in freshwater (32,43).	Lifespan 3 yr
Bluegill	*Lepomis macrochirus*	Introduced	Present	R	omnivore	bentho-pelagic	Aquatic insects, mollusks, crayfish, amphipods, fish eggs (35,43)	Zooplankton, aquatic insects, fish eggs (43)	prefer deep weed beds (28); most abundant along shorelines, low gradient, low velocity, and high % of pool area (37).	Lifespan 1-4 yr (37)
Common carp	*Cyprinus carpio*	Introduced	Present	R	omnivore	bentho-pelagic	algae, vegetation, clams, insects, zooplankton (43)	zooplankton, plants (43)	large water bodies with slow flowing or standing water and soft bottom sediments; tolerant of turbidity, low oxygen levels, high temperatures; require vegetation to lay eggs (7,43).	Reported max age is 15 yr; mature at 2-4 yr (males) and 3-5 yr (females) (7)
Pumpkinseed	*Lepomis gibbosus*	Introduced	Present	R	omnivore	bentho-pelagic	aquatic insects, mollusks, crustaceans (43)	ND	Quiet vegetated pools of small rivers (28); shallow, warm waters, low-velocity currents (43).	Lifespan 6 yr; mature at age 2-3yr

Species	Scientific Name	Origin[A]	Abundance in LWR[B]	Resident or Migratory[C]	Feeding Guild[D]	Location in water column[E]	Prey items for Adults	Prey items for Juveniles	Habitat preferences	Life span & age of maturity[E]
Largescale sucker	*Catostomus macrocheilus*	Native	Common	R	omnivore	benthic (pelagic juvenile until > 18mm)	diatoms, crustaceans, insect larvae, amphipods, snails, detritus (4,43).	zooplankton, aquatic insect larvae	Larvae and juveniles prefer nearshore areas, shallow pools, backwaters w/ low velocity (4); adults live close to bottom in shallow waters (43).	Lifespan 11 yr; mature in 3-5 yr (males) and 4-6 yr (females)
Fathead minnow	*Pimephales promelas*	Introduced	Not reported	R	omnivore	benthic	detritus, algae, zooplankton (35)	ND	pools of headwaters, creeks and small rivers or ponds, tolerant of turbidity, warm temperatures, low oxygen (28).	ND
Black bullhead	*Ameiurus melas*	Introduced	Rare	R	omnivore	benthic	fish, benthic weeds, algae (40); clams, snails (35)	insect larvae, crustaceans (35)	Pools, backwater, and slow current areas, soft substrates, creeks, small to large rivers, impoundments, oxbows, and ponds (35).	Lifespan 10yr (max) (35)
Brown bullhead	*Ameiurus nebulosus*	Introduced	Present	R	omnivore	benthic	benthic macroinvertebrates, detritus, and small fish (35,43)	Chironmid larvae, cladocerans, ostracods, amphipods, insects (35)	warm-water of ponds, lakes, slow current streams, spawn and feed in shallow, weedy areas; tolerant of high temperatures and low dissolved oxygen (43).	Lifespan 5 yr
Goldfish	*Carassius auratus*	Introduced	Present	R	omnivore	benthic	plants, small crustaceans, insects, and detritus (43)	zooplankton, plants (43)	Rivers, lakes, ponds and ditches with stagnant or slow-flowing water (43).	Reported max age is 25 yr
Green sturgeon	*Acipenser medirostris*	Native	Present in Columbia R.	M	omnivore	benthic	invertebrates, fish (43)	amphipods, mysid shrimp (43)	most often in marine waters, migrate to estuaries and lower rivers to spawn, habitat preferences not well known (43).	Likely similar to white sturgeon
Oriental weatherfish	*Misgurnus anguillicaudatus*	Introduced	Not reported	R	omnivore	benthic	ND	ND	pools or areas with mud substrate, can tolerate low oxygen (28).	ND

Species	Scientific Name	Origin[A]	Abundance in LWR[B]	Resident or Migratory[C]	Feeding Guild[D]	Location in Water Column[C]	Prey Items for Adults	Prey Items for Juveniles	Habitat Preferences	Life Span & Age of Maturity[C]
White sturgeon	*Acipenser transmontanus*	Native	Common (10)	M	omnivore	benthic	crayfish, clams, shrimp, mollusks, insects, annelids, small fish (29,43)	amphipods, mysid shrimp (21,29,43)	Adults migrate to freshwater in fall, overwinter, then migrate back to estuary after spawning in the spring/summer (20); spawn in rivers with swift current and large cobbled bottoms.	Lifespan can be 100+ yr; iteroparous; mature at 13 yr (females) and 9-10 yr (males) (20).
Yellow bullhead	*Ameiurus natalis*	Introduced	Present	R	omnivore	benthic	insects, crustaceans, mollusks, small fish (35,43).	ND	warm, clear water of slow streams, spawn in shallow, secluded, backwater areas with nest undercover of root wads, boulders (43).	Lifespan 5 yr; mature at 2-3 yr
American shad	*Alosa sapidissima*	Introduced	Common (10)	M	invertivore	bentho-pelagic	Plankton, crustaceans, and small fish-do not feed on spawning runs (36,43)	Plankton, aquatic insects, benthic invertebrates . crustaceans (35,43)	prefer spawning in rivers w/ broad flats or shallow water at depths=0.5-12m (36); Juveniles spend first summer in freshwater, move to sea in late fall (43).	Maximum age 11 yr (36); mature at 3 yr (male), 4 yr (female); iteroparous
Banded killifish	*Fundulus diaphanus*	Introduced	Rare	R	invertivore	bentho-pelagic	Chironomid larvae, copepods, amphipods, insects, mollusks (35)	ND	near sand-bottomed shallows and submerged aquatic plants (28,35)	ND
Brook trout	*Salvelinus fontinalis*	Introduced	Not reported	M	invertivore	bentho-pelagic	Aquatic insect larvae, shrimp, worms, snails, fish (43)	Zooplankton (43)	cool, clear headwater ponds and spring-fed streams, usually found under cover of banks and vegetation (43).	Lifespan 4 yr
Brown trout	*Salmo trutta*	Introduced	Not reported	R	invertivore	bentho-pelagic	Fish, crustaceans, aquatic insect larvae (43)	Mayflies, stoneflies, shrimp, isopods, crustaceans (43)	tolerant of turbid, low oxygen, warm water, deep pools of streams or under banks during day (43).	Reproductively mature in 3-5 yr (31)

Species	Scientific Name	Origin[A]	Abundance in LWR[B]	Resident or Migratory[C]	Feeding Guild[D]	Location in Water Column[C]	Prey Items for Adults	Prey Items for Juveniles	Habitat Preferences	Life Span & Age of Maturity[C]
Lake trout	*Salvelinus namaycush*	Introduced	Not reported	R/M	invertivore	bentho-pelagic (28)	fish, plankton, crustaceans, insect (28, 13)	crustaceans, larval insects, fish (43)	tend to remain in deeper waters near bottom; home ranges are large during spring and fall, travel far (19).	Lifespan 10 yr
Chinook salmon	*Oncorhynchus tshawytscha*	Native	Common	M	invertivore	bentho-pelagic	invertebrates and fish (marine only) (43)	aquatic insect larvae and terrestrial insects (12,43)	spawn in gravel riffles of streams and rivers, eggs require high oxygen levels through gravel, juveniles reside in marginal areas of river with shallow water and abundant cover (12).	Smolt 1-2 yr (stream type) or 3 months (ocean type); reproductively mature after 3-4 yr in ocean
Chum salmon	*Oncorhynchus keta*	Native	Rare	M	invertivore	bentho-pelagic	insects, epibenthic crustaceans, fish (feed only at sea) (6, 14)	Diptera larvae, diatoms, cyclops (43)	for spawning areas, exposed cobble or gravel beaches in nearshore areas (14); usually ~100km from marine waters (33).	Juveniles migrate shortly after emergence from gravel; mature in 3-5 yr (14).
Coastal cutthroat trout	*Oncorhynchus clarki clarki*	Native	Common	M	invertivore	bentho-pelagic	fish, epibenthic crustaceans, pelagic organisms, insects (marine only) (39)	fish, insect larvae, sand shrimp (39)	spawn in smallest headwater streams (43); juveniles prefer low-velocity backwater areas until big enough to move into riffles and higher velocities of larger streams; overwinter in pools with logs, roots, and vegetation for cover (39).	Smolt in 2-4 yr; iteroparous (15)
Coho salmon	*Oncorhynchus kisutch*	Native	Common	M	invertivore	bentho-pelagic	fish, invertebrates (feed only at sea) (6)	zooplankton, insects, worms, fish eggs, spiders, fish (6)	spawn in gravel at head of stream riffle (6,55); juveniles prefer shallow water of 10-20ft (14, 6), backwaters, side channels and small creeks with overhanging vegetation (55).	Smolt in 1-2 yr; reproductively mature in 3rd year (55)
Kokanee	*Oncorhynchus nerka kennerlyi*	Introduced	Not reported	R	invertivore	bentho-pelagic	zooplankton, aquatic insect larvae (43)	zooplankton (43)	spawn in gravel riffles of streams and tributaries to lakes, juveniles migrate to lake environs, mature and live as adults in pelagic zone of lake (43)	Reproductively mature in 3-5 yr

Species	Scientific Name	Origin[A]	Abundance in LWR[B]	Resident or Migratory[C]	Feeding Guild[D]	Location in Water Column[C]	Prey Items for Adults	Prey Items for Juveniles	Habitat Preferences	Life Span & Age of Maturity[C]
Mosquitofish	*Gambusia affinis*	Introduced	Rare/incidental	R	invertivore	bentho-pelagic	insects, benthic inverts, diatoms (28,43)	insect larvae, diatoms, zooplankton (43)	Standing to slow-flowing water; most common in vegetated ponds and lakes, backwaters, and quiet pools of streams (28).	Lifespan 1 yr
Mountain whitefish	*Prosopium williamsoni*	Native	Present	R	invertivore	bentho-pelagic	aquatic insect larvae, crayfish, fish eggs, shrimp, fish (43)	ND	riffle areas and large pools of cold streams (48-52 deg F); spawn in gravel riffles (43).	Reproductively mature in 3-4 yr
Peamouth	*Mylocheilus caurinus*	Native	Common	R	invertivore	bentho-pelagic	plankton, insects, sculpins, crustaceans, mollusks (43)	zooplankton (43)	shallow, vegetated areas of lakes and slow-flowing small to medium rivers; near shore in winter, deeper water in summer (43).	Lifespan 13+ yr; mature at age 3 (males) and age 4 (females)
Rainbow trout	*Oncorhynchus mykiss*	Native	Common	R	invertivore	bentho-pelagic	aquatic and terrestrial insects, fish (30)	aquatic insects and larvae, worms and fish eggs (43)	Clear, cold water; 1:1 pool:riffle ratio, abundant vegetative cover (30)	Lifespan 3-8 yr (30)
Redside shiner	*Richardsonius balteatus*	Native	Rare	R	invertivore	bentho-pelagic	aquatic & terrestrial insects, zooplankton (43)	zooplankton, algae (43)	shallow, vegetated areas of ponds, lakes, and streams; prefers gravel bottomed streams for spawning habitat (43).	Lifespan 5 yr
Sockeye salmon	*Oncorhynchus nerka nerka*	Introduced	Present	M	invertivore	bentho-pelagic	crustaceans, plankton (feed only at sea) (43)	zooplankton (43)	Spawn in gravel riffles of streams and tributaries to lakes, juveniles migrate to lake environs and live in pelagic zone of lake (43).	Smolt in 1-2 yr; reproductively mature 3-5 yr
Steelhead	*Oncorhynchus mykiss gairdneri*	Native	Common	M	invertivore	bentho-pelagic	marine only	aquatic insects and larvae, worms and fish eggs (43)	spawn in gravel riffles of streams and rivers.	Smolt at 2 yr; spend 2 yr in sea before spawning (3)

Species	Scientific Name	Origin[A]	Abundance in LWR[B]	Resident or Migratory[C]	Feeding Guild[D]	Location in Water Column[C]	Prey Items for Adults	Prey Items for Juveniles	Habitat Preferences	Life Span & Age of Maturity[C]
Prickly sculpin	*Cottus asper*	Native	Common	R	invertivore	benthic (juvenile-pelagic for first 30 days)	crustaceans, aquatic insect larvae, mollusks, fish eggs,and small fish (43)	planktonic crustaceans, aquatic insect larvae (43)	shallow waters; sand, gravel, or rubble bottoms; vegetative cover; tolerant of salinity (43)	Lifespan 4-5 yr
Threespine stickleback	*Gasterosteus aculeatus*	Native	Present	R/M	invertivore	benthic (freshwater)	zooplankton, aquatic insect larvae (43)	fish eggs (43)	bottom of streams and lakes, aquatic vegetation; spawn in freshwater habitats, nests made of algae and detritus and located near vegetation (43).	Lifespan 1-2 yr
Reticulate sculpin	*Cottus perplexus*	Native	Common	R	invertivore	benthic	aquatic insect larvae, other sculpins, salmon eggs, fry (43)	aquatic insect larvae (43)	pools and riffles of small streams, can burrow up to 36 cm into gravel substrates (43).	Lifespan 6-7 yr
Green sunfish	*Lepomis cyanellus*	Introduced	Not reported	R	invertivore	benthic	insects, crustaceans, fish (43)	zooplankton, aquatic insects, fish eggs (38)	abundant pools with vegetative or woody debris for cover; gravel, sand substrate (38,43).	Lifespan 6 yr (6); mature at age 1-3 yr (38)
Leopard dace	*Rhinichthys falcatus*	Native	Not reported	R	invertivore	benthic	terrestrial insects, algae, diatoms, worms (43)	aquatic insects and larvae (43)	flowing pools, gravel runs (35).	Lifespan 5 yr
Longnose dace	*Rhinichthys cataractae*	Native	Rare	R	invertivore	benthic	aquatic insect larvae, algae, fish eggs (43)	ND	Rubble and gravel riffles (28); swift-moving currents and turbulent waters (43).	Lifespan 5 yr
Mottled sculpin	*Cottus bairdi*	Native	Present	R	invertivore	benthic	aquatic insects, fish eggs, and fish fry (43)	aquatic insects, fish eggs, and fish fry (43)	fast-flowing streams, shallow water, rocky substrate (43).	Lifespan 5 yr
Oregon chub	*Oregonichthys crameri*	Native	Rare/ incidental Endangered (USFWS)	R	invertivore	benthic	ND	ND	sand- and gravel-bottomed pools and backwaters of creeks and small rivers, often in vegetation (28); sensitive to habitat alterations (28).	ND

Species	Scientific Name	Origin[A]	Abundance in LWR[B]	Resident or Migratory[C]	Feeding Guild[D]	Location in Water Column[C]	Prey Items for Adults	Prey Items for Juveniles	Habitat Preferences	Life Span & Age of Maturity[C]
Paiute sculpin	*Cottus beldingi*	Native	Present	R	invertivore	benthic	ostracods, algae, insect larvae, insects, snails, clams (43)	ostracods, algae, insect larvae, insects, snails, clams (43)	moderate gradient streams, riffles with rubble and gravel substrates (43).	Lifespan 5 yr
Redear sunfish	*Lepomis microlophus*	Introduced	Not reported	R	invertivore	benthic	bottom insects, midge larvae, snails, mayfly larvae, &dragonfly naiad (42)	bottom insects, green algae, crustaceans (42)	low turbidity; prefer warm, very low velocity; adults prefer deeper, open water; vegetation for cover and food substrate (42).	Reported maximum age is 8 yr (42)
Riffle sculpin	*Cottus gulosus*	Native	Present	R	invertivore	benthic	crustaceans, aquatic insect larvae, snails (43)	crustaceans, aquatic insect larvae, snails (43)	riffles of cold streams, moderate to fast-moving currents, sand or gravel substrate (43).	Lifespan 4 yr
Sand roller	*Percopsis transmontana*	Native	Rare	R	invertivore	benthic	presumed similar to trout-perch in diet: crustaceans, plankton, larval insects (43)	ND	quiet backwaters with abundant cover provided by banks, vegetation, woody debris (43).	ND
Shorthead sculpin	*Cottus confuscus*	Native	Present	R	invertivore	benthic	ND	ND	cold water, fast-moving current, riffles, higher altitudes, rubble or gravel substrates (43).	Lifespan 4-5 yr
Speckled dace	*Rhinichthys osculus*	Native	Not reported	R	invertivore	benthic	aquatic insects, shrimp, plant material, zooplankton (43)	plankton	Rocky riffles, pools (28); shallow waters, < 3ft deep (43).	Max age is 3 yr
Starry flounder	*Platichthys stellatus*	Native	Common	M	invertivore	benthic	crabs, mollusks, annelids, echinoderms, small fish (27)	copepods, amphipods, annelids, mollusks (27)	shallow to deep water of bays, estuaries, inlets (43, 27); avoids rocky bottoms (43). Spawn in estuarine waters.	Mature at 3 yr (males) and 4 yr (females) (27)

Species	Scientific Name	Origin[A]	Abundance in LWR[B]	Resident or Migratory[C]	Feeding Guild[D]	Location in Water Column[C]	Prey Items for Adults	Prey Items for Juveniles	Habitat Preferences	Life Span & Age of Maturity[C]
Tench	*Tinca tinca*	Introduced	Not reported	R	invertivore	benthic	bottom invertebrates, aquatic insects (43)	algae	warm lakes & pools w/ weed & mud bottoms (43); breeds in shallow water among dense veg.	ND
Torrent sculpin	*Cottus rhotheus*	Native	Present	R	invertivore	benthic	zooplankton, aquatic insects and larvae, crayfish, fish eggs (43)	ND	fast-moving currents, rocky or gravel substrates, beach areas of streams (43).	Lifespan 6 yr
Warmouth	*Lepomis gulosus*	Introduced	Present	R	invertivore	benthic	aquatic insect larvae, crayfish, fish (43)	protozoa, bacteria, zooplankton (43)	slow-moving backwater, near zero gradient, dense cover of aquatic vegetation; adversely affected by channelization (22).	Mature in 1-3 yr (22)
White catfish	*Ameiurus catus*	Introduced	Not reported	R	invertivore	benthic	fish, invertebrates (40)	zoobenthos, insects (40)	Sluggish, mud-bottomed pools, open channels, and backwaters of small to large rivers; also in lakes and impoundments. (28); can tolerate brackish waters (40).	
Channel catfish	*Ictalurus punctatus*	Introduced	Rare	R	invertivore / omnivore	benthic	crayfish, small fish, fish eggs, aquatic insects (35,43)	planktonic crustaceans, aquatic insect larvae (35,43)	moderate to swift currents, tolerates muddy water, feed in shallow water, returns to deep, sheltered areas for cover (43).	Lifespan 14+ yr; mature at 6-7 yr (24)
Bull trout	*Salvelinus confluentus*	Native	Not reported	M	piscivore	bentho-pelagic (28)	fish, zooplankton	ND	deep pools, large, cold rivers (28)	ND
Black crappie	*Pomoxis nigromaculatus*	Introduced	Common	R	piscivore	bentho-pelagic	fish, insects, mysid shrimp, fish eggs, and crustaceans (35,43).	zooplankton, insect larvae (43)	Backwater and pools, usually in vegetation over mud or sand (35); low turbidity, vegetative cover, low gradient, low velocity, availability of pools (5).	life span 13 yr (maximum) (5). Mature at age 2-3 yr
Largemouth bass	*Micropterus salmoides*	Introduced	Common	R	piscivore	bentho-pelagic	fish, crustaceans, crayfish, worms, mollusks, insects (41,43)	copepods, cladocerans, insect larvae (41,43)	warm (80 degrees F), shallow water, abundant aquatic plants and woody debris to provide cover (43).	Lifespan 12-16 yr; mature at age 1-4 yr.

Species	Scientific Name	Origin[A]	Abundance in LWR[B]	Resident or Migratory[C]	Feeding Guild[D]	Location in Water Column[C]	Prey Items for Adults	Prey Items for Juveniles	Habitat Preferences	Life Span & Age of Maturity[C]
Northern pikeminnow	*Ptychocheilus oregonensis*	Native	Common	R	piscivore	bentho-pelagic	fish, crayfish, insects (2,13,43)	aquatic and terrestrial insects, fish (43)	slow to moderate currents; summer: inshore or shallow areas, winter: deeper waters (43)	Max age reported: 19 yr; mature at 3 yr (males) and 4 yr (females)
Smallmouth bass	*Micropterus dolomieui*	Introduced	Common	R	piscivore	bentho-pelagic	fish, crayfish, worms, mullusks, insects, tadpoles (35,43)	zooplankton, chironomid larvae, insects, crayfish (11,43)	broken rocky substrate; moderate current; do not travel far, small home range (43); riprap used for cover (9).	Lifespan 10 yr; reach maturity at age 3-4 yr
Walleye	*Stizostedion vitreum*	Introduced	Present	R	piscivore	bentho-pelagic	fish, insects, crayfish (23,43).	zooplankton, insect larvae, fish (23,43)	moderate-to-large lacustrine or riverine systems w/ cold, shallow water, extensive littoral areas, clean rocky substrate (23); spawn in rocky areas and in white water below falls and dams (35,43).	Lifespan 17+ yr; mature at age 2-4 (males) and 3-8 (females) (23)
White crappie	*Pomoxis annularis*	Introduced	Common	R	piscivore	benthic	fish, insects, fish eggs, and crustaceans (26,43)	zooplankton, insects, algae (6, 26,43)	low gradient, low velocity, low turbidity; clay, dirt, or gravel substrate; aquatic plant important for cover (6).	Lifespan 7-9 yr; mature at 1-3 yr (6)
Yellow perch	*Perca flavescens*	Introduced	Common	R	piscivore	benthic	fish, aquatic insects, nymphs, fish eggs, crayfish (13,18,43).	zooplankton, insect larvae (18,43)	shoreline areas w/ some vegetation and pools present, can be found in brackish, but need freshwater for spawning (18,43).	Max age is 9-10 yr (18); mature at 2-3 yr (males) and 3-4 yr (females)
Pacific brook lamprey	*Lampetra pacifica*	Native	Present (17)	R	detritivore (as juveniles)	benthic (juveniles)	adults do not feed (17)	diatoms, detritus (17, 25)	spawn in gravel riffles and clear, cool streams; ammocoetes in muddy to sandy sections; move downstream as mature (17).	Little known, assumed same as western brook lamprey (17)
Pacific lamprey	*Lampetra tridentata*	Native	Present (17)	M	detritivore (as juveniles)	benthic (juveniles)	parasitic adults do not feed in freshwater (17)	diatoms, detritus (17, 25)	spawn in gravel and sandy substrate, in low gradient streams. Ammocoetes bury selves in silt or sand in eddies and backwater areas, migrate to ocean when mature (17).	11 year lifespan; > 5-7 yr as filter-feeding juvenile (1,17)

Species	Scientific Name	Origin[A]	Abundance in LWR[B]	Resident or Migratory[C]	Feeding Guild[D]	Location in Water Column[C]	Prey Items for Adults	Prey Items for Juveniles	Habitat Preferences	Life Span & Age of Maturity[C]
River lamprey	*Lampetra ayresi*	Native	Present (17)	M	detritivore (as juveniles)	benthic (juveniles)	parasitic adults do not feed in freshwater (17)	diatoms, detritus (17, 25)	spawn in gravel substrate in streams (28). Ammocoetes burrow into mud and migrate to ocean when mature (17); Prefer larger, deep (3-6m) rivers w/ quick access to ocean (17).	7-8 year lifespan; 4-6 yr as filter-feeding juvenile (17)
Western brook lamprey	*Lampetra richardsoni*	Native	Present (17)	R	detritivore (as juveniles)	benthic (juveniles)	adults do not feed (17)	diatoms, detritus (17, 25)	spawn in gravel substrate, in clear, cool streams (28); ammocoetes: in muddy/sandy backwaters (28); adults: cool streams and backwaters (17).	6 year lifespan; 5 yr as filter-feeding juvenile (17)

[a] Altman et al. 1997

[b] Hughes and Gammon 1987, Farr and Ward 1992, Farr and Ward 1993, Tetra Tech 1995, Beak 2000, Wydoski and Whitney 1979

[c] Wydoski and Whitney

[d] Altman et al. 1997, Wydoski and Whitney 1979, Scott and Crossman 1973

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Table 2-3. Habitat associations of fish in Portland Harbor

Species	Habitat Preference
Black crappie, white crappie, smallmouth bass, bluegill	Most abundant at RM 10, a site characterized by a wharf with closely-spaced pilings, a completely riprapped shoreline, and a shallow backwater immediately downstream from the wharf.
Northern pikeminnow[a]	Common in all habitats, especially with no structures present
Starry flounder[a]	Most abundant at sites with no development
Walleye	Most abundant RM 7, a site with riprap and a sandy beach
White sturgeon[a]	Sandy beach shoreline with no structures present

Source: Farr and Ward (1993)

[a] Species native to the Willamette River system

Table 2-4. Potentially resident birds breeding along the lower Willamette River

Species	Scientific Name	Feeding Guild	Feeding Method[A]	Year-round or summer resident[B]	Diet composition[A,C]	Habitat Preferences[C]	Notes
Canada goose	*Branta canadensis*	Diving herbivore	Surface dips, ground glean	Some residents; some winter guests	feed on terrestrial and aquatic plants	nest on ground near water; often near marshes but not exclusively	
Mallard	*Anas platyrhynchos*	Diving herbivore	Dabbles	Resident	mostly aquatic plants, some inverts	nest on ground near water; forage in open water, prefer emergent vegetation	
American dipper	*Cinclus mexicanus*	Diving carnivore	Dive from rocks/water	Mostly year-round	aquatic insects (larvae & flying adults), small fish	nest in cliffs along swift streams/rivers	Rare in lower Willamette basin. (Nehls 2002)
Common merganser	*Mergus merganser*	Diving carnivore	Surface dives	Mostly year-round	fish (< 20 cm), some inverts	nest in tree cavities in wooded areas along river/lake shore.	
Hooded merganser	*Lophodytes cucullatus*	Diving carnivore	Surface dives	Some year-round; some winter guests	small fish and inverts	nest in tree cavities, usually in very close proximity to water/shoreline; feed in water <5ft. deep (Bellrose 1976)	

Species	Scientific Name	Feeding Guild	Feeding Method[A]	Year-round or summer resident[B]	Diet composition[A,C]	Habitat Preferences[C]	Notes
Pied-billed grebe	*Podilyumbus podiceps*	Diving carnivore	Surface dives	Summer; many winter guests	aquatic insects, fish, crayfish...	floating nests in quiet waters; emergent vegetation preferred; forage in open water	Common winter visitor, little nesting habitat in lower Willamette (Nehls 2002)
American coot	*Fulica americana*	Diving omnivore	Surface dips, ground glean	Year-round	aquatic vegetation, aquatic inverts	require cover along shorelines for nesting; floating nests	
Cinnamon teal	*Anas cyanoptera*	Diving omnivore	Surface dips, dabbles	Summer	aquatic plants, mollusks, inverts (midges and larvae)	ground nests; vegetative cover along shoreline	
Wood duck	*Aix sponsa*	Diving omnivore	Dabbles	Some year-round	aquatic inverts, seeds, plants	nest in trees and snags along water, whereever food is available	
Common snipe	*Gallinago gallinago*	Sediment probing invertivore	Probe	Mostly year-round	insects, crustaceans, mollusks, earthworms	ground nests; grassy areas near water	
Killdeer	*Charadrium vociferous*	Sediment probing invertivore	Ground glean	Year-round; some winter guests	insects (flying), spiders, worms, crayfish, snails...	ground nests; along open water, not selective	
Spotted sandpiper	*Aetitis macularia*	Sediment probing invertivore	Ground glean	Some year-round	aquatic inverts (worms), insect larvae, small fish...	ground nest amid herbaceous vegetation; feeds along shallow gravel shorelines and beaches	
Sora	*Porzana carolina*	Sediment probing omnivore	Ground glean, probes	Mostly summer; some winter guests	seeds, insects, aquatic inverts	floating nests; emergent vegetation along water bodies	
Virginia rail	*Rallus limicola*	Sediment probing omnivore	Probe, ground glean	Some year-round	insects, aquatic inverts, seeds, small fish	nest on ground, usually in marshes w/ vegetation. Shallow water w/ good cover	
American bittern	*Botaurus lentiginosus*	Piscivore	Stalk and strike	Year-round	fish, herps, crayfish...	ground nests, near water. Often amid emergent vegetation	

Species	Scientific Name	Feeding Guild	Feeding Method[A]	Year-round or summer resident[B]	Diet composition[A,C]	Habitat Preferences[C]	Notes
Bald eagle	*Haliaeetus leucocephalus*	Piscivore	Low patrol, swoops	Mostly year-round; some winter guests	fish, birds, mammals	Need large trees or snags for perches. Require shallow water habitats for hunting	Active nest on Ross Isl.; old nests on Sauvie Isl. (Isaacs and Anthony 2001)
Belted kingfisher	*Ceryle alcyon*	Piscivore	High dives	Mostly year-round	small fish (< 10 cm)	Stream courses and lake/pond edges. Clear waters not overgrown w/ veg. to facilitat hunting	
Double-crested cormorant	*Phalacrocorax auritus*	Piscivore	Surface dives, dips	Some summer; many winter guests	fish, few crayfish	Nest in trees, cliffs, rocks, etc. in colonies; near open water	
Great blue heron	*Ardea herodias*	Piscivore	Stalk and strike	Year-round	fish, some herps and inverts	Nest preferably in trees near water in colonies. Feed anywhere can find food, usually in shallow water for fish	Active heronry on Ross Isl (Thomas and Anthony 1997)
Green heron	*Butorides virescens*	Piscivore	Stalk and strike	Some year-round	small fish, inverts (crustaceans, snails...)	Riparian woodlands, nest in trees; sometimes amid emergent vegetation	
Osprey	*Pandion halieatus*	Piscivore	High dives	Summer	fish (almost 100%)	Need large trees or snags for perches. Require shallow water habitats for hunting	Two nests within ISA (Henny 2002)

[a] Ehrlich et al. 1988

[b] Puchy and Marshall 1993

[c] Csuti et al. 1997

Table 2-5. Birds seasonally occurring in or minimally associated with aquatic habitat in the ISA

Species	Scientific Name	Feeding Guild[A]	Feeding method[A]	Year-round Resident or Winter Guest[B,C]	Notes on residents
American peregrine falcon	*Falco peregrinus*	Carnivore	Aerial pursuit	Resident	Nests on Freemont Bridge (City of Portland 2000), preys mostly on birds
Barrow's goldeneye	*Bucephala islandica*	Diving carnivore	Surface dives	Winter guest	
Bonaparte's gull	*Larus philadelphia*	Diving carnivore	Surface dips, dives, gleans	Winter guest	
Bufflehead	*Bucephala albeola*	Diving carnivore	Surface dives	Winter guest	
Common goldeneye	*Bucephala clangula*	Diving carnivore	Surface dives	Winter guest	
Common teal (green-winged teal)	*Anas carolinensis*	Diving carnivore	Ground glean, dabbles	Winter guest	
Eared grebe	*Podiceps nigricollis*	Diving carnivore	Surface dives	Winter guest	
Greater scaup	*Aythya marila*	Diving carnivore	Surface dives	Winter guest	
Harlequin duck	*Histrionicus histrionicus*	Diving carnivore	Surface dives, dabbles	Winter guest	
Horned grebe	*Podiceps auritus*	Diving carnivore	Surface dives	Winter guest	
Lesser scaup	*Aythya affinis*	Diving carnivore	Surface dives	Winter guest	
Red-necked grebe	*Podiceps grisegena*	Diving carnivore	Surface dives	Winter guest	
Ruddy duck	*Oxyura jamaicensis*	Diving carnivore	Surface dives	Winter guest	
Wilson's phalarope	*Phalaropus tricolor*	Diving carnivore	Surface dips, gleans	Winter guest	
Aleutian Canada goose	*Branta canadensis leucopareia*	Diving herbivore	Surface dips, ground glean	Winter guest	
American wigeon	*Anas americana*	Diving herbivore	Dabbles	Winter guest	
Canvasback	*Aythya valisineria*	Diving herbivore	Surface dives	Winter guest	
Gadwall	*Anas strepera*	Diving herbivore	Dabbles, surface dips	Winter guest	
Northern pintail	*Anas acuta*	Diving herbivore	Dabbles, ground glean	Winter guest	
Northern shoveler	*Anas clypeata*	Diving herbivore	Surface dips	Winter guest	

Species	Scientific Name	Feeding Guild[A]	Feeding method[A]	Year-round Resident or Winter Guest[B,C]	Notes on residents
Ring-necked duck	*Aythya collaris*	Diving herbivore	Surface dives	Winter guest	
Tundra swan	*Cygnus columbianus*	Diving herbivore	Surface dips, gleans	Winter guest	
Common Loon	*Gavia immer*	Diving piscivore	Surface dives	Winter guest	
Pelagic cormorant	*Phalacrocorax pelagicus*	Diving piscivore	Surface dives	Winter guest	
Western grebe	*Aechmophorus occidentalis*	Diving piscivore	Surface dives	Winter guest	
American pipit	*Anthus rubescens*	Insectivore	Ground glean	Winter guest	
Barn swallow	*Hirundo rustica*	Insectivore	Aerial foraging	Resident	Mostly eats terrestrial insects, consumes water[b]
Black tern	*Chlidonias niger*	Insectivore	Aerial foraging	Winter guest	
Cliff swallow	*Hirundo pyrrhonota*	Insectivore	Aerial foraging	Resident	Mostly eats terrestrial insects, consumes water[b]
Ring-billed gull	*Larus delawarensis*	Omnivore	Ground glean, dives	Winter guest	
Sandhill crane	*Grus canadensis*	Omnivore	Ground glean	Winter guest	Occasionally overwinter on Sauvie Island[b]
Tri-colored blackbird	*Agelaius tricolor*	Omnivore	Ground and Foliage glean	Resident	Mostly eat terrestrial insects, some clams, snails, and tadpoles[b]
American white pelican	*Pelecanus erythrorhynchos*	Piscivore	Surface dips	Winter guest	
Black-crowned night heron	*Nycticorax nycticorax*	Piscivore	Stalk and strike	Winter guest	
Caspian tern	*Sterna caspia*	Piscivore	High dives	Winter guest	
Forster's tern	*Sterna forsteri*	Piscivore	High dives	Winter guest	
Great egret	*Ardea alba*	Piscivore	Stalk and strike	Winter guest	
Greater yellowlegs	*Tringa melanoleuca*	Piscivore	Ground glean	Winter guest	
Western gull	*Larus occidentalis*	Piscivore	Low patrol, ground glean	Winter guest	
California gull	*Larus californicus*	Sediment probing carnivore	Low dives	Winter guest	

Species	Scientific Name	Feeding Guild[A]	Feeding method[A]	Year-round Resident or Winter Guest[B,C]	Notes on residents
Dunlin	*Calidris alpina*	Sediment probing carnivore	Ground glean, probes	Winter guest	
Greater yellowlegs	*Tringa melanoleuca*	Sediment probing carnivore	Ground glean	Winter guest	
Least sandpiper	*Calidris minutilla*	Sediment probing carnivore	Ground glean, probes	Winter guest	
Lesser yellowlegs	*Tringa flavipes*	Sediment probing carnivore	Probe, ground glean	Winter guest	
Long-billed curlew	*Numenius americanus*	Sediment probing carnivore	Probe, ground glean	Winter guest	
Long-billed dowitcher	*Limnodromus scolopaceus*	Sediment probing carnivore	Probe	Winter guest	
Marbled godwit	*Limosa fedoa*	Sediment probing carnivore	Probe	Winter guest	
Mew gull	*Larus canus*	Sediment probing carnivore	Ground glean, surface dips	Winter guest	
Semipalmated plover	*Charadrius semipalmatus*	Sediment probing carnivore	Ground glean	Winter guest	
Short-billed dowitcher	*Limnodromus griseus*	Sediment probing carnivore	Probe	Winter guest	
Solitary sandpiper	*Tringa solitaria*	Sediment probing carnivore	Probe, ground glean	Winter guest	
Western sandpiper	*Calidris mauri*	Sediment probing carnivore	Ground glean, probes	Winter guest	
Willet	*Catoptrophorus semipalmatus*	Sediment probing carnivore	Probe, ground glean	Winter guest	

[a] Ehrlich et al. 1988

[b] Csuti et al. 1997

[c] Transient species during migration are also termed winter guests

Table 2-6. Mammals potentially utilizing the lower Willamette River

Species	Scientific Name	Diet	Habitat Preference
Beaver	*Castor canadensis*	terrestrial plants (especially willow and aspen) and aquatic plants	In or near water (natural and artificial)
California sea lion	*Zalophus californianus*	mostly fish, some benthic inverts	Transient through ISA each spring for feeding at Willamette Falls
Mink	*Mustela vision*	fish, birds, mammals, frogs, and inverts (opportunists)	Den sites found 5-100 m from water's edge (no more than 200 m). Prefer areas with dense vegetation, canopy cover, large woody debris.
Muskrat	*Ondatra zibethicus*	aquatic plants, grasses, crawfish, fish, turtles	In or near water (lakes to ditches)
Nutria	*Myocastor coypus*	aquatic plants, grasses, fruit, some mollusks	Burrow near water and amid emergent vegetation
Raccoon	*Procyon lotor*	opportunists; small mammals, fish, frogs, birds, fruit, nuts, berries	Wide variety of habitats
River otter	*Lutra canadensis*	fish, frogs, crayfish…	Along streams, rivers; similar habitat requirements as mink

Source: Csuti et al. 1997

Table 2-7. Amphibians and reptiles possibly occurring in or near the ISA

Common Name	Scientific Name	USFW Status	ODFW Status	Diet	Preferred Habitat	Known Sightings
Bullfrog	*Rana catesbeiana*			Earthworms, terrestrial insects, crayfish, tadpoles, small birds and mammals, algae, aquatic insects	Can occur anywhere there is open water and some vegetation; hibernate in bottom mud of ponds	Found at South Rivergate Corridor
Cope's giant salamander	*Dicamptodon copei*		S	Terrestrial insects, earthworms, fish	forests near cold water streams or ponds; located under in-stream rocks and other cover	
Long-toed salamander	*Ambystoma macrodactylum*			Terrestrial insects, earthworms, spiders, zooplankton, aquatic insects, mollusks	Many near-water habitats; lives under bark and rocks near ponds, lakes, and streams	Found at South Rivergate Corridor

Common Name	Scientific Name	USFW Status	ODFW Status	Diet	Preferred Habitat	Known Sightings
Northern red-legged frog	*Rana aurora aurora*	SOC	S	Aquatic insects, terrestrial insects, algae, and debris	Meadows and forests with dense groundcover near water; forage in forests near water	Found along Miller Creek at Linnton, Harborton Forest and Wetlands, active breeding population at Doane Lake
Northwest salamander	*Ambystoma gracile*			Terrestrial insects, earthworms, mollusks, terrestrial invertebrates, zooplankton, aquatic insects	Meadows and forests near water; lives underground and under rocks and logs	
Pacific chorus frog	*Pseudacris regilla*			Terrestrial insects, algae, and detritus	Adapted to a wide variety of near-water habitats	
Pacific giant salamander	*Dicamptodon tenebrosus*			Terrestrial insects, small mammals, slugs, snails, amphibians, lizards, insect larvae, tadpoles, fish	Humid mixed conifer and deciduous forest and riparian zones; requires downed logs; larvae live in cold, clear water of streams, rivers, lakes, and ponds	Harborton Forest and Wetlands site
Painted turtle	*Chrysemys picta*		S	Aquatic plants, terrestrial insects, crayfish, fish, tadpoles	Lakes, ponds, marshes, small streams with muddy or sandy substrate; need basking sites and aquatic vegetation; hibernate in bottom mud	In seven ponds in South Rivergate and found in North Doane Lake, Smith and Bybee lakes, Burlington Bottoms, and the Peninsular Drainage Canal
Roughskin newt	*Ambystoma macrodactylum*			Mollusks, terrestrial insect larvae, earthworms, amphibian eggs, tadpoles, zooplankton, aquatic insects	Meadows and forests near water; hides under rocks, bark, or logs	
Tailed frog	*Ascaphus truei*	SOC	S	Diatoms, algae, pollen, small invertebrates	Cold, fast flowing permanent streams with substantial riparian vegetation; usually in forests	
Western pond turtle	*Clemmys marmorata marmorata*	SOC	S	Aquatic plants, terrestrial insects, earthworms, mollusks, crayfish, fish, tadpoles	Small lakes or marshes, quiet water in lakes, streams, or rivers; likes muddy or rocky bottoms; needs basking sites; hibernate in bottom mud	Known to occur in Multnomah County, but no known sightings
Western red-backed salamander	*Plethodon vehiculum*			Terrestrial insects	Forest dweller near running water	Found at Harborton Forest and Wetlands site

COMMON NAME	SCIENTIFIC NAME	USFW STATUS	ODFW STATUS	DIET	PREFERRED HABITAT	KNOWN SIGHTINGS
Western toad	*Bufo boreas*		S	Aquatic insects, terrestrial insects, earthworms, crayfish, tadpoles, algae, detritus	Adapted to a wide variety of near water habitats	

Sources: Hayes (2002); Corkran (2002); Hennings (2002); Csuti et al. (1997); Altman et al. (1997), Adolfson et al. (2000); North Doane Lake Level II Aquatic Ecological Risk Assessment, RPAC – Portland Site, October 15, 2002, conducted by Rhone Poulenc.

S – sensitive

SOC-Species of Concern

Table 2-8. Species of special interest in the ISA

Common Name	Scientific Name	Federal Status	State Status
Aquatic plants			
Howell's bentgrass	*Agrostis howellii*	SOC	T
White-topped aster	*Aster curtus*	SOC	T
Wayside aster	*Aster vialis*	SOC	T
Peacock larkspur[a]	*Delphinium pavonaceum*	SOC	E
Willamette daisy[a]	*Erigeron decumbens*	E	E
Howellia[a]	*Howellia aquatilis*	T	-
Bradshaw's lomatium[a]	*Lomatium bradshawii*	E	E
Nelson's sidalcea[a]	*Sidalcea nelsoniana*	T	T
Hitchcock's blue-eyed grass[a]	*Sisyrinchium hitchcockii*	SOC	-
Invertebrates			
Columbia pebblesnail (spire snail)	*Fluminicola fuscus (Fluminicola columbiana)*	SOC	-
Fish			
Pacific lamprey	*Lampetra tridentata*	SOC	SV
River lamprey	*Lampetra ayresi*	SOC	-
Coastal cutthroat trout (Southwestern Washington/ Columbia River ESU)	*Oncorhynchus clarki clarki*	PT	SC
Chum salmon (Lower Columbia River ESU)	*Oncorhynchus keta*	T	SC
Steelhead (Lower Columbia River ESU)	*Oncorhynchus mykiss*	T	SU
Chinook salmon (Lower Columbia River ESU/Upper Willamette River ESU)	*Oncorhynchus tshawytscha*	T	SC
Bull Trout	*Salvelinus malma*	T	-
Birds			
Aleutian Canada goose (wintering population)	*Branta canadensis leucopareia*	T	E
Black tern[b]	*Chlidonias niger*	SOC	-
American peregrine falcon	*Falco peregrinus annatum*	Delisted	E
Bald eagle	*Haliaeetus leucocephalus*	T	T
Reptiles/amphibians			
Painted turtle	*Chrysemys picta belli*	-	SC
Copes giant salamander	*Dicamptodon copei*	-	S
Western toad	*Bufo boreas*	-	S
Tailed frog	*Ascaphus truei*	SOC	S
Northwestern pond turtle	*Clemmys marmorata marmorata*	SOC	SC
Northern red-legged frog	*Rana aurora aurora*	SOC	SU

Notes for Table 2-8:

E – endangered

PT - proposed threatened

S - sensitive

SC - sensitive, critical

SOC - species of concern

SU - sensitive, undetermined status

SV - sensitive, vulnerable

T – threatened

[a] The presence of these species has not been confirmed in the ISA, they have been identified as species present in the Willamette Valley.

[b] This species is also on ONHP's List 4, which contains taxa of conservation concern that require continued monitoring.

Table 3-1. Surface water surveys within the ISA

Survey	Date	Agency	Usability	QA Level
McCormick & Baxter RI Phase 3	1999	ODEQ	Acceptable	Category 1 and 2
Rhône-Poulenc St Helens Road Facility Q1, 95	1995	Woodward-Clyde Consultants	Acceptable	Category 2
ODEQ Ambient Water Quality Monitoring	1990-2001	ODEQ	Acceptable	Category 2

Table 3-2. Concentrations of chemicals detected in surface water samples collected from the ISA

Analyte	Number of Samples	Detection Frequency (%)	Minimum Concentration	Maximum Concentration
Metals (mg/L)				
Aluminum	91	100.0	19	700
Arsenic	13	7.7	0.0067	
Cadmium	12	8.3	0.0027	
Chromium	12	33.0	0.0024	0.013
Iron	91	98.0	50	570
Lead	8	12.5	0.2	
Manganese	91	100.0	3.3	149
Mercury	8	12.5	0.0014	
Zinc	12	8.3	0.57	
PAHs (µg/L)				
Acenaphthene	9	44.4	0.4	1.2

Analyte	Number of Samples	Detection Frequency (%)	Minimum Concentration	Maximum Concentration
Fluoranthene	9	44.4	0.2	0.4
Fluorene	9	44.4	0.3	0.7
Naphthalene	9	44.4	0.2	1.1
Phenanthrene	9	44.4	0.4	0.5
Pyrene	9	44.4	0.1	0.2
High Molecular Weight PAH	9	44.4	0.3	0.6
Low Molecular Weight PAH	9	55.5	0.3	2.4
Polycyclic Aromatic Hydrocarbons	9	55.5	0.3	2.5
Dioxins and furans (pg/L)				
1,2,3,4,6,7,8-Heptachlorodibenzofuran	4	25.0	110	
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	4	25.0	540	
2,3,7,8-Tetrachlorodibenzofuran	4	50.0	6.1	6.4
Heptachlorodibenzofuran	4	25.0	340	
Heptachlorodibenzo-p-dioxin	4	25.0	1100	
Hexachlorodibenzofuran	4	25.0	87	
Hexachlorodibenzo-p-dioxin	4	25.0	79	
Octachlorodibenzofuran	4	25.0	340	
Octachlorodibenzo-p-dioxin	4	50.0	67	6200
Tetrachlorodibenzofuran	4	50.0	6.1	90
Tetrachlorodibenzo-p-dioxin	4	25.0	31	
Other Organic compounds (µg/L)				
2,4-D	4	25.0	1	
Chlordane (alpha & gamma)	4	25.0	0.65	
Chlorobenzene	8	12.5	0.6	
gamma-Hexachlorocyclohexane	4	25.0	0.035	
Silvex	4	25.0	0.083	
Toluene	4	25.0	0.77	

Table 3-3. Sediment surveys within the ISA

Survey	Date	Agency	Usability*
Analyses of Bottom Materials from the Willamette River Portland Harbor	1977	ACOE-Portland District	Too old
Baseline Sediment Assessment Riedel	1997	Triangle Park, L.L.C.	Acceptable
Broadway Bridge Evaluation of Sediment Lead Levels	1988	ACOE-Portland District	Too old
Characterization of Stormwater Outfalls	1994	U.S. EPA, Region 10	Acceptable
Chevron Dredging Permit Application	2001	Chevron Products Company	Category 2
Columbia & Lower Wil Rivers Channel Deepening Reconnaissance Study	1990	ACOE-Portland District	Category 2
CRCD - Willamette River Channel Deepening	1997	ACOE-Portland District	Acceptable
Elf Atochem Willamette River 1999	1998-1999	ODEQ	Acceptable
Elutriation Study of Willamette River Bottom Material and Willamette Columbia River Water	1977	ACOE-Portland District	Too old
Focused ESA Riedel	1996	Triangle Park, L.L.C.	Category 2
Gasco PI Remedial Investigation	1996	Northwest Natural	Category 2
Gasco Source Control Evaluation	2001	ODEQ	Acceptable
G-P Linnton Site Preliminary Assessment	2000	Georgia-Pacific West, Inc.	Category 2
Lower Willamette Portland Harbor 1996	1996	ACOE-Portland District	Acceptable
Lower Willamette River March & April 1988	1988	ACOE-Portland District	Too old
Lower Willamette River Portland Harbor 1992	1992	ACOE-Portland District	Acceptable
Lower Willamette River Sept 1988	1988	ACOE-Portland District	Too old
Marine Finance Expanded Preliminary Assessment Data Report	2000	ODEQ	Category 2
McCall Oil Dock 12/1986	1986	ACOE-Portland District	Too old
McCall Oil Dock 9/1986	1986	ACOE-Portland District	Too old
McCormick & Baxter RI Phase 1	1990	ODEQ	Category 2
McCormick & Baxter RI Phase 2	1991-1992	ODEQ	Category 2
McCormick & Baxter RI Phase 3	1999	ODEQ	Acceptable
McCormick & Baxter RI Phase 4	2001	ODEQ	Acceptable
Organic Compounds in Willamette sediments	1982-1984	ACOE-Portland District	Too old
Port of Portland 1992 Terminal 1 Sediment Characterization Results	1991	Port of Portland	Category 2
Port of Portland Berth 311 Dredge Data	1990-1992	Port of Portland	Acceptable
Port of Portland T4 - Slip 1 & Berth 401 Sediment Characterization	1999	Port of Portland	Category 2
Port of Portland T4 RI	1998	Port of Portland	Acceptable
Port of Portland Terminal 4 Berth 416 1997 Sediment Characterization Study	1997	Port of Portland	Category 2
Portland Harbor Sediment Investigation	1997-1999	EPA/ODEQ	Acceptable
Portland Shipyard DD3 Post-Dredge Data	1994	Port of Portland	Acceptable

Survey	Date	Agency	Usability[a]
Portland Shipyard DD4 Post-Dredge Data	1992	Port of Portland	Acceptable
Portland Shipyard Env. Audit	1997-1998	Cascade General	Acceptable
Portland Shipyard Sed. Inv.	1998	Port of Portland	Acceptable
Quality of Bottom Materials & Elutriates in the Lower Willamette River Portland Or	1983	ACOE-Portland District	Too old
Rhône-Poulenc St Helens Road Facility Q1,95	1995	Woodward-Clyde Consultants	Category 2
Sed Char Local Sponsors of Columbia/Willamette Channel Deepening	1998	ACOE-Portland District	Acceptable
Sediment Study Marine Terminals 2 and 4	1998	Port of Portland	Acceptable
T4 Berth 408 Maintenance Dredging	1993	Port of Portland	Acceptable
Terminal 2 and Terminal 5 2001 Dredge Characterization Study	2001	Port of Portland	Category 2
TOSCO Sediment Sampling Results 1999	1999	ACOE-Portland District	Acceptable
Union Pacific Railroad Albina Yard Expanded Preliminary Assessment Data Report	2000	ODEQ	Category 2
US Moorings June 1994	1994	ACOE-Portland District	Acceptable
US Moorings May 1995	1995	ACOE-Portland District	Acceptable
US Moorings Preliminary Assessment Sampling	1994	ACOE-Portland District	Category 2
US Moorings Sediment Quality Evaluation	1989	ACOE-Portland District	Too old
USGS - Bonn	1992-1995	USGS	Category 2
Willamette Cove SA	1995	ODEQ	Acceptable
Willamette River 1998 Data	1998	Cascade General	Acceptable
Willamette River Burlington Northern RR Bridge Sediment Quality Evaluation	1989	ACOE-Portland District	Too old
Willamette River Sediment Quality Evaluation - April	1999	ACOE-Portland District	Acceptable
Willamette River Sediment Quality Evaluation - November	1999	ACOE-Portland District	Acceptable
Willamette River Toxic Pollutants Summary	1987-1992	ODEQ	Category 2
Willbridge Terminal Facility 1998	1998	ODEQ	Acceptable

[a] For description of categorization process see Section 4 and Table 4-1 in Programmatic Work Plan and Appendix F.

Table 3-4a. Category 1 concentrations of chemicals detected in 0-4 ft sediment samples collected from the ISA

Analyte	Number of Samples	Detection Frequency (%)	Minimum Concentration	Maximum Concentration
Inorganics (mg/kg)				
Aluminum	192	100	15,400	46,200
Ammonia	62	100	1.4	327
Antimony	322	34.8	0.02	24
Arsenic	432	60.9	0.7	140
Barium	203	100	58.9	330
Beryllium	216	88.9	0.3	4.8
Cadmium	389	91.3	0.05	6.6
Calcium	192	100	4,310	16,000
Chromium	424	100	9	165
Cobalt	192	100	10.1	24.6
Copper	432	100	11.3	2,200
Cyanide	27	77.8	0.2	5.4
Iron	203	100	25,800	64,500
Lead	441	95.9	2.28	1,160
Magnesium	192	100	3710	8,560
Manganese	203	100	261	1,000
Mercury	389	86.1	0.01	2.1
Nickel	405	100	12	594
Potassium	192	100	570	1,670
Selenium	227	73.6	0.33	20
Silver	389	84.6	0.06	4.8
Sodium	192	100	563	57,800
Thallium	216	64.8	0.5	48
Tin	11	100	0.891	5.37
Titanium	98	100	1120	3,490
Vanadium	192	100	66.6	152
Zinc	416	100	17.3	2,700
PAHs (µg/L)				
1-Methylnaphthalene	8	75.0	0.9	33.6
2-Methylnaphthalene	363	43.5	0.9	44,000
Acenaphthene	545	58.5	1	580,000
Acenaphthylene	545	28.3	0.7	20,000
Anthracene	545	64.6	0.8	250,000
Benz(a)anthracene	545	88.4	2	120,000
Benzo(a)pyrene	545	88.3	3	130,000
Benzo(b)fluoranthene	534	89.9	2	83,000

Analyte	Number of Samples	Detection Frequency (%)	Minimum Concentration	Maximum Concentration
Benzo(b+k)fluoranthene	545	90.3	3	157,000
Benzo(g,h,i)perylene	545	81.7	0.6	90,000
Benzo(k)fluoranthene	534	86.3	3	92,000
Chrysene	545	92.3	3	160,000
Dibenz(a,h)anthracene	545	49.2	0.7	25,000
Dibenzofuran	421	42.3	2	20,000
Fluoranthene	583	94.7	0.8	480,000
Fluorene	545	58.9	0.5	260000
High Molecular Weight PAH	545	95.0	2	1,893,000
Indeno(1,2,3-cd)pyrene	545	82.4	0.7	110,000
Low Molecular Weight PAH	545	88.1	2.5	4,299,000
Naphthalene	573	52.5	0.5	1,900,000
Phenanthrene	545	88.3	1	1,300,000
Polycyclic Aromatic Hydrocarbons	546	95.1	3	6,192,000
Pyrene	545	94.7	0.8	670,000
Phenols (µg/kg)				
2,4,5-Trichlorophenol	316	0.316	40	5,000
2,4,6-Trichlorophenol	319	0.313	5	5,000
2,4-Dichlorophenol	316	0.316	50	5,000
2,4-Dimethylphenol	396	0.758	6	6,000
2,4-Dinitrophenol	281	0.356	18	35,000
2-Chlorophenol	316	0.633	19	5,000
2-Methylphenol	396	0.505	6	6,000
4-Methylphenol	362	46.7	19	20,000
Pentachlorophenol	458	1.97	16	60,000
Phenol	396	3.79	19	20,000
Tetrachlorophenol	3	66.7	5	13
Phthalates (µg/kg)				
Bis(2-ethylhexyl) phthalate	407	66.1	15	38,000
Butylbenzyl phthalate	407	29.7	10	20,000
Dibutyl phthalate	406	24.6	10	20,000
Diethyl phthalate	407	1.23	10	20,000
Dimethyl phthalate	407	5.90	10	20,000
Di-n-octyl phthalate	407	16.0	10	20,000
Volatiles (µg/kg)				
1,2,4-Trichlorobenzene	303	1.98	10	5,000
1,2-Dichlorobenzene	390	0.769	1	5,000
1,3-Dichlorobenzene	390	0.769	1	5,000
1,4-Dichlorobenzene	390	0.769	1	5,000
2,4-Dinitrotoluene	251	0.398	20	5,000

Analyte	Number of Samples	Detection Frequency (%)	Minimum Concentration	Maximum Concentration
Acetone	25	28	50	2,000
Benzene	146	7.53	0.01	120
Chlorobenzene	54	14.8	4	34,000
Ethylbenzene	169	14.8	0.009	2,000
m,p-Xylene	103	16.5	0.02	50
Methylethyl ketone	28	3.57	20	2,000
Nitrobenzene	251	0.398	10	5,000
o-Xylene	103	19.4	0.008	50
Tetrachloroethene	127	0.787	5	250
Toluene	146	4.79	0.01	600
Xylene	66	24.2	5	3,200
Pesticides and PCBs (µg/kg)				
2,4-D	7	57.1	2.6	93
2,4-DB	7	57.1	3.9	130
4,4'-DDD	185	57.8	0.4	29,000
4,4'-DDE	184	45.1	0.7	15,000
4,4'-DDT	185	56.8	0.2	81,000
Total of 3 isomers: pp-DDT,-DDD,-DDE	185	68.6	0.8	84,909
Aldrin	184	4.35	0.2	3,800
alpha-Hexachlorocyclohexane	149	4.03	0.4	3,800
Aroclor 1242	215	1.86	5	75,000
Aroclor 1254	215	38.6	10	75,000
Aroclor 1260	215	32.6	3	75,000
PCBs	216	44.0	3	150,000
beta-Endosulfan	175	0.571	0.8	7,500
Dieldrin	184	3.26	0.003	7,500
Endosulfan sulfate	175	1.71	0.7	7,500
Endrin	175	1.14	0.8	7,500
Endrin aldehyde	175	2.29	0.5	7,500
gamma-Chlordane	131	3.05	0.4	3,800
gamma-Hexachlorocyclohexane	184	3.80	0.2	3,800
Heptachlor	184	0.543	0.4	3,800
Hexachlorobenzene	320	2.19	10	20,000
Hexachlorobutadiene	332	2.41	10	34,000
Hexachloroethane	259	4.25	19	20,000
Methoxychlor	175	0.571	1	38,000
Methylene chloride	54	7.41	5	1,000
Butyltins (µg/kg)				
Butyltin ion	119	26.1	0.4	740
Dibutyltin ion	119	36.1	1	2,020

Analyte	Number of Samples	Detection Frequency (%)	Minimum Concentration	Maximum Concentration
Tributyltin ion	141	89.4	1	47,000
Tetrabutyltin	108	13.9	1	270
Other Organic Compounds (µg/kg)				
Benzoic acid	313	6.39	100	100,000
Benzyl alcohol	320	2.19	5.5	6,000
Carbazole	225	46.7	10	10,000
Isophorone	251	0.398	10	5,000
Dioxins and furans (ng/kg)				
1,2,3,4,6,7,8-Heptachlorodibenzofuran	26	96.2	8.7	5,400
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	26	100	29	6,300
1,2,3,4,7,8,9-Heptachlorodibenzofuran	26	84.6	3.1	2,200
1,2,3,4,7,8-Hexachlorodibenzofuran	25	92.0	4.9	22,000
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	26	69.2	1.2	89
1,2,3,6,7,8-Hexachlorodibenzofuran	26	46.2	2.9	5,600
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	25	92.0	3.1	460
1,2,3,7,8,9-Hexachlorodibenzofuran	26	73.1	2.5	2,700
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	26	76.9	1.4	180
1,2,3,7,8-Pentachlorodibenzofuran	26	38.5	1.6	18,000
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	26	53.8	1.3	48
2,3,4,6,7,8-Hexachlorodibenzofuran	26	80.8	3.6	1,300
2,3,4,7,8-Pentachlorodibenzofuran	26	69.2	1.9	11,000
2,3,7,8-Tetrachlorodibenzofuran	25	60.0	1	15,000
2,3,7,8-Tetrachlorodibenzo-p-dioxin	26	53.8	0.51	6.9
Dioxin/furan TCDD toxicity equivalent	2	100	16.09	38.96
Heptachlorodibenzofuran	12	100	50	1,400
Heptachlorodibenzo-p-dioxin	12	100	140	11,000
Hexachlorodibenzofuran	13	100	16	1,800
Hexachlorodibenzo-p-dioxin	12	91.7	6.4	2,000
Octachlorodibenzofuran	26	100	55	4,900
Octachlorodibenzo-p-dioxin	26	100	180	39,000
Pentachlorodibenzofuran	13	92.3	4.9	150
Pentachlorodibenzo-p-dioxin	13	61.5	1.6	210
Tetrachlorodibenzofuran	12	66.7	1	24
Tetrachlorodibenzo-p-dioxin	12	58.3	1	22

Table 3-4b. Category 1and 2 concentrations of chemicals detected in 0-4ft sediment samples collected from the ISA

Analyte	Number of Samples	Detection Frequency (%)	Minimum Concentration	Maximum Concentration
Inorganics (mg/kg)				
Aluminum	215	100	14,000	46,200
Ammonia	65	100	1.4	327
Antimony	384	36.7	0.02	24
Arsenic	622	72.8	0.7	640
Barium	226	100	58.9	330
Beryllium	255	87.8	0.3	4.8
Cadmium	477	85.7	0.05	8
Calcium	202	100	4,310	16,000
Chromium	569	100	9	165
Chromium hexavalent	64	78.1	0.07	0.99
Cobalt	215	100	10.1	27
Copper	569	100	1	2,200
Cyanide	27	77.8	0.2	5.4
Iron	226	100	25,800	64,500
Lead	542	95.9	2.28	1,160
Magnesium	215	100	3,500	8,560
Manganese	226	100	261	1,000
Mercury	460	87.6	0.01	2.1
Nickel	488	100	11	594
Potassium	202	100	320	1,670
Selenium	259	65.3	0.31	20
Silver	465	80.4	0.05	4.8
Sodium	202	100	330	57,800
Thallium	235	67.2	0.06	48
Tin	24	45.8	0.891	5.37
Titanium	111	100	608	3,490
Vanadium	215	100	66.6	160
Zinc	556	100	17.3	7,000
PAHs (µg/kg)				
1-Methylnaphthalene	8	75.0	0.9	33.6
2-Methylnaphthalene	420	45.2	0.9	1,300,000
Acenaphthene	692	63.6	1	1,600,000
Acenaphthylene	692	35.5	0.7	190,000
Anthracene	692	69.1	0.8	1,100,000
Benz(a)anthracene	692	88.4	2	840,000
Benzo(a)pyrene	690	87.8	3	1,000,000

Analyte	Number of Samples	Detection Frequency (%)	Minimum Concentration	Maximum Concentration
Benzo(b)fluoranthene	597	89.3	2	930,000
Benzo(b+k)fluoranthene	692	89.9	3	1,280,000
Benzo(e)pyrene	65	81.5	13	50,000
Benzo(g,h,i)perylene	686	78.7	0.6	820,000
Benzo(k)fluoranthene	593	85.5	3	350,000
Chrysene	692	91.9	3	1,300,000
Dibenz(a,h)anthracene	692	48.7	0.7	98,000
Dibenzofuran	478	44.1	2	620,000
Fluoranthene	730	94.4	0.8	3,000,000
Fluorene	692	63.2	0.5	1,100,000
High Molecular Weight PAH	692	94.8	2	12,268,000
Indeno(1,2,3-cd)pyrene	692	78.6	0.7	530,000
Low Molecular Weight PAH	692	89.0	2.5	14,140,000
Naphthalene	720	58.1	0.5	5,100,000
Phenanthrene	692	89.2	1	5,400,000
Polycyclic Aromatic Hydrocarbons	693	94.8	3	26,408,000
Pyrene	692	94.4	0.8	3,400,000
Phenols (µg/kg)				
2,3,4,6-Tetrachlorophenol	74	1.35	14	11,000
2,4,5-Trichlorophenol	418	0.478	14	29,000
2,4,6-Trichlorophenol	421	0.238	1.4	11,000
2,4-Dichlorophenol	409	0.244	23	45,000
2,4-Dimethylphenol	459	0.871	1.4	12,000
2,4-Dinitrophenol	309	0.324	18	45,000
2-Chlorophenol	359	0.557	14	22,000
2-Methylphenol	455	0.440	1.4	90,000
4-Chloro-3-methylphenol	359	0.279	14	45,000
4-Methylphenol	412	44.7	16	90,000
4-Nitrophenol	341	0.293	45	45,000
Pentachlorophenol	581	4.30	14	60,000
Phenol	460	7.39	6	45,000
Tetrachlorophenol	3	66.7	5	13
Phthalates (µg/kg)				
Bis(2-ethylhexyl) phthalate	464	66.6	15	88,000
Butylbenzyl phthalate	464	27.2	3	20,000
Dibutyl phthalate	463	22.2	10	20,000
Diethyl phthalate	464	2.59	2	20,000
Dimethyl phthalate	464	6.03	0.5	20,000
Di-n-octyl phthalate	464	14.2	10	20,000

Analyte	Number of Samples	Detection Frequency (%)	Minimum Concentration	Maximum Concentration
Volatiles (µg/kg)				
1,2,4-Trichlorobenzene	333	1.80	5	22,000
1,2-Dichlorobenzene	422	1.18	1	9,000
1,3-Dichlorobenzene	422	0.711	1	9,000
1,4-Dichlorobenzene	422	1.18	1	9,000
2,4-Dinitrotoluene	281	0.356	20	45,000
2,6-Dinitrotoluene	281	0.356	10	22,000
Acetone	31	22.58	50	2,000
Benzene	170	8.24	0.01	22,000
Chlorobenzene	70	15.7	1	34,000
Ethylbenzene	193	13.5	0.009	10,000
m,p-Xylene	103	16.5	0.02	50
Methylethyl ketone	34	2.94	20	2,000
Nitrobenzene	281	0.356	10	22,000
o-Xylene	103	19.4	0.008	50
Tetrachloroethene	138	0.725	1	250
Toluene	170	4.71	0.01	4,200
Xylene	90	18.9	2	18,000
PCBs and Pesticides (µg/kg)				
2,4-D	12	33.3	2.6	1,200
2,4-DB	12	33.3	3.9	5,000
4,4'-DDD	232	59.9	0.4	29,000
4,4'-DDE	231	49.8	0.54	15,000
4,4'-DDT	232	57.8	0.2	81,000
Total of 3 isomers: pp-DDT,-DDD,-DDE	232	69.8	0.8	84,909
Aldrin	231	3.46	0.2	3,800
alpha-Chlordane	155	1.29	0.4	3,800
alpha-Hexachlorocyclohexane	196	3.06	0.4	3,800
beta-Endosulfan	222	0.450	0.4	7,500
beta-Hexachlorocyclohexane	222	0.450	0.4	3,800
Aroclor 1242	263	3.42	5	75,000
Aroclor 1254	263	31.6	10	75,000
Aroclor 1260	263	32.3	3	75,000
PCBs	273	40.7	3	980,000
Dieldrin	231	2.60	0.003	7,500
Endosulfan sulfate	222	1.80	0.4	7,500
Endrin	222	0.901	0.4	7,500
Endrin aldehyde	222	2.25	0.5	7,500
gamma-Chlordane	152	5.26	0.4	3,800
gamma-Hexachlorocyclohexane	231	3.03	0.2	3,800

Analyte	Number of Samples	Detection Frequency (%)	Minimum Concentration	Maximum Concentration
Heptachlor	231	0.43	0.4	3,800
Hexachlorobenzene	404	1.73	10	20,000
Hexachlorobutadiene	423	1.89	10	34,000
Hexachloroethane	291	3.78	19	45,000
Methoxychlor	222	0.450	0.8	38,000
Methylene chloride	65	6.15	5	1,000
Butyltins (µg/kg)				
Butyltin ion	150	36.00	0.4	740
Dibutyltin ion	150	46.67	0.8	2,020
Tributyltin ion	172	89.53	0.7	47,000
Tetrabutyltin	117	15.38	0.5	270
Other Organic Compounds (µg/kg)				
Benzoic acid	345	8.70	50	220,000
Benzyl alcohol	352	1.99	5.5	45,000
Bis(2-chloroethoxy)methane	281	1.07	10	5,000
Carbazole	303	46.2	1	44,000
Dibenzothiophene	13	69.2	1.7	340
Isophorone	281	0.356	10	5,000
N-Nitrosodiphenylamine	352	0.284	10	60,000
N-Nitrosodipropylamine	281	0.356	3	45,000
Dioxins and furans (ng/kg)				
1,2,3,4,6,7,8-Heptachlorodibenzofuran	44	93.2	6.3	7,600
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	45	100	26	77,000
1,2,3,4,7,8,9-Heptachlorodibenzofuran	45	75.6	0.88	2,200
1,2,3,4,7,8-Hexachlorodibenzofuran	44	88.6	1.2	22,000
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	45	64.4	0.4	1,100
1,2,3,6,7,8-Hexachlorodibenzofuran	45	51.1	1.9	5,600
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	44	86.4	1.3	4,100
1,2,3,7,8,9-Hexachlorodibenzofuran	45	57.8	0.18	2,700
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	45	75.6	1	3,200
1,2,3,7,8-Pentachlorodibenzofuran	45	51.1	0.51	18,000
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	45	48.9	0.44	590
2,3,4,6,7,8-Hexachlorodibenzofuran	45	71.1	0.41	1,300
2,3,4,7,8-Pentachlorodibenzofuran	45	62.2	0.65	11,000
2,3,7,8-Tetrachlorodibenzofuran	44	77.3	1	15,000
2,3,7,8-Tetrachlorodibenzo-p-dioxin	45	48.9	0.24	100
Dioxin/furan TCDD toxicity equivalent	2	100	16.09	38.96
Heptachlorodibenzofuran	22	100	12	1,400
Heptachlorodibenzo-p-dioxin	22	100	83	11,000
Hexachlorodibenzofuran	23	100	5.2	1,800

Analyte	Number of Samples	Detection Frequency (%)	Minimum Concentration	Maximum Concentration
Hexachlorodibenzo-p-dioxin	22	95.5	5	2,000
Octachlorodibenzofuran	45	100	15	32,000
Octachlorodibenzo-p-dioxin	45	100	180	220,000
Pentachlorodibenzofuran	23	87.0	0.94	680
Pentachlorodibenzo-p-dioxin	23	47.8	0.85	210
Tetrachlorodibenzofuran	22	81.8	1	270
Tetrachlorodibenzo-p-dioxin	22	68.2	0.93	66

Table 3-4c. Category 1 concentrations of chemicals detected in 0-1 ft sediment samples collected from the ISA

Analyte	Number of Samples	Detection Frequency (%)	Minimum Concentration	Maximum Concentration
Inorganics (mg/kg)				
Antimony	251	35.9	0.02	24
Aluminum	154	100	15,400	46,200
Ammonia	42	100	12.2	326
Arsenic	329	58.4	0.7	98
Barium	165	100	58.9	322
Beryllium	178	86.5	0.3	4.8
Cadmium	303	91.1	0.05	6.6
Calcium	154	100	4430	14,400
Chromium	327	100	9.3	165
Cobalt	154	100	10.1	23.9
Copper	329	100	11.3	2000
Cyanide	18	77.8	0.2	5.4
Iron	164	100	25,800	6,4500
Lead	330	95.8	2.6	1,160
Magnesium	154	100	3710	8,560
Manganese	164	100	261	1,000
Mercury	303	84.2	0.01	1.5
Nickel	310	100	12	594
Potassium	154	100	570	1,670
Selenium	189	68.8	0.33	20
Silver	303	84.2	0.06	4.8
Sodium	154	100	563	21,500
Thallium	178	69.1	0.5	48
Tin	10	100	0.891	5.37
Titanium	73	100	1120	3,450
Vanadium	154	100	66.6	152

Analyte	Number of Samples	Detection Frequency (%)	Minimum Concentration	Maximum Concentration
Zinc	321	100	17.3	2,700
PAHs (µg/kg)				
1-Methylnaphthalene	2	50.0	0.9	33.6
2-Methylnaphthalene	278	34.2	0.9	44,000
Acenaphthene	398	56.5	1	180,000
Acenaphthylene	398	25.6	0.7	20,000
Anthracene	398	63.6	0.8	160,000
Benz(a)anthracene	398	88.2	2	100,000
Benzo(a)pyrene	398	88.4	3	99,000
Benzo(b)fluoranthene	390	90.0	2	83,000
Benzo(b+k)fluoranthene	398	90.5	3	156,000
Benzo(g,h,i)perylene	398	80.7	0.6	76,000
Benzo(k)fluoranthene	390	85.9	3	76000
Chrysene	398	92.5	3	140,000
Dibenz(a,h)anthracene	398	49.0	0.7	25,000
Dibenzofuran	318	39.9	2	20,000
Fluoranthene	433	95.6	0.8	320,000
Fluorene	398	58.3	0.5	110,000
High Molecular Weight PAH	398	95.7	2	1,057,400
Indeno(1,2,3-cd)pyrene	398	82.2	0.7	110,000
Low Molecular Weight PAH	398	87.7	2.5	791,800
Naphthalene	419	51.3	0.5	180,000
Phenanthrene	398	87.9	1	400,000
Polycyclic Aromatic Hydrocarbons	399	95.5	4.5	1,829,200
Pyrene	398	95.2	0.8	270,000
Phenols (µg/kg)				
2,4-Dimethylphenol	304	0.987	6	6,000
2-Chlorophenol	253	0.395	19	5,000
2-Methylphenol	304	0.658	6	6,000
4-Methylphenol	283	47.0	19	20,000
Pentachlorophenol	338	2.66	16	60,000
Phenol	304	2.63	19	20,000
Tetrachlorophenol	3	66.7	5	13
Phthalates (µg/kg)				
Bis(2-ethylhexyl) phthalate	314	67.2	20	38,000
Butylbenzyl phthalate	314	30.6	10	20,000
Dibutyl phthalate	313	26.2	10	20,000
Diethyl phthalate	314	1.27	10	20,000
Dimethyl phthalate	314	6.37	10	20,000
Di-n-octyl phthalate	314	19.4	10	20,000

Analyte	Number of Samples	Detection Frequency (%)	Minimum Concentration	Maximum Concentration
Volatiles (µg/kg)				
1,2,4-Trichlorobenzene	236	1.27	10	5,000
1,2-Dichlorobenzene	299	1.00	1	5,000
1,3-Dichlorobenzene	299	0.33	1	5,000
1,4-Dichlorobenzene	299	1.00	1	5,000
2,4-Dinitrotoluene	203	0.493	20	5,000
Acetone	25	28.0	50	2,000
Benzene	112	7.14	0.01	120
Chlorobenzene	47	14.9	4	34,000
Ethylbenzene	125	16.0	0.009	2,000
Methylethyl ketone	28	3.57	20	2,000
m,p-Xylene	69	17.4	0.02	50
Nitrobenzene	203	0.493	10	5,000
o-Xylene	69	18.8	0.008	50
Tetrachloroethene	92	1.09	5	250
Toluene	112	3.57	0.01	600
Xylene	56	26.8	5	3,200
PCBs and Pesticides (µg/kg)				
2,4-D	7	57.1	2.6	93
2,4-DB	7	57.1	3.9	130
4,4'-DDD	136	52.9	0.4	11,000
4,4'-DDE	135	45.9	0.7	1,480
4,4'-DDT	136	58.1	0.2	81,000
Total of 3 isomers: pp-DDT,-DDD,-DDE	136	66.2	0.8	84,909
Aldrin	135	3.70	0.2	200
Aroclor 1242	162	1.23	5	2,000
Aroclor 1254	162	29.0	10	2,000
Aroclor 1260	162	26.5	3	2,500
PCBs	163	35.0	3	4,000
Dieldrin	135	3.70	0.4	235
Endosulfan sulfate	127	2.36	0.7	240
Endrin	127	0.787	0.8	200
Endrin aldehyde	127	3.15	0.5	215
gamma-Chlordane	95	4.21	0.4	99
gamma-Hexachlorocyclohexane	135	2.22	0.2	540
Heptachlor	135	0.741	0.4	200
Hexachlorobenzene	246	1.22	10	20,000
Hexachlorobutadiene	256	1.56	10	20,000
Hexachloroethane	205	2.44	19	5,000
Methoxychlor	127	0.787	1	990

Analyte	Number of Samples	Detection Frequency (%)	Minimum Concentration	Maximum Concentration
Methylene chloride	47	8.51	5	1,000
Butyltins (µg/kg)				
Butyltin ion	83	19.3	0.4	740
Dibutyltin ion	83	30.1	1	2,020
Tetrabutyltin	72	8.33	1	150
Tributyltin ion	99	91.9	2.1	47,000
Other Organic Compounds (µg/kg)				
Benzoic acid	242	0.826	100	100,000
Benzyl alcohol	246	1.63	6	6,000
Carbazole	178	44.4	10	10,000
Chrysene	398	92.5	3	140,000
Dioxins and furans (ng/kg)		**0**		
1,2,3,7,8-Pentachlorodibenzofuran	23	34.8	1.6	210
1,2,3,6,7,8-Hexachlorodibenzofuran	23	47.8	2.9	61
2,3,7,8-Tetrachlorodibenzofuran	23	56.5	1	49
2,3,7,8-Tetrachlorodibenzo-p-dioxin	23	56.5	0.51	4
Tetrachlorodibenzo-p-dioxin	12	58.3	1	22
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	23	60.9	1.3	48
2,3,4,7,8-Pentachlorodibenzofuran	23	65.2	1.9	42
Pentachlorodibenzo-p-dioxin	12	66.7	4.8	210
Tetrachlorodibenzofuran	12	66.7	1	24
1,2,3,7,8,9-Hexachlorodibenzofuran	23	69.6	2.5	31
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	23	78.3	2.2	89
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	23	78.3	4.7	180
2,3,4,6,7,8-Hexachlorodibenzofuran	23	78.3	3.6	38
1,2,3,4,7,8,9-Heptachlorodibenzofuran	23	82.6	3.1	33
1,2,3,4,7,8-Hexachlorodibenzofuran	23	91.3	4.9	150
Hexachlorodibenzo-p-dioxin	12	91.7	6.4	2,000
Pentachlorodibenzofuran	12	91.7	4.9	110
1,2,3,4,6,7,8-Heptachlorodibenzofuran	23	95.7	8.7	490
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	23	95.7	4.9	460
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	23	100	71	6,300
Heptachlorodibenzofuran	12	100	50	1,400
Heptachlorodibenzo-p-dioxin	12	100	140	11,000
Hexachlorodibenzofuran	12	100	16	1,800
Octachlorodibenzofuran	23	100	55	740
Octachlorodibenzo-p-dioxin	23	100	590	39,000

Table 3-4d. Category 1and 2 concentrations of chemicals detected in 0-1 ft sediment samples collected from the ISA

Analyte	Number of Samples	Detection Frequency (%)	Minimum Concentration	Maximum Concentration
Inorganics (mg/kg)				
Aluminum	177	100	14,000	46,200
Ammonia	62	100	1.4	327
Antimony	299	37.8	0.02	24
Arsenic	499	72.5	0.7	640
Barium	188	100	58.9	322
Beryllium	208	88.0	0.3	4.8
Cadmium	375	85.9	0.05	8
Calcium	192	100	4,310	16,000
Chromium	454	100	9.3	165
Chromium hexavalent	62	77.4	0.07	0.99
Cobalt	177	100	10.1	27
Copper	452	100	1	2,000
Cyanide	18	77.8	0.2	5.4
Iron	187	100	25,800	64,500
Lead	413	96.4	2.6	1,160
Magnesium	192	100	3,710	8,560
Manganese	187	100	261	1,000
Mercury	364	86.0	0.01	1.5
Nickel	377	100	11	594
Potassium	192	100	570	1,670
Selenium	218	60.6	0.31	20
Silver	369	79.7	0.05	4.8
Sodium	192	100	563	57,800
Thallium	194	71.1	0.07	48
Tin	23	43.5	0.891	5.37
Titanium	98	100	1,120	3,490
Vanadium	177	100	66.6	160
Zinc	447	100	17.3	7,000
PAHs (µg/kg)				
1-Methylnaphthalene	2	50.00	0.9	33.6
2-Methylnaphthalene	328	37.20	0.9	1,300,000
Acenaphthene	530	63.02	1	1,600,000
Acenaphthylene	530	35.09	0.7	190,000
Anthracene	530	69.25	0.8	1,100,000
Benz(a)anthracene	530	88.49	2	840,000
Benzo(a)pyrene	528	88.07	3	1,000,000
Benzo(b)fluoranthene	443	89.39	2	930,000
Benzo(b+k)fluoranthene	530	90.19	3	1,280,000

Analyte	Number of Samples	Detection Frequency (%)	Minimum Concentration	Maximum Concentration
Benzo(e)pyrene	60	81.67	13	50,000
Benzo(g,h,i)perylene	524	77.48	0.6	820,000
Benzo(k)fluoranthene	440	85.00	3	350,000
Bis(2-chloroethoxy)methane	228	1.32	10	5,000
Chrysene	530	92.26	3	1,300,000
Dibenz(a,h)anthracene	530	48.87	0.7	98,000
Dibenzofuran	368	42.12	2	620,000
Fluoranthene	565	95.22	0.8	3,000,000
Fluorene	530	63.58	0.5	1,100,000
High Molecular Weight PAH	530	95.47	2	12,268,000
Indeno(1,2,3-cd)pyrene	530	77.92	0.7	530,000
Low Molecular Weight PAH	530	89.06	2.5	14,140,000
Phenanthrene	530	89.25	1	5,400,000
Polycyclic Aromatic Hydrocarbons	531	95.3	4.5	26,408,000
Pyrene	530	94.9	0.8	3,400,000
Phenols (µg/kg)				
2,3,4,6-Tetrachlorophenol	69	1.45	14	11,000
2,4,5-Trichlorophenol	345	0.290	14	29,000
2,4-Dimethylphenol	359	1.11	1.4	12,000
2-Chlorophenol	291	0.344	14	22,000
2-Methylphenol	355	0.563	1.4	90,000
4-Chloro-3-methylphenol	291	0.344	14	45,000
4-Methylphenol	328	43.9	16	90,000
Pentachlorophenol	448	5.36	14	60,000
Phenol	360	6.67	6	45000
Tetrachlorophenol	3	66.7	5	13
Phthalates (µg/kg)				
Bis(2-ethylhexyl) phthalate	364	68.41	15	88,000
Butylbenzyl phthalate	364	27.47	3	20,000
Dibutyl phthalate	363	22.87	10	20,000
Diethyl phthalate	364	2.47	2	20,000
Dimethyl phthalate	364	6.32	0.6	20,000
Di-n-octyl phthalate	364	17.03	10	20,000
Volatiles (µg/kg)				
1,2,4-Trichlorobenzene	261	1.15	10	22,000
1,2-Dichlorobenzene	324	1.54	1	9,000
1,3-Dichlorobenzene	324	0.309	1	9,000
1,4-Dichlorobenzene	324	1.54	1	9,000
2,4-Dinitrotoluene	228	0.439	20	45,000
2,6-Dinitrotoluene	228	0.439	10	22,000
Acetone	29	24.1	50	2,000
Benzene	132	8.33	0.01	22,000
Chlorobenzene	61	16.4	1	34,000

Analyte	Number of Samples	Detection Frequency (%)	Minimum Concentration	Maximum Concentration
Ethylbenzene	145	14.5	0.009	10,000
m,p-Xylene	69	17.4	0.02	50
Methylethyl ketone	32	3.13	20	2,000
Nitrobenzene	228	0.439	10	22,000
o-Xylene	69	18.8	0.008	50
Tetrachloroethene	101	0.990	1	250
Toluene	132	3.79	0.01	4,200
Xylene	76	21.1	2	18,000
PCBs and Pesticides (µg/kg)				
2,4-D	12	33.3	2.6	1,200
2,4-DB	12	33.3	3.9	5,000
4,4'-DDD	179	57.0	0.4	11,000
4,4'-DDE	178	51.7	0.54	1,480
4,4'-DDT	179	59.8	0.2	81,000
Total of 3 isomers: pp-DDT,-DDD,-DDE	179	68.7	0.8	84,909
Aldrin	178	2.81	0.2	200
alpha-Chlordane	114	1.75	0.4	110
Aroclor 1242	197	3.55	5	2,000
Aroclor 1254	197	23.9	10	2,000
Aroclor 1260	197	27.9	3	2,500
PCBs	207	33.8	3	980,000
beta-Hexachlorocyclohexane	170	0.588	0.4	600
Dieldrin	178	2.8	0.4	235
Endosulfan sulfate	170	2.4	0.4	500
Endrin	170	0.588	0.4	200
Endrin aldehyde	170	2.94	0.5	215
gamma-Chlordane	114	7.02	0.4	99
gamma-Hexachlorocyclohexane	178	1.69	0.2	540
Heptachlor	178	0.562	0.4	200
Hexachlorobenzene	318	0.943	10	20,000
Hexachlorobutadiene	335	1.19	10	22,000
Hexachloroethane	230	2.17	19	45,000
Methoxychlor	170	0.588	0.8	1,000
Methylene chloride	56	7.14	5	1,000
Naphthalene	551	58.3	0.5	5,100,000
Butyltins (µg/kg)				
Butyltin ion	105	35.2	0.4	740
Dibutyltin ion	105	44.8	0.8	2020
Tributyltin ion	121	93.4	0.7	47000
Tetrabutyltin	78	11.5	0.5	150
Other organic compounds (µg/kg)				
Benzoic acid	267	3.37	50	220,000
Benzyl alcohol	271	1.48	6	45,000

Analyte	Number of Samples	Detection Frequency (%)	Minimum Concentration	Maximum Concentration
Carbazole	248	43.55	9	44,000
Dibenzothiophene	13	69.23	1.7	340
N-Nitrosodiphenylamine	271	0.37	10	60,000
N-Nitrosodipropylamine	228	0.44	3	45,000
Dioxins and furans (ng/kg)				
1,2,3,4,6,7,8-Heptachlorodibenzofuran	36	91.7	6.3	7,600
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	36	100	26	77,000
1,2,3,4,7,8,9-Heptachlorodibenzofuran	36	75.0	0.88	770
1,2,3,4,7,8-Hexachlorodibenzofuran	36	88.9	1.2	1,300
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	36	66.7	0.4	1,100
1,2,3,6,7,8-Hexachlorodibenzofuran	36	50.0	1.9	350
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	36	88.9	1.3	4,100
1,2,3,7,8,9-Hexachlorodibenzofuran	36	55.6	0.18	530
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	36	75.0	1	3,200
1,2,3,7,8-Pentachlorodibenzofuran	36	47.2	0.94	210
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	36	50.0	0.44	590
2,3,4,6,7,8-Hexachlorodibenzofuran	36	72.2	0.41	270
2,3,4,7,8-Pentachlorodibenzofuran	36	58.3	0.65	290
2,3,7,8-Tetrachlorodibenzofuran	36	72.2	1	90
2,3,7,8-Tetrachlorodibenzo-p-dioxin	36	50.0	0.24	100
Heptachlorodibenzofuran	18	100	12	1,400
Heptachlorodibenzo-p-dioxin	18	100	83	11,000
Hexachlorodibenzofuran	18	100	5.2	1,800
Hexachlorodibenzo-p-dioxin	18	94.4	5	2,000
Octachlorodibenzofuran	36	100	15	32,000
Octachlorodibenzo-p-dioxin	36	100	250	220,000
Pentachlorodibenzofuran	18	88.9	0.94	180
Pentachlorodibenzo-p-dioxin	18	44.4	0.85	210
Tetrachlorodibenzofuran	18	77.8	1	97
Tetrachlorodibenzo-p-dioxin	18	66.7	0.93	66

Table 3-5. Fish tissue surveys conducted in the ISA

Station	Title	Reference	Samples Collected
BI-1	McCormick & Baxter Creosoting Company Remedial Investigation Report	PTI 1992	3 largescale sucker (muscle tissue) at each station; 1 crayfish (whole body w/o shell) at each station
BI-2			
BI-3			
BI-4			
BI-5			
BI-6			
F02	The Oregonian's River of Risk Series	Oregonian 2000	A total of 5 black crappie, 4 smallmouth bass, and 6 common carp whole body samples
F03			
F04			
F05			
F06			
F07			
F08			
F09			
F10			
F11			
F12			
F13			
F14			
F15			
F16			
402000	DEQ Water Quality Program - Mercury (Gene Foster per Avocet)	ODEQ 2000	5 common carp, 1 largemouth bass, 1 northern pikeminnow, 1 largescale sucker, and 1 smallmouth bass (all fillets)
EPA18	EPA national study of chemical residues in fish (1992)	EPA 1992	9 common carp fillets and 9 northern pikeminnow fillets
EPA35			
2	Dioxins and Furans in Bed Sediment and Fish Tissue of the Willamette Basin, Oregon (1992-95)	Bonn 1998	1 common carp (whole body)

Table 3-6. Concentrations of chemicals detected in fish tissue samples collected from within the ISA

Area	Station	Species	Analysis	Analyte	Detected Concentration		Unit	Organ	# Composited Samples
					Min	Max			
Harborton Forest and Wetlands	F02	black crappie	pesticides, PCBs [a], DDTs, mercury	4,4'-DDD	10.71	na [c]	ppb	whole body	1
				4,4'-DDE	34.2	na	ppb		
				4,4'-DDT	9.02	na	ppb		
				mercury	0.18	na	ppm		
				PCBs	11.3	na	ppb		
				alpha-chlordane	0.74	na	ppb		
				dieldrin	1.28	na	ppb		
				gamma-chlordane	0.37	na	ppb		
				gamma-hexachlorocyclohexane	0.1	na	ppb		
Terminal 4	F03	black crappie	pesticides, PCBs [a], DDTs, mercury	4,4'-DDD	10.71	na	ppb	whole body	1
				4,4'-DDE	27.2	na	ppb		
				4,4'-DDT	4.22	na	ppb		
				mercury	0.097	na	ppm		
				PCBs	17.8	na	ppb		
				alpha-chlordane	0.55	na	ppb		
				dieldrin	1.64	na	ppb		
				gamma-chlordane	0.32	na	ppb		
				gamma-hexachlorocyclohexane	0.1	na	ppb		
	F04	black crappie	pesticides, PCBs [a], DDTs, mercury	4,4'-DDD	9.61	na	ppb	whole body	1
				4,4'-DDE	29.4	na	ppb		
				4,4'-DDT	2.06	na	ppb		
				PCBs	12.9	na	ppb		
				alpha-chlordane	0.47	na	ppb		
				dieldrin	1.43	na	ppb		
				gamma-chlordane	0.3	na	ppb		
				gamma-hexachlorocyclohexane	0.18	na	ppb		

Table 3-6 continued

Area	Station	Species	Analysis	Analyte[a]	Detected Concentration		Unit	Organ	# Composited Samples
					Min	Max			
River Miles 5-6	F05	common carp	pesticides, PCBs[a], DDTs, mercury	4,4'-DDD	7.2	na	ppb	whole body	1
				4,4'-DDE	29	na	ppb		
				4,4'-DDT	3.3	na	ppb		
				PCBs	6.6	na	ppb		
	F06	common carp	pesticides, PCBs[a], DDTs, mercury	4,4'-DDD	37	na	ppb	whole body	1
				4,4'-DDE	85	na	ppb		
				4,4'-DDT	6.5	na	ppb		
				PCBs	25.8	na	ppb		
				alpha-chlordane	2.5	na	ppb		
				Dieldrin	4.6	na	ppb		
	F07	smallmouth bass	pesticides, PCBs[a], DDTs, mercury	4,4'-DDD	31	na	ppb	whole body	1
				4,4'-DDE	140	na	ppb		
				4,4'-DDT	79	na	ppb		
				PCBs	71.2	na	ppb		
				dieldrin	3.5	na	ppb		
	F08	smallmouth bass	pesticides, PCBs[a], DDTs, mercury	4,4'-DDD	32	na	ppb	whole body	1
				4,4'-DDE	94	na	ppb		
				4,4'-DDT	62	na	ppb		
				PCBs	130.1	na	ppb		
				dieldrin	2.6	na	ppb		
	F09	common carp	pesticides, PCBs[a], DDTs, mercury	4,4'-DDD	35	na	ppb	whole body	1
				4,4'-DDE	82	na	ppb		
				4,4'-DDT	6.8	na	ppb		
				mercury	0.068	na	ppm		
				PCBs	74	na	ppb		
				dieldrin	3.2	na	ppb		

Table p3-6 continued

Area	Station	Species	Analysis	Analyte[a]	Detected Concentration		Unit	Organ	# Composited Samples
					Min	Max			
Railroad Bridge Area	402000	common carp	mercury	mercury	0.14	0.49	ppm	fillet	5
		largemouth bass			0.91	na	ppm		1
		northern pike-minnow			0.8	na	ppm		1
		largescale sucker			0.12	0.27	ppm		5
		smallmouth bass			0.15	0.28	ppm		4
	BI-1	largescale sucker	hexachloro-butadiene, hexachloro-benzene, arsenic, chromium, copper, zinc, PAHs, phenols	chromium	0.21	0.27	ppm	muscle	3
				copper	0.26	0.32	ppm		
				zinc	4.9	6.4	ppm		
				HPAH	180	na	ppb		
				LPAH	120	140	ppb		
				naphthalene	28	40	ppb		
		crayfish		chromium	0.86	na	ppm	whole body, less shell	1
				copper	12	na	ppm		
				zinc	15	na	ppm		
				acenaphthene	21	na	ppb		
				LPAH	130	na	ppb		
				naphthalene	26	na	ppb		
	BI-2	largescale sucker	hexachloro-butadiene, hexachloro-benzene, arsenic, chromium, copper, zinc, PAHs, phenols	chromium	0.26	0.55	ppm	muscle	3
				copper	0.28	0.3	ppm		
				zinc	6.5	7.1	ppm		
				acenaphthene	57	na	ppb		
				fluorene	46	na	ppb		
				LPAH	220	na	ppb		
				naphthalene	60	na	ppb		
		crayfish		chromium	0.92	na	ppm	whole body, less shell	1
				copper	11	na	ppm		
				zinc	14	na	ppm		
	BI-3	largescale sucker	hexachloro-butadiene, hexachloro-benzene, arsenic, chromium, copper, zinc, PAHs, phenols	chromium	0.29	0.34	ppm	muscle	3
				zinc	5.7	6	ppm		
				acenaphthene	24	na	ppb		
				LPAH	150	na	ppb		
				naphthalene	42	na	ppb		
		crayfish		chromium	1.6	na	ppm	whole body, less shell	1
				copper	12	na	ppm		
				zinc	14	na	ppm		
				LPAH	140	na	ppb		
				naphthalene	43	na	ppb		

Table 3-6 continued

Area	Station	Species	Analysis	Analyte[a]	Detected Concentration		Unit	Organ	# Composited Samples
					Min	Max			
Railroad Bridge Area, continued	BI-4	largescale sucker	hexachloro-butadiene, hexachloro-benzene, arsenic, chromium, copper, zinc, PAHs, phenols	LPAH	110	200	ppb	muscle	3
				chromium	0.26	0.45	ppm		
				copper	0.053	0.17	ppm		
				zinc	4.3	5.1	ppm		
				naphthalene	21	78	ppb		
				acenaphthene	23	33	ppb		
				HPAH	28	na	ppb		
		crayfish		chromium	1.3	na	ppm	whole body, less shell	1
				copper	11	na	ppm		
				zinc	14	na	ppm		
	BI-5	largescale sucker	hexachloro-butadiene, hexachloro-benzene, arsenic, chromium, copper, zinc, PAHs, phenols	chromium	0.22	0.34	ppm	muscle	3
				copper	0.32	0.5	ppm		
				zinc	4.3	5	ppm		
		crayfish		chromium	0.5	na	ppm	whole body, less shell	1
				copper	13	na	ppm		
				zinc	14	na	ppm		
				LPAH	160	na	ppb		
				naphthalene	57	na	ppb		
	EPA18	common carp	dioxin/furans	dioxin/furans	0.26	3.52	ng/kg	fillet w/o skin	6
		northern pike-minnow			0.8	30.31	ng/kg	whole body	6
	EPA35	common carp	pesticides, PCBs[b], DDTs	4,4'-DDD	8	10	µg/kg	fillet	3
				4,4'-DDE	53	68	µg/kg		
				4,4'-DDT	5	7	µg/kg		
				delta-hexachlorocyclohexane	2	na	µg/kg		
				PCBs as Aroclor (1260)		1,403	µg/kg		
				PCBs as congeners	62	na	µg/kg		
				heptachlor	2	3	µg/kg		
		northern pike-minnow	pesticides, PCBs[b], DDTs	alpha-hexachlorocyclohexane	4	na	µg/kg	whole body	3
				4,4'-DDE	52	na	µg/kg		
				PCBs as Aroclor (1260)		209	µg/kg		
				PCBs as congeners	24	na	µg/kg		

Table 3-6 continued

Area	Station	Species	Analysis	Analyte[a]	Detected Concentration Min.	Detected Concentration Max	Unit	Organ	# Composited Samples
Swan Island Lagoon	F10	smallmouth bass	pesticides, PCBs[a], DDTs, mercury	4,4'-DDD	3.1	na	ppb	whole body	1
				4,4'-DDE	68	na	ppb		
				4,4'-DDT	46	na	ppb		
				PCBs	70.5	na	ppb		
	F11	smallmouth bass	pesticides, PCBs[a], DDTs, mercury	4,4'-DDD	2.2	na	ppb	whole body	1
				4,4'-DDE	33	na	ppb		
				4,4'-DDT	18	na	ppb		
				mercury	0.12	na	ppm		
				PCBs	17.5	na	ppb		
	F12	common carp	pesticides, PCBs[a], DDTs, mercury	4,4'-DDD	13	na	ppb	whole body	1
				4,4'-DDE	66	na	ppb		
				4,4'-DDT	15	na	ppb		
				PCBs	69.4	na	ppb		
				dieldrin	4	na	ppb		
	F13	black crappie	pesticides, PCBs[a], DDTs, mercury	4,4'-DDD	8.3	na	ppb	whole body	1
				4,4'-DDE	36	na	ppb		
				4,4'-DDT	6.9	na	ppb		
				mercury	0.13	na	ppm		
				PCBs	19.4	na	ppb		
				dieldrin	2.7	na	ppb		
	F14	black crappie	pesticides, PCBs[a], DDTs, mercury	4,4'-DDD	7	na	ppb	whole body	1
				4,4'-DDE	34	na	ppb		
				4,4'-DDT	8	na	ppb		
				PCBs	17.2	na	ppb		
	F15	common carp	pesticides, PCBs[a], DDTs, mercury	4,4'-DDD	16	na	ppb	whole body	1
				4,4'-DDE	28	na	ppb		
				4,4'-DDT	16	na	ppb		
				mercury	0.054	na	ppm		
				PCBs	41.7	na	ppb		
				alpha-chlordane	8.2	na	ppb		
				gamma-chlordane	4.2	na	ppb		
	F16	common carp	pesticides, PCBs[a], DDTs, mercury	4,4'-DDD	8.4	na	ppb	whole body	1
				4,4'-DDE	25	na	ppb		
				4,4'-DDT	9.3	na	ppb		
				PCBs	37.5	na	ppb		
River Mile 9	2	common carp	dioxin/furans	dioxin/furans	1.2	34	ppt	whole body	1

[a] Total PCBs are the sum of individual congeners

[b] Total PCBs are the sum of Aroclors

[c] Not applicable, only one measured value

Table 3-7. Concentration ranges of chemicals in great blue heron egg tissues from Ross Island in 1994 and 1995

Contaminant		Minimum	Maximum
p,p'-DDE (µg/g)		0.01	7.4
p,p'-DDT (µg/g)		0.01	0.08
trans-Nonachlor (µg/g)		0.06	0.85
Total PCBs (µg/g)		0.11	33.17
Dioxins (pg/g)	2378-TCDD	0.7	23
	12378-PnCDD	1.3	14
	OCDD	8.4	26
Furans (pg/g)	23478-PnCDF	0.6	11
Mercury (µg/g)		0.31	0.91

Source: Thomas and Anthony (1997)

Table 3-8. Bioassay data from environmental investigations in the ISA

Date	Title	Purpose	Tests	Samples	Results	Reference	Data Quality Category[a]
Oct-01	McCormick & Baxter Creosoting Company Sediment Remedial Design Phase 1	remediation	10-day amphipod *Hyalella azteca* midge mortality and growth *Chironomus tentans*	39	25 pass 12 1-hit 2 2-hit	Ecology and Environment 2001	1
Aug-01	Results of Sediment Sampling and Analysis, Cargill Elevator Terminal	dredging	10-day amphipod *Hyalella azteca* midge mortality and growth *Chironomus tentans*	3	2 pass 1 1-hit	Harding ESE 2001	1
Oct-00	McCormick & Baxter Creosoting Company Sediment Remedial Design Phase 2	remediation	10-day amphipod *Hyalella azteca* midge mortality and growth *Chironomus tentans*	17	13 pass 4 1-hit	Ecology and Environment 2001	1
Nov-99	Willamette River Sediment Sampling Evaluation, Portland District	site investigation	10-day amphipod *Hyalella azteca* midge mortality and growth *Chironomus tentans*	4	4 pass	ACOE 1999	1
Jan-99	January 1999 Sediment Sampling Results for TOSCO Terminal	dredging	10-day amphipod *Hyalella azteca* midge mortality and growth *Chironomus tentans*	2	2 1-hit	Exponent 1999	1
Oct-98	Sediment Characterization Study, Marine Terminal 4, Berth 416, Port of Portland	dredging	10-day amphipod *Hyalella azteca* midge mortality and growth *Chironomus tentans*	1	1 pass	Hart Crowser 1999a	1
Oct-98	Sediment Characterization Study, Marine Terminal 4, Berths 203-206 , Port of Portland	dredging	10-day amphipod *Hyalella azteca* midge mortality and growth *Chironomus tentans*	2	1 pass	Hart Crowser 1999b	1
Oct-98 Dec-98	Remedial Investigation Report, Terminal 4, Slip 3 Sediments, Port of Portland (Phase 1 & 2)	remediation	10-day amphipod *Hyalella azteca* midge mortality and growth *Chironomus tentans*	16	10 pass 5 1-hit 1 2 hit	Hart Crowser 1999c	1
Apr-98	Portland Shipyard Sediment Investigation	site investigation	10-day amphipod *Hyalella azteca* midge mortality and growth *Chironomus tentans* Microtox porewater	36	16 pass 19 1-hit	SEA 1999	1, except 25 samples with Microtox holding time exceedances, which are category 2.
Jan-98	Willamette River Data	site investigation	10-day amphipod *Hyalella azteca*	2	2 1-hit	Dames & Moore 1998	1

Date	Title	Purpose	Tests	Samples	Results	Reference	Data Quality Category[a]
Dec-97	Portland Shipyard Sediment Environmental Audit	site investigation	10-day amphipod *Hyalella azteca*	3	3 1-hit	Dames & Moore 1997	1
May-94	Dredging Study Marine Terminal (Terminal 2, Berth 203)	dredging	10-day amphipod *Hyalella azteca* 48-hr mortality *Daphnia magna*	1	1 pass	ACOE 1994	1
Jan-92	McCormick & Baxter Creosoting Company Sediment Remedial Investigation Phase 2	remediation	10-day Amphipod *Hyalella azteca* Microtox porewater	15	7 pass 8 1-hit	PTI 1992	2
Dec-91	Port of Portland Dry Dock 4	dredging	10-day amphipod *Hyalella azteca* 48-hr mortality *Daphnia magna* 96-hr mortality *Daphnia magna* rainbow trout mortality	1	na	ACOE 1991	2
Sep-90	McCormick & Baxter Creosoting Company Sediment Remedial Investigation Phase 1	remediation	10-day amphipod *Hyalella azteca*	46	39 pass 7 1-hit	PTI 1992	2

a – Bioassay data quality were evaluated based on validation guidelines and performance criteria from PSEP (PTI 1989). See section 4 and Table 4-8 in Programmatic Work Plan and Appendix F for additional details.

Table 5-1. The DQO process for the ecological risk evaluation: Amphibians, reptiles and plants

DQO Step	Output
1. State the problem	Amphibians and Reptiles: Amphibians and/or reptiles may be at risk from exposure to chemicals resulting from historical and ongoing releases and/or sources within the ISA. Aquatic Plants: Aquatic plants may be at risk from exposure to chemicals resulting from historical and ongoing releases and / or sources within the ISA.
2. Identify the decision	Determine whether exposure to hazardous substances in the ISA poses an unacceptable risk to amphibians or reptiles that may forage in the area or aquatic plants. The testable hypothesis is: Are levels of contaminants in abiotic and biotic media in the ISA sufficient to cause adverse effects to the growth, survival or reproduction of amphibians, reptiles or aquatic plants utilizing the habitat within the ISA?
3. Identify inputs to the decision	Presence/absence of amphibian and aquatic plants was confirmed with field reconnaissance survey. Reptiles were not found but have been found in the ISA during other field surveys. Evaluation of existing amphibian life history information and plant community information to determine potential habitat areas and potential for exposure. Evaluation of toxicological literature to determine potential toxicity and/or bioavailability. Collection of surface water in quiescent areas and other potential exposure areas.
4. Define the boundaries to the study	The ISA will be the initial geographic boundary. Risk to amphibians will be assessed quantitatively if possible. Risk to aquatic plants cannot be quantitatively assessed because of lack of appropriate toxicity data. Amphibians will be used as surrogate to assess the risk to reptiles. If suitable reptile habitat is found within the ISA a comparative evaluation of toxicity will be performed using literature data. Temporal variability will influence study design. Detection limits will be those currently achievable by the analytical laboratory conducting the analyses as described in the approved QAPP. Detection limits will be lower (if analytically achievable) than risk-based values for protection of amphibians and aquatic plants.
5. Develop a decision rule	If the COPC concentration using the maximum concentration is greater than the NOEC/LOEC for amphibians, the COPC will be retained for further evaluation (NOEC used for sensitive species). Aquatic plants will be assessed qualitatively. Amphibian assessment will be a surrogate for the reptile evaluation since the amphibians are more sensitive.
6. Specify tolerable limits on decision errors	Null Hypothesis: Amphibians and aquatic plants are exposed to hazardous substances within the ISA. Alternate Hypothesis: Amphibians and aquatic plants are not exposed to hazardous substances within the ISA. Evaluation of variability of exposure concentrations relative to sample design. Evaluation of the variability of toxicity values relative to the decision rule.
7. Optimize the design for obtaining data	Surface water samples will be collected in quiescent areas and within other potential habitat areas.

Table 5-2. The DQO Process for the ecological risk evaluation: Benthic invertebrate communities

DQO Step	Output
1. State the problem	Benthic invertebrate communities may be at risk from exposure to chemicals resulting from historical and ongoing releases and / or sources within the ISA. There is a need for additional characterization of the aquatic invertebrate community to better understand their potential exposure pathways and their role in the food web within the ISA.
2. Identify the decision	Determine whether exposure to hazardous substances in the ISA poses an unacceptable risk to benthic invertebrate populations and communities in the area. Determine what structural characteristics of the benthic community could be important for evaluation of direct and indirect risks to higher trophic level organisms. The test hypothesis is: Are levels of contaminants in media in the ISA sufficient to cause adverse effects to the growth, survival or reproduction of shellfish epibenthic (e.g., crayfish) and benthic invertebrates?
3. Identify inputs to the decision	Existing sediment data, bathymetry, toxicity testing, STA, and SPI results will be evaluated to characterize the benthic community, refine potential exposure areas and identify data gaps. Existing invertebrate community information was evaluated to determine potential exposure areas. Toxicological literature and existing toxicity test results will be evaluated to determine potential toxicity and/or bioavailability issues. Round 1 investigations included collection of additional infaunal grab samples and multiplate samples. These will be used to further characterize the invertebrate community. Surface sediment and invertebrate tissue data (infaunal, epifaunal) were collected and surface water will be collected, to assess potential adverse effects to the invertebrate community. Existing SQVs and chemical data will be used to rank sediment stations over a concentration gradient. Bioassays will be conducted at stations representing this gradient. Sediment chemistry and bioassay results will be used to develop a predictive model of chemistry-to-effects to assess risk from bulk sediment at other site locations. If the groundwater DQO process suggests that groundwater sampling at the point of exposure to the river is warranted, groundwater may be collected at point of exposure to evaluate potential localized adverse effects to the invertebrate community. The clam survey was conducted to determine potential exposure areas (and locations of clam beds) and clam tissue samples were collected where sufficient tissue was available.
4. Define the boundaries to the study	The ISA will be the initial geographic boundary. Surface sediment and invertebrate tissue samples were collected in summer/fall 2002 within receptor habitat near identified sources. Surface water will be collected within the ISA. Detection limits will be those currently achievable by the analytical laboratory conducting the analyses described in the approved QAPP. Detection limits will be lower (if analytically achievable) than risk-based values for protection of benthic/epibenthic organisms.

DQO STEP	OUTPUT
5. Develop a decision rule	If the COPC concentration using the 95th UCL or maximum concentration is greater than the LOEC, the COPC will be retained for further evaluation. If the groundwater DQO process suggests that groundwater discharging to the river poses a risk to infaunal invertebrate communities at the groundwater/surface water interface (porewater), a risk-based approach will be applied to assess this pathway.
6. Specify tolerable limits on decision errors	Null Hypothesis: The aquatic invertebrate community (characterized in Round 1a and Round 1) may have unacceptable risk from exposure to hazardous substances within the ISA. Alternate hypothesis: There is no risk to aquatic invertebrate communities from exposure to hazardous substances within the ISA. Evaluate ecosystem and receptor characteristics that may modify/impact risk management decisions. Evaluate uncertainty of toxicity values relative to decision rule. Evaluate uncertainty of exposure concentrations relative to sample design. Evaluate variability of natural invertebrate community.
7. Optimize the design for obtaining data	Collect surface sediment samples and surface water samples in each invertebrate exposure area. Collect benthic infaunal organisms to qualitatively determine community structure. Collect invertebrate samples from multiplates to qualitatively determine community structure of epibenthic community. Collect surface sediment, surface water, and invertebrate tissue data in areas that are likely depositional (e.g., not subject to significant scour under most hydrologic conditions). Collect porewater samples at locations identified by ecological risk screening process

Table 5-3. The DQO process for the ecological risk evaluation: Fish

DQO Step	Output
1. State the problem	Fish may be at risk from exposure to chemicals resulting from historical and ongoing releases and / or sources within the ISA.
2. Identify the decision	Determine whether exposure to hazardous substances in the ISA poses an unacceptable risk to fish in the area. The testable hypotheses are: Are levels of contaminants in abiotic and biotic media in the ISA sufficient to cause adverse effects to the growth, survival or reproduction of detritivorous fish utilizing the habitat within the ISA? Are levels of contaminants in abiotic and biotic media in the ISA sufficient to cause adverse effects to the growth, survival or reproduction of invertivorous fish utilizing the habitat within the ISA? Are levels of contaminants in abiotic and biotic media in the ISA sufficient to cause adverse effects to the growth, survival or reproduction of piscivorous fish utilizing the habitat within the ISA? Are levels of contaminants in abiotic and biotic media in the ISA sufficient to cause adverse effects to the growth, survival or reproduction of herbivorous fish utilizing the habitat within the ISA?
3. Identify inputs to the decision	Existing Category 1 and Category 2 data were evaluated to define the conceptual site model and identify data gaps. Category 1 data will continue to be used to update the conceptual site model and re-evaluate data gaps. Existing fish life history information (described in Appendix C) will be evaluated to determine potential exposure areas. Toxicological literature will be evaluated to determine potential toxicity and/or bioavailability issues. Tissue residue data from the literature will be used to determine adverse effect levels. Surface sediment, surface water, invertebrate tissue (benthic infauna) and fish tissue (sculpin, juvenile chinook salmon, largescale sucker, peamouth, pikeminnow, smallmouth bass) data were or will be collected in exposure areas.
4. Define the boundaries to the study	The ISA will be the initial geographic boundary. Spatial boundaries on exposure areas are different for each fish species and will depend on fish foraging habits within the river. Fish and invertebrate tissue and surface sediment have been collected and surface water will be collected. Detection limits will be those currently achievable by the analytical laboratory conducting the analyses. Detection limits will be lower (if analytically achievable) than risk-based values for protection of fish.
5. Develop a decision rule	If the COPC concentration using the 95th UCL or maximum concentration is greater than the NOEC in the special-status species assessment, the COPC will be retained for further evaluation. If the COPC concentration using the 95th UCL or maximum concentration is greater than the LOEC in the population level assessment, the COPC will be retained for further evaluation.

DQO Step	Output
6. Specify tolerable limits on decision errors	Null Hypothesis: Fish may have unacceptable risk from exposure to hazardous substances within the ISA. Alternate hypothesis: There is no risk to fish from exposure to hazardous substances within the ISA. Evaluate ecosystem and receptor characteristics that may modify/impact risk management decision. Evaluate uncertainty of exposure concentrations relative to sample design. Evaluate uncertainty of toxicity values relative to decision rule.
7. Optimize the design for obtaining data	Collect surface water samples for comparison to effects-based criteria (e.g., AWQC). Collect additional fish tissue, if warranted, from exposure areas to compare to tissue residue effects data. Collect additional invertebrate tissue, if warranted, and sediment grab samples to evaluate dietary pathway (dietary-based NOEAL or LOAEL) in exposure areas.

Table 5-4. The DQO process for the ecological risk evaluation: Birds

DQO Step	Output
1. State the problem	Birds may be at risk from exposure to chemicals resulting from historical and ongoing releases and / or sources within the ISA.
2. Identify the decision	Determine whether or not exposure to hazardous substances in the ISA poses an unacceptable risk to birds that may forage in the area. The testable hypotheses are: Are levels of contaminants in abiotic and biotic media in the ISA sufficient to cause adverse effects to the growth, survival or reproduction of diving carnivorous birds utilizing the habitat within the ISA? Are levels of contaminants in abiotic and biotic media in the ISA sufficient to cause adverse effects to the growth, survival or reproduction of sediment probing invertivorous birds utilizing the habitat within the ISA? Are levels of contaminants in abiotic and biotic media in the ISA sufficient to cause adverse effects to the growth, survival or reproduction of piscivorous birds utilizing the habitat within the ISA?
3. Identify inputs to the decision	Existing Category 1 and Category 2 data were evaluated to determine potential exposure areas and data gaps. Existing life history information of representative avian species will be reviewed to select appropriate representative species and exposure parameters. Toxicological literature will be searched to develop no observed adverse effects level (NOAEL) and lowest observed adverse effects level (LOAEL) for birds to determine relative sensitivities. Bird exposure areas will be determined based on a reconnaissance habitat survey and evaluation of their local life-history characteristics. Surface sediment and prey data will be collected in bird exposure areas.

DQO Step	Output
4. Define the boundaries to the study	The ISA will be the initial geographic boundary. Sediment and fish and invertebrate tissue were collected in bird exposure areas within the ISA. Data was collected in summer/fall 2002. Detection limits will be those currently achievable by the analytical laboratory conducting the analyses as described in the approved QAPP. Detection limits will be lower (if analytically achievable) than risk-based values for protection of avian species.
5. Develop a decision rule	If the dose estimate using the 95th UCL or maximum concentration is greater than the NOAEL in the special-status species assessment, the COPC will be retained for further evaluation. If the dose estimate using the 95th UCL or maximum concentration is greater than the LOAEL in the population level assessment, the COPC will be retained for further evaluation.
6. Specify tolerable limits on decision errors	Null Hypothesis: Birds may have unacceptable risk from exposure to hazardous substances within the ISA. Alternate Hypothesis: There is no risk to birds from exposure to hazardous substances within the ISA. Evaluate ecosystem and receptor characteristics that may modify/impact risk management decision. Evaluate uncertainty of exposure concentrations relative to sample design. Evaluate uncertainty of toxicity values relative to decision rule.
7. Optimize the design for obtaining data	Collect additional surface sediment samples, if warranted, in each shorebird bird exposure area and at other bird habitat areas. Collect additional prey tissue (invertebrate and/or fish tissue), if warranted, from each bird exposure area. Additional sampling may be conducted based on the results of the iterative risk assessment to reduce uncertainties.

Table 5-5. The DQO process for the ecological risk evaluation - Mammals

DQO Step	Output
1. State the problem	Mammals may be at risk from exposure to chemicals resulting from historical and ongoing releases and / or sources within the ISA.
2. Identify the decision	Determine whether exposure to hazardous substances in the ISA poses an unacceptable risk to mammals that may forage in the area. The testable hypothesis is: Are levels of contaminants in abiotic and biotic media in the ISA sufficient to cause adverse effects to the growth, survival or reproduction of mammals utilizing the habitat within the ISA?
3. Identify inputs to the decision	Existing Category 1 and Category 2 data were evaluated to determine potential exposure areas and data gaps. Existing life history information of representative mammals were reviewed to select an appropriate representative species and exposure parameters. Toxicological literature will be searched to develop no observed adverse effects level (NOAEL) and lowest observed adverse effects level (LOAEL) for mammals to determine relative sensitivities. Surface sediment and prey data (crayfish, clams, fish) were collected in mammalian exposure areas.
4. Define the boundaries to the study	The ISA will be the initial geographic boundary. Surface sediment and fish/invertebrate tissue chemistry data were collected from mammalian exposure areas. Detection limits will be those currently achievable by the analytical laboratory conducting the analyses as described in the approved QAPP. Detection limits will be lower (if analytically achievable) than risk-based values for protection of mammalian species.
5. Develop a decision rule	If the dose estimate using the 95th UCL or maximum concentration is greater than the NOAEL in the special-status species assessment, the COPC will be retained for further evaluation. If the dose estimate using the 95th UCL or maximum concentration is greater than the LOAEL in the population level assessment, the COPC will be retained for further evaluation.
6. Specify tolerable limits on decision errors	Null Hypothesis: Mammals may have unacceptable risk from exposure to hazardous substances within the ISA. Alternate Hypothesis: There is no risk to mammals from exposure to hazardous substances within the ISA. Evaluate ecosystem and receptor characteristics that may modify/impact risk management decision. Evaluate uncertainty of exposure concentrations relative to sample design. Evaluate uncertainty of toxicity values relative to decision rule.
7. Optimize the design for obtaining data	Collect additional surface sediment samples, if warranted, in each mammalian exposure area. Collect additional co-located prey tissue (invertebrate and/or fish tissue), if warranted, from each mammalian exposure area.

Table 5-6. Limited list of secondary stressors that may influence receptor populations within the LWR

Receptor	Secondary Stressor	Effect on Receptor Population	Source
Birds and mink	Loss of riparian vegetation and woody debris due to bank revetments and channelization	Decreases abundance and suitability of nest and den sites and prey resources. Directly affects ability of habitat to support local bird and mink populations.	1, 2, 3
Juvenile chinook salmon	Increased water temperature and decreased dissolved oxygen concentrations	Stresses juvenile salmonids by slowing their growth, reducing their food conversion efficiency and swimming performance, and increasing mortality.	4, 5
Amphibians	Introduction of exotic bullfrog	Negatively affects growth, development, and survival of native amphibians such as red-legged frogs by out-competing frogs for habitat and resources.	6, 7
Fish	Introduction of pathogen from exotic fish	Increased mortality of summer-run salmonids due to lack of immunity and timing of migration when water temperature is high and disease is most virulent.	8

Sources:

1 Allen 1986
2 Isaacs and Anthony 2001
3 Henny 2000
4 Gregory and Bisson 1997
5 Bjornn and Reiser 1991
6 Altman et al. 1997
7 Kiesecker and Blaustein 1998
8 Li et al. 1987

LWG
LOWER WILLAMETTE GROUP

PORTLAND HARBOR RI/FS
PROGRAMMATIC WORK PLAN

APPENDIX B:
ECOLOGICAL RISK ASSESSMENT APPROACH
FIGURES

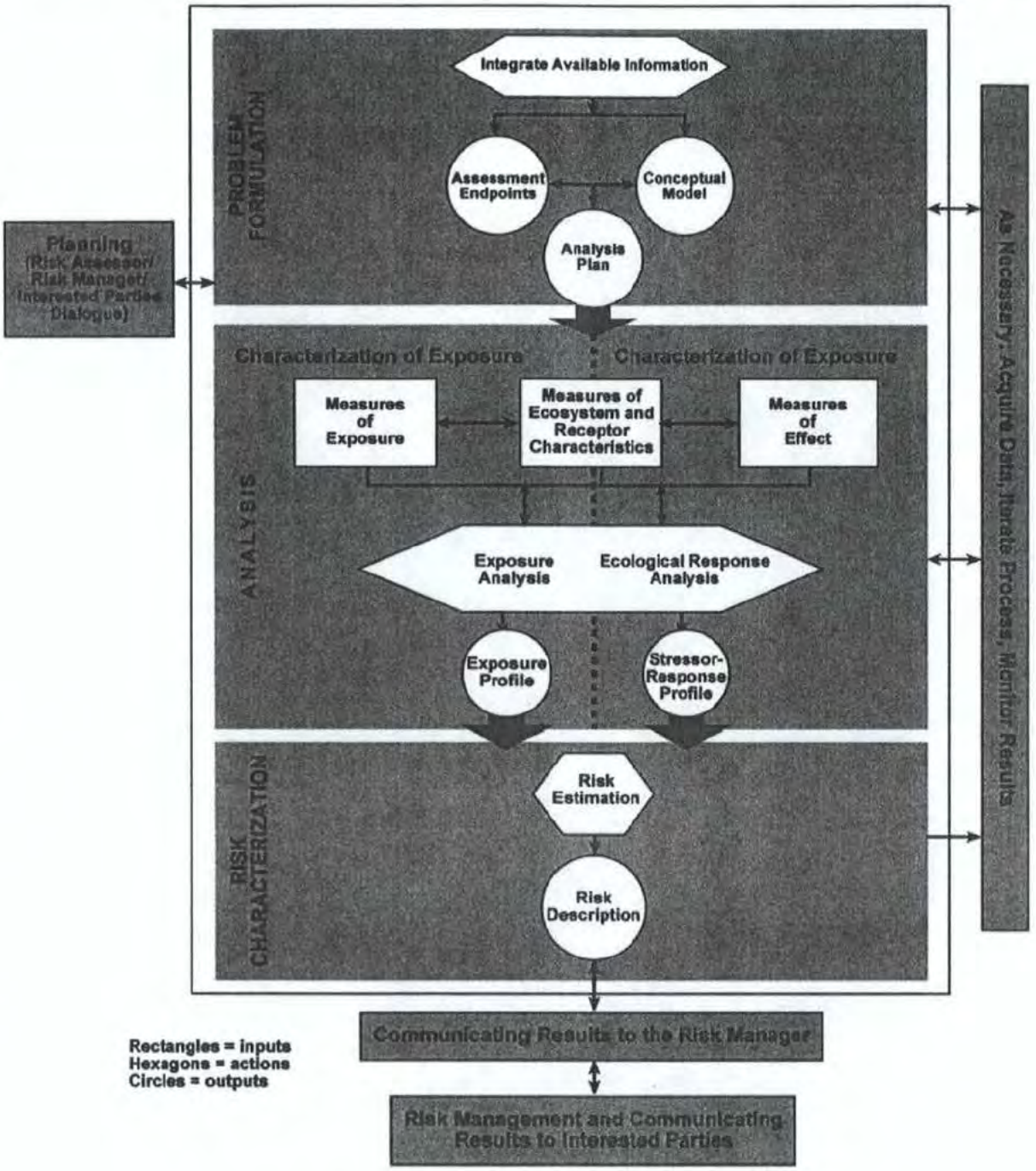
REVISED DRAFT FINAL
November 13, 2003

Prepared for:
The Lower Willamette Group

Prepared by:
Windward Environmental LLC

List of Figures for Appendix B

Figure 1-1.	*EPA's ERA process*	*1*
Figure 2-1.	*Wildlife food-web model*	*2*
Figure 2-2.	*Fish food-web model*	*3*
Figure 2-3.	*Bank and riparian conditions*	*4*
Figure 2-4.	*Timing of adult and juvenile salmonid migrations in the Willamette River below Willamette Falls*	*5*
Figure 2-5.	*Summary of available home range data for fish species considered for receptor selection*	*6*
Figure 2-6.	*Smallmouth bass, juvenile chinook, Pacific lamprey, and largescale sucker habitat*	*7*
Figure 2-7.	*Sculpin and crayfish habitat*	*8*
Figure 2-8.	*Hooded merganser habitat*	*9*
Figure 2-9.	*Spotted sandpiper habitat*	*10*
Figure 2-10.	*Mink habitat*	*11*
Figure 2-11.	*Amphibian habitat*	*12*
Figure 2-12.	*Preliminary ecological conceptual site model*	*13*
Figure 3-1.	*Results of historical bioassay studies in the ISA*	*14*
Figure 5-1.	*Assessment of benthic community*	*15*
Figure 5-2.	*Fish receptor assessment*	*16*
Figure 5-3.	*Wildlife receptor assessment*	*17*



The ecological risk assessment framework (EPA 1998)

Figure 1-1. EPA's ERA process

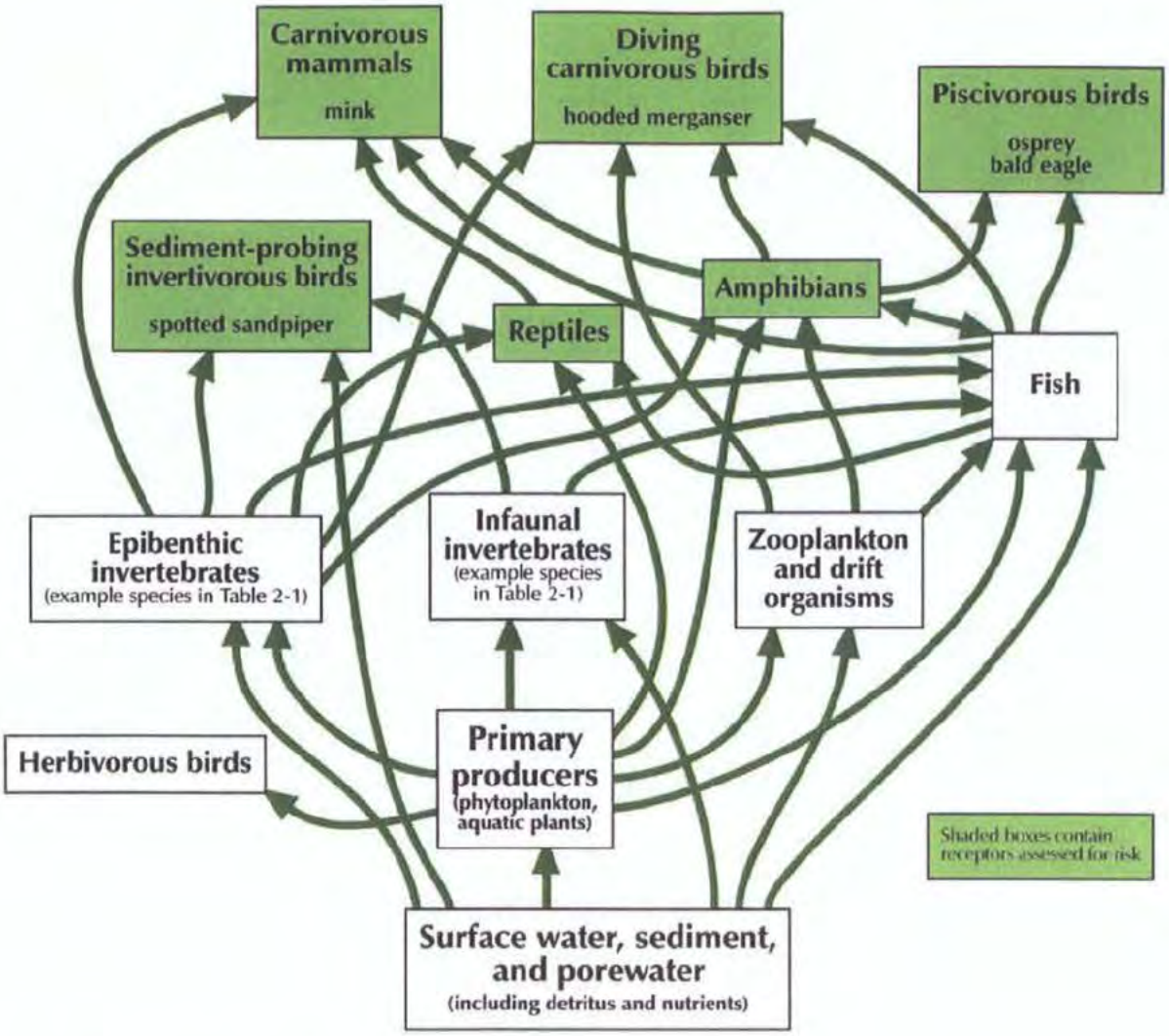


Figure 2-1. Wildlife food-web model

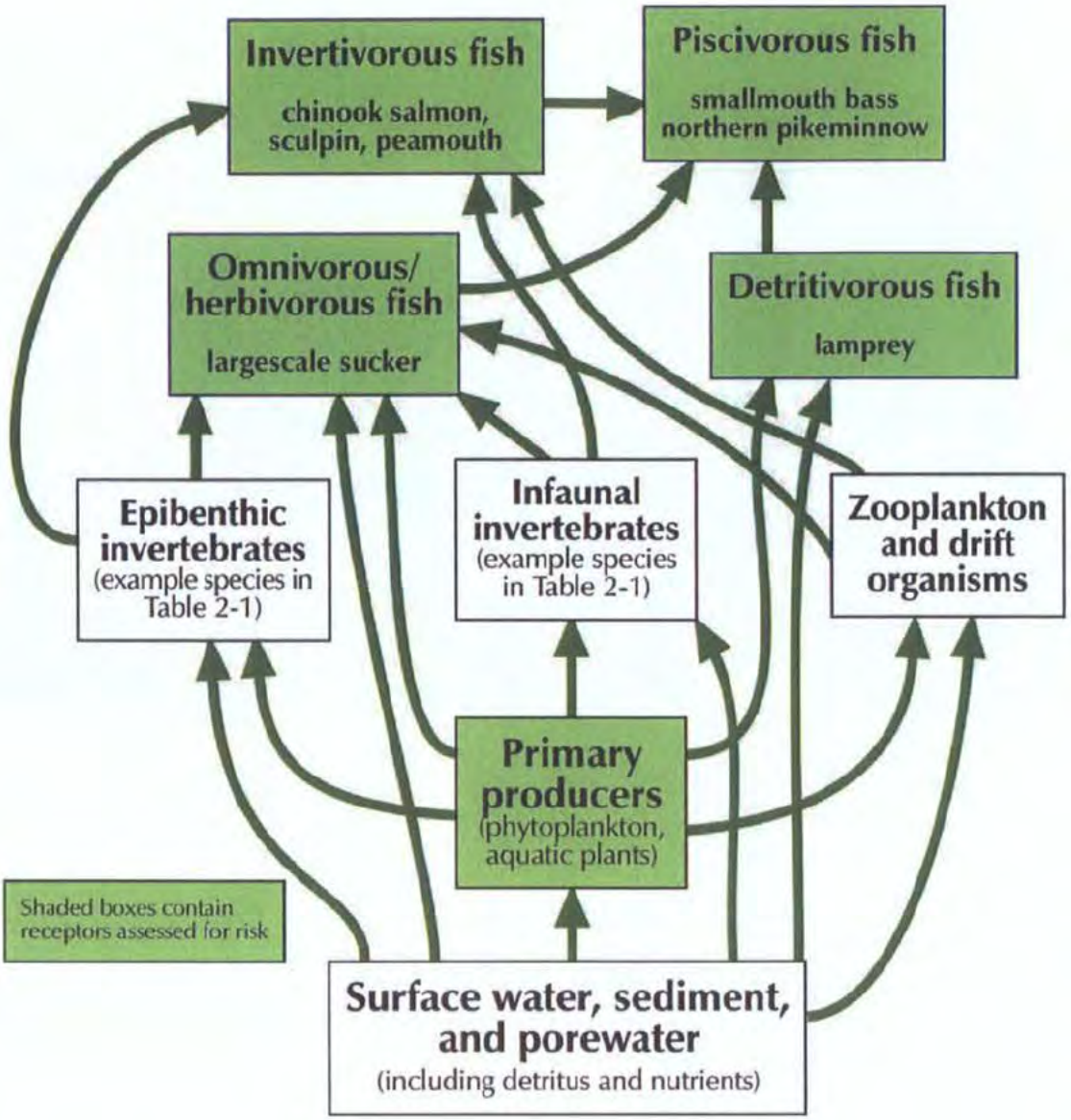
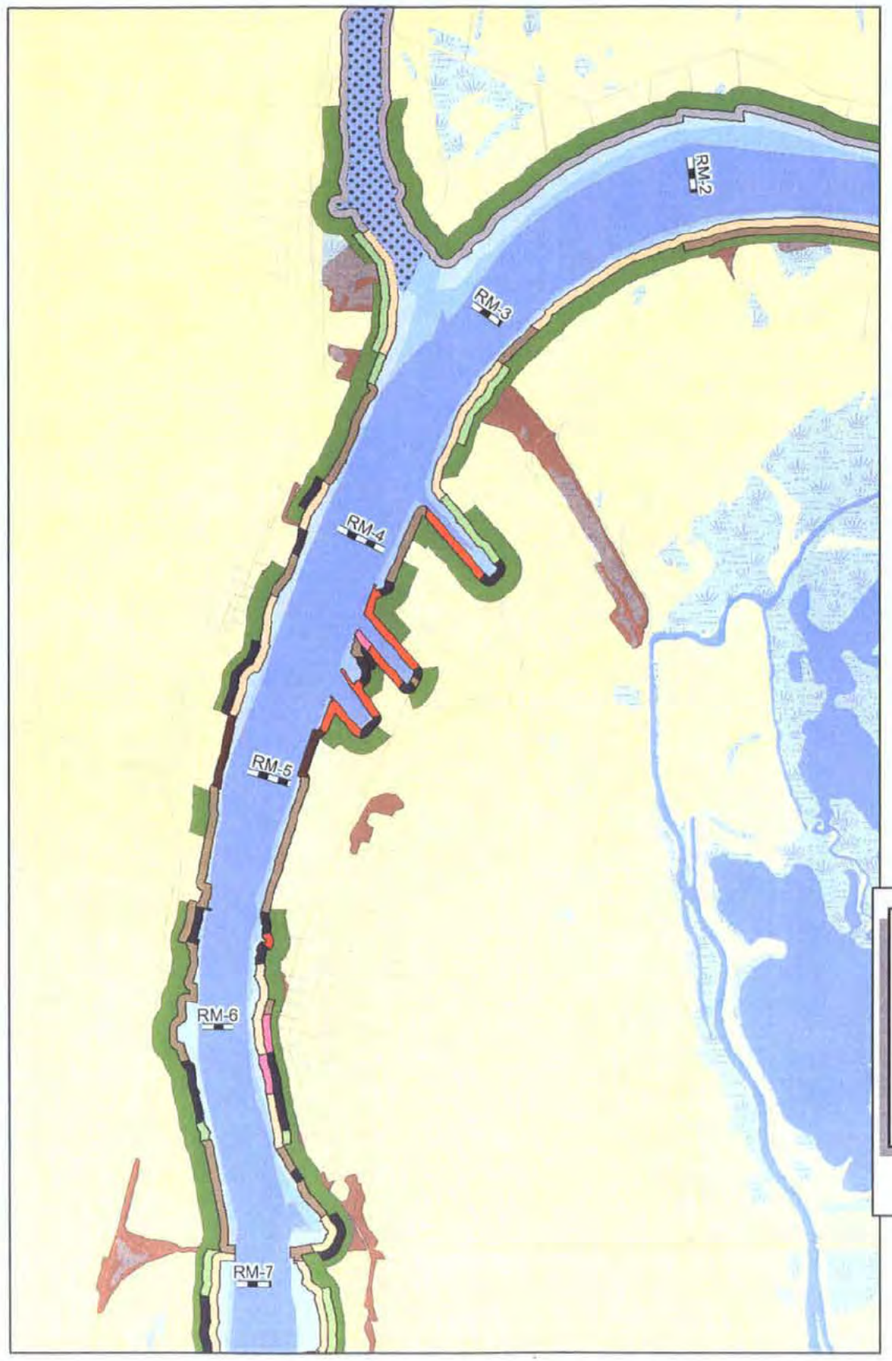


Figure 2-2. Fish food-web model



River Miles 2-7

River bank conditions*

- River beach
- Natural bank
- Riprap
- Seawall
- Bioengineered soils
- Structures
- Unclassified fill
- Bank condition data unavailable
- Riparian vegetation

Bathymetry

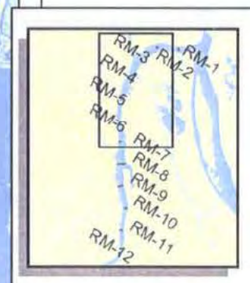
- ≤ 5 ft
- ≤ 20 ft
- > 20 ft
- Bathymetry data unavailable

Other Features

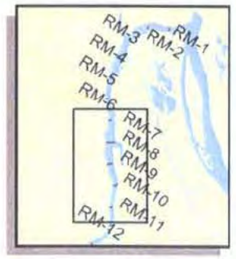
- Willamette River Inventory Sites
- Streets
- Railroads
- Wetlands
- River miles

***River bank conditions**

River bank conditions are shown in up to three bands adjacent to the shoreline depending on how many different conditions are present. Neither the distance of the bank condition symbol from the shoreline nor the width of the symbol from the shoreline to the outer edge represent actual measurements.



RM 2-7



RM 7-11

N

0 0.25 0.5 1 mi

0 0.5 1 2 km

River Miles 7-11

Figure 2-3. River bank conditions and bathymetry in the ISA

Windward

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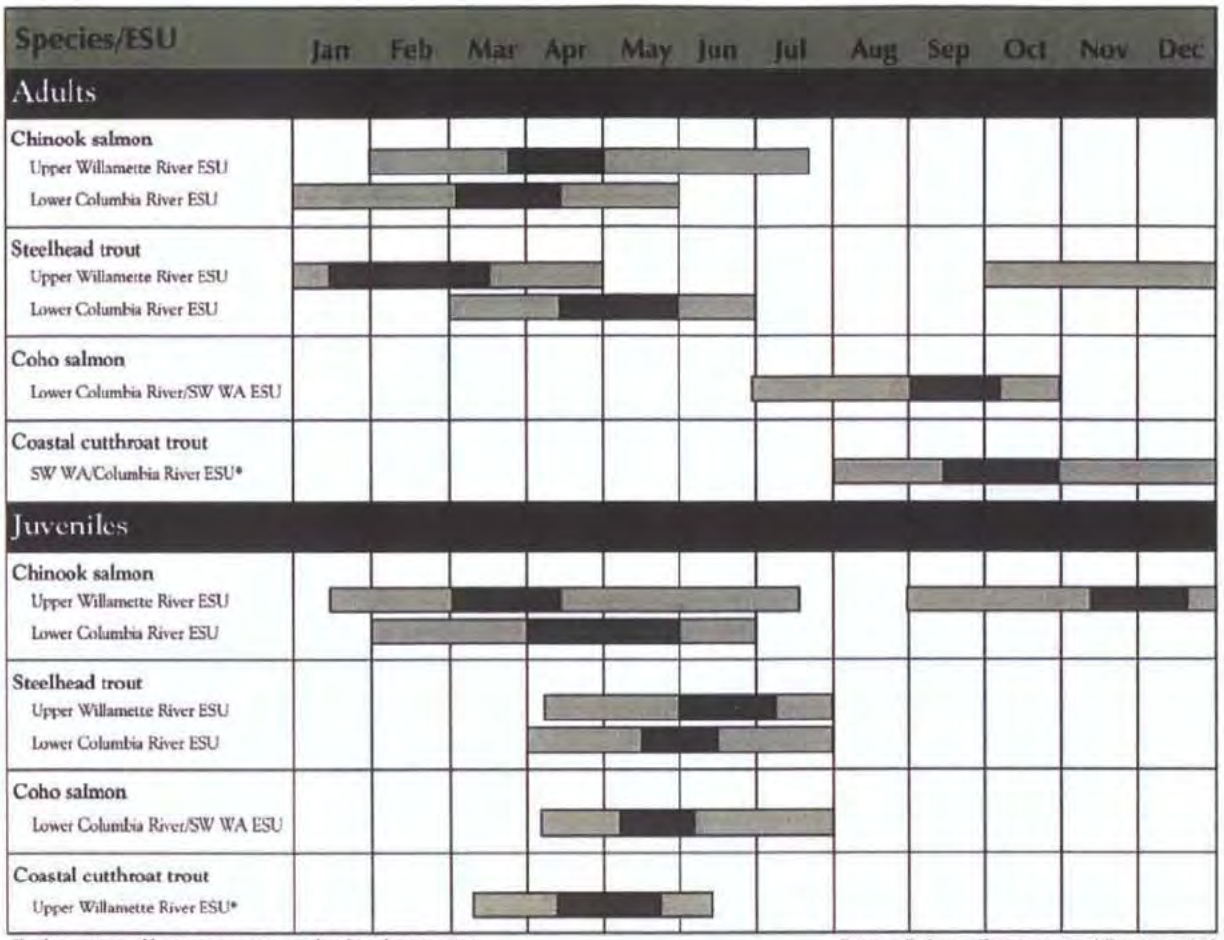


Dark sections of bars represent periods of peak migration

Source: Fishman Environmental Services 2000

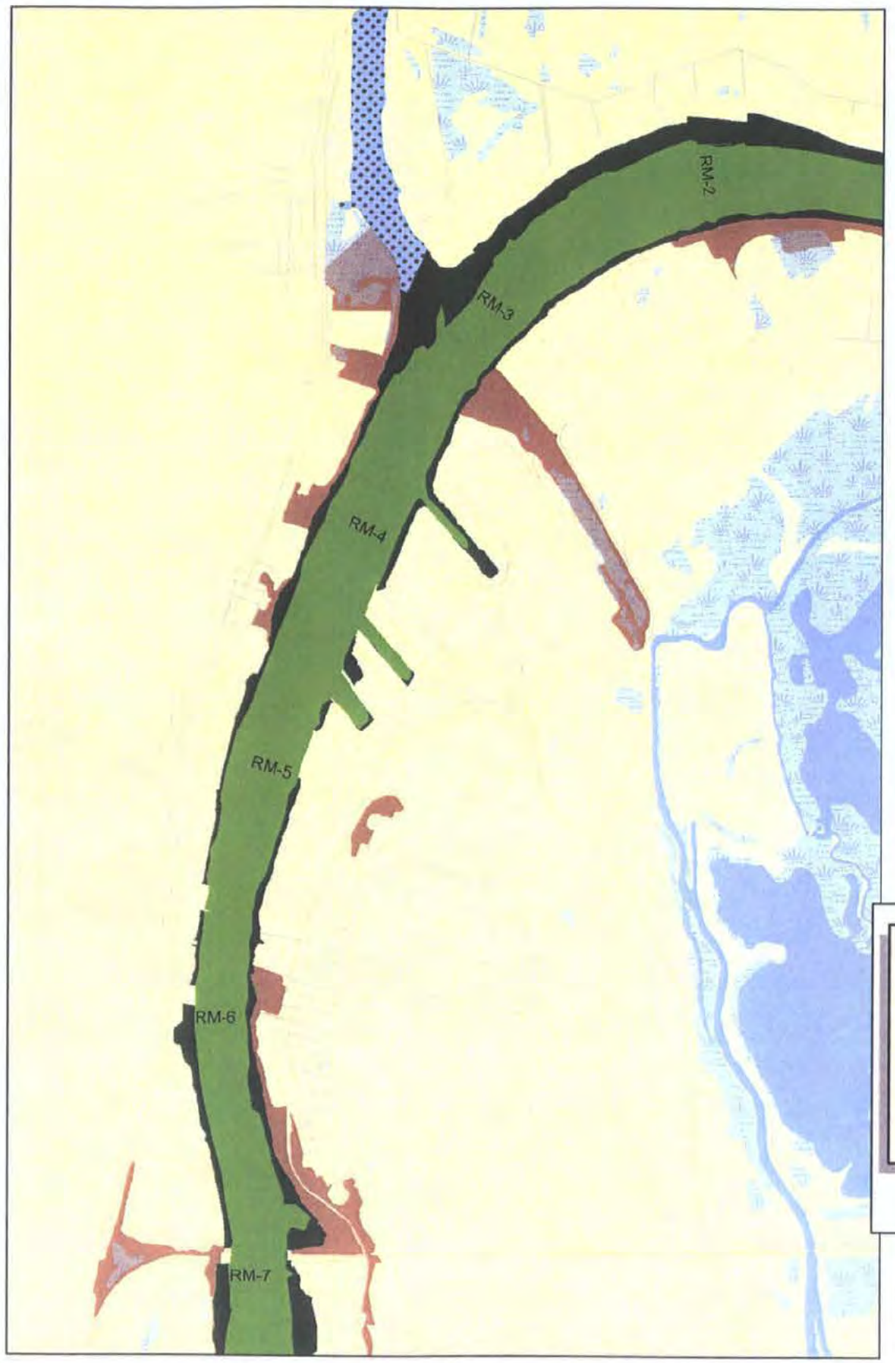
* Best estimate based on limited information for Willamette and Columbia basins

Figure 2-4. Timing of adult and juvenile salmonid migrations in the Willamette River below Willamette Falls

Piscivores		
Smallmouth bass[a]	11	most recaptured <0.5 miles[a]
Black crappie[b]	8	
Northern pikeminnow[a]	30	most recaptured <0.5 miles[a]
Omnivores		
Yellow bullhead[c]		species likely moves in and out of ISA
White sturgeon	5,049	home range up to or greater than 100 miles[d]
Largescale sucker	92	home range up to 37 miles; most recaptured <0.5 miles, although majority of population considered to be transient[e]
Common carp[f]		species likely moves in and out of ISA
Carnivores		
Sculpin*		<1 mi
Peamouth*		species likely moves in and out of ISA
Detritivore		
Pacific lamprey ammocoete*		<1 mi

Note: Shaded area represents maximum recapture distance reported
n - number of recaptures in study
* No information regarding home range of these species has been identified in the literature review; home ranges are estimated
[a] North et al. (2002)
[b] Ward et al. (1991)
[c] Makes local spawning and forage migrations (Scott and Crossman 1973)
[d] Devore and Grimes (1993)
[e] Dauble (1986)
[f] Makes spawning migrations; may be long distance (Panek 1987)

Figure 2-5. Summary of available home range data for fish species considered for receptor selection



River Miles 2-7

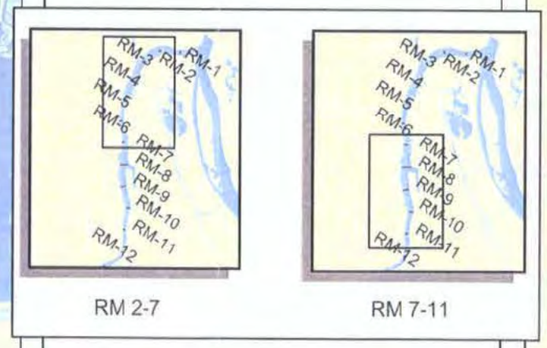
Optimum fish habitat
Fish habitat, Rd1 prelim. results*
Insufficient habitat data
Wetlands
Willamette River Inventory sites
River miles
Railroads
Streets

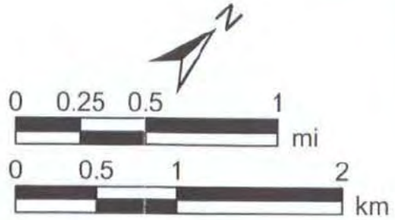
Characteristics of fish habitat**

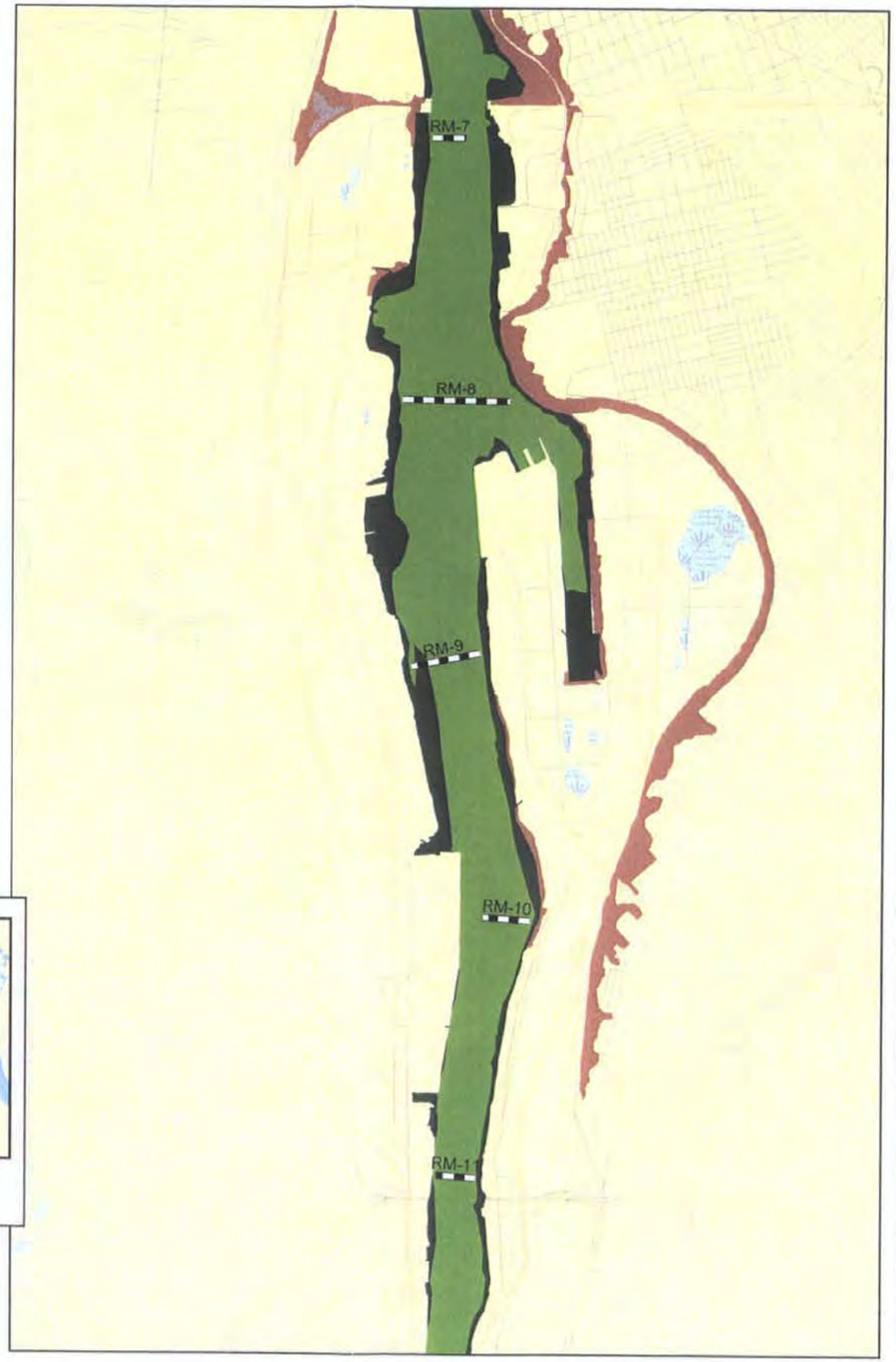
- Riprap or rocky substrate for cover
- Quiescent, shallow areas (<20 ft)

* In 2002 surveys, these fish species were observed in areas characterized in the literature as preferred habitat as well as in areas not characterized as preferred habitat.

** Wydoski and Whitney 1979, Healy 1991, Farr and Ward 1992







River Miles 7-11

Figure 2-6. Smallmouth bass, juvenile chinook, Pacific lamprey, and largescale sucker habitat

Windward

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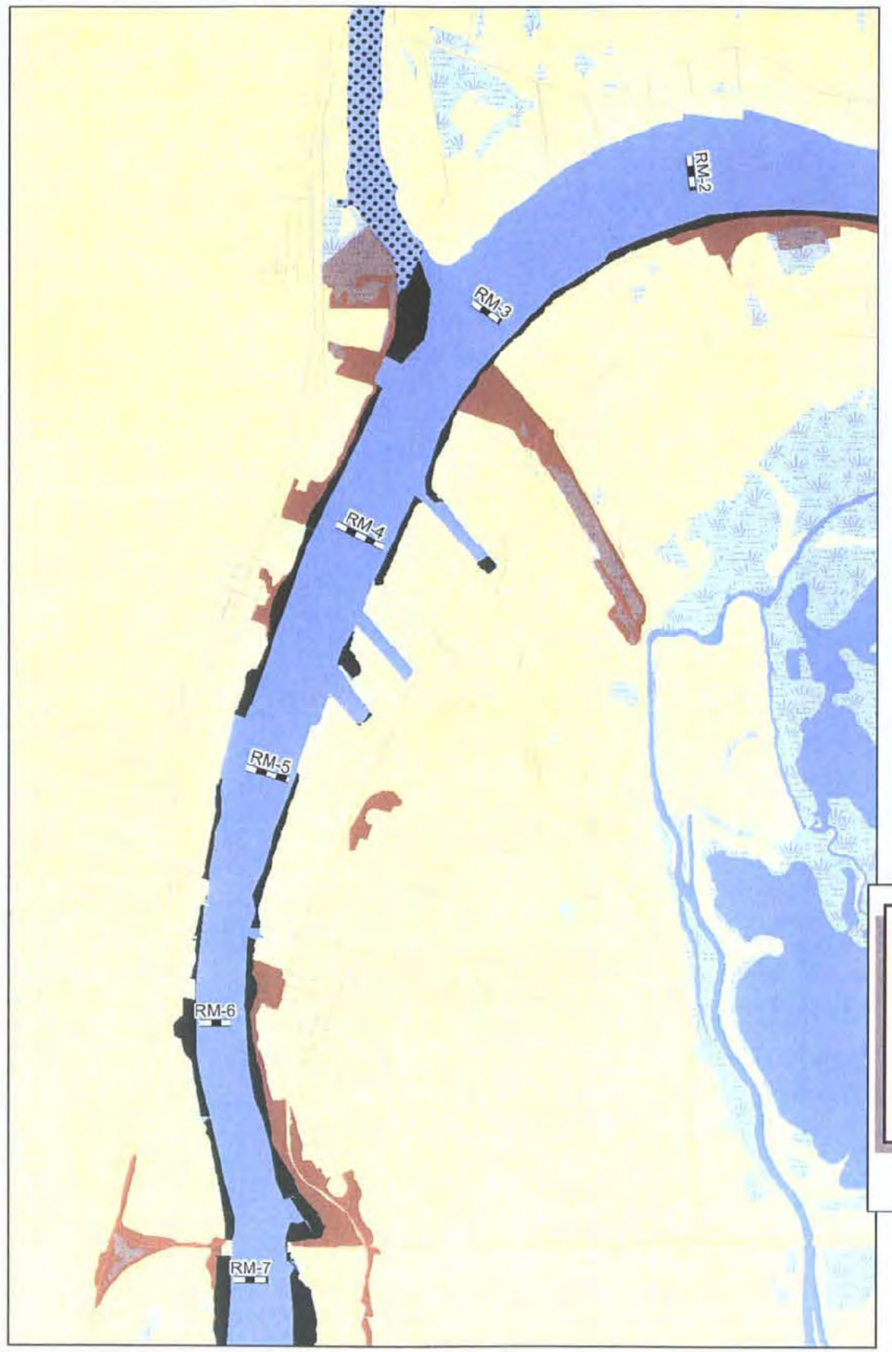


River Miles 2-7

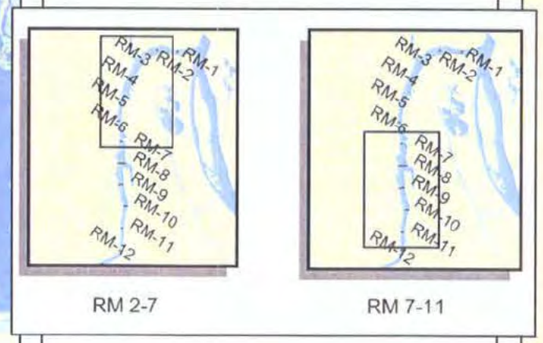
Sculpin and crayfish habitat
Insufficient habitat data
Wetlands
River miles
Willamette River Inventory Sites
Railroads
Streets

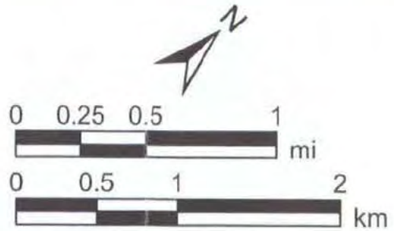
Characteristics of sculpin* and crayfish habitat**

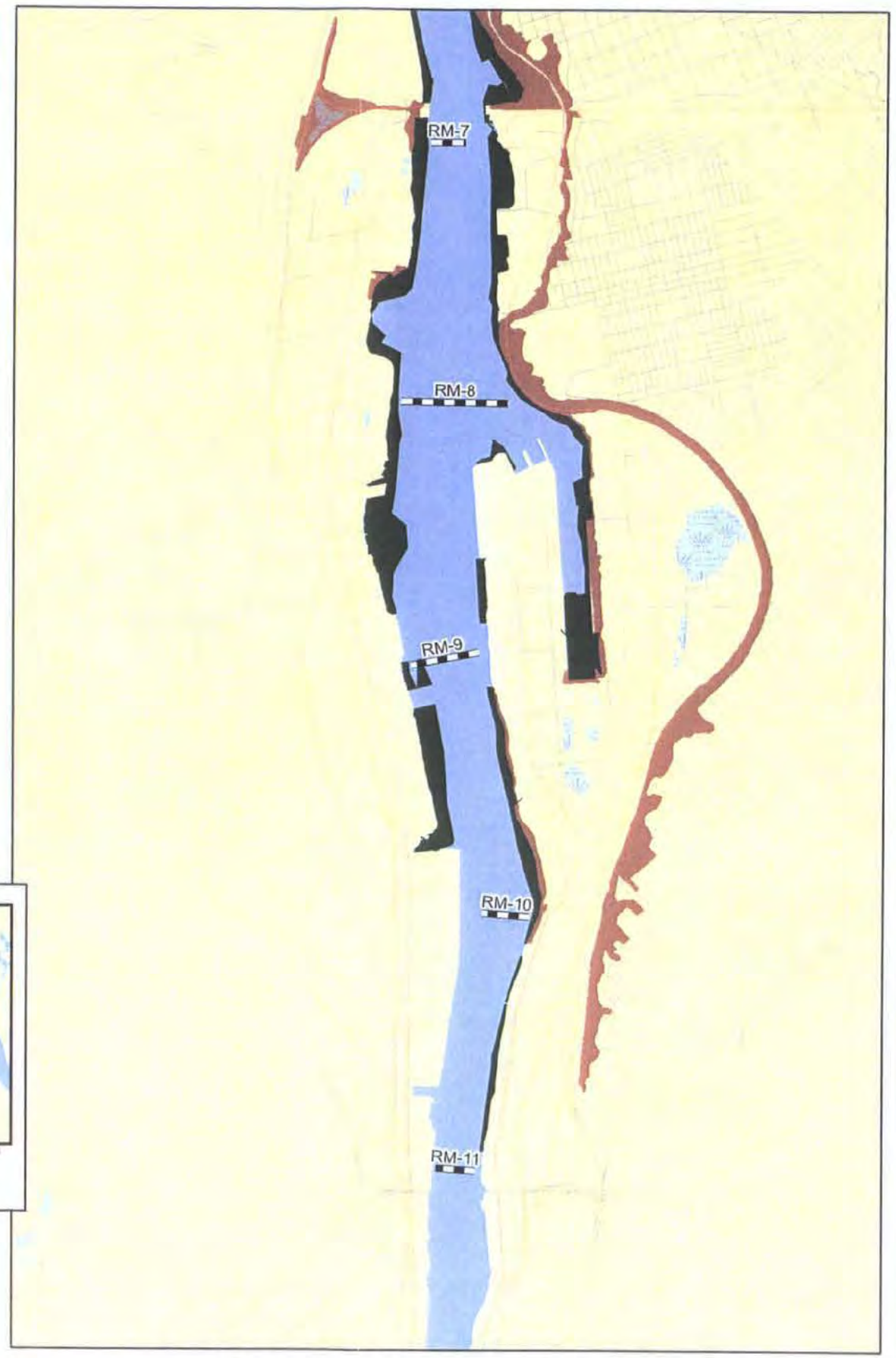
- Riprap or other type of anthropogenically introduced fill for cover
- River beaches
- Less than 20 ft in depth

*Wydoski and Whitney 1979

** Hobbs 2001







River Miles 7-11

Figure 2-7. Sculpin and crayfish habitat

Wind Ward

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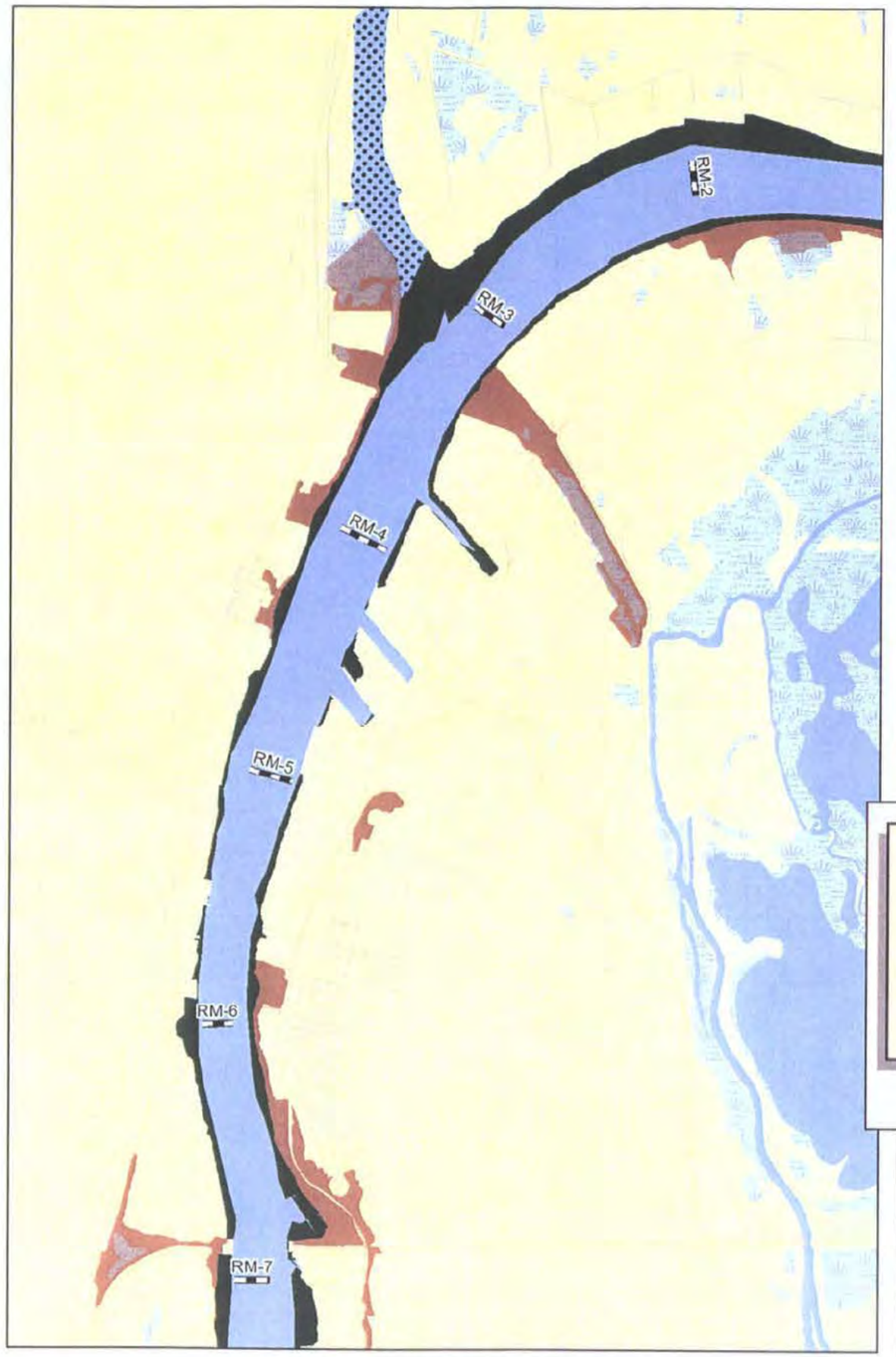


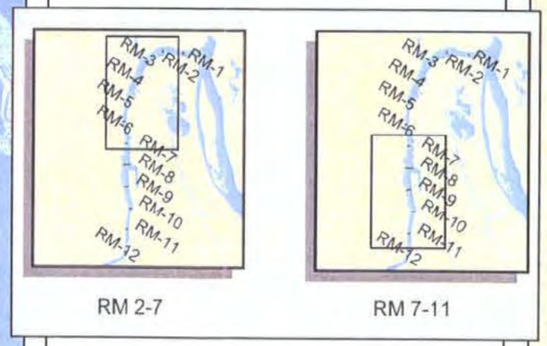
River Miles 2-7

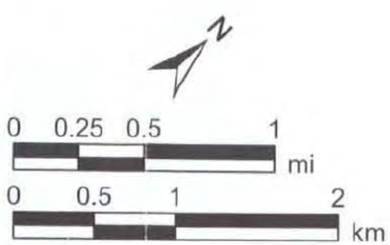
Hooded merganser habitat
Insufficient habitat data
Willamette River Inventory sites
Railroads
Wetlands
Streets
River miles

Characteristics of hooded merganser habitat

- Less than 20 ft in depth*

* Bellrose (1976) shows that hooded merganser habitat encompasses areas less than 5 ft in depth, but June 2002 surveys revealed this species using areas up to approximately 20 ft in depth.





River Miles 7-11

Figure 2-8. Hooded merganser habitat

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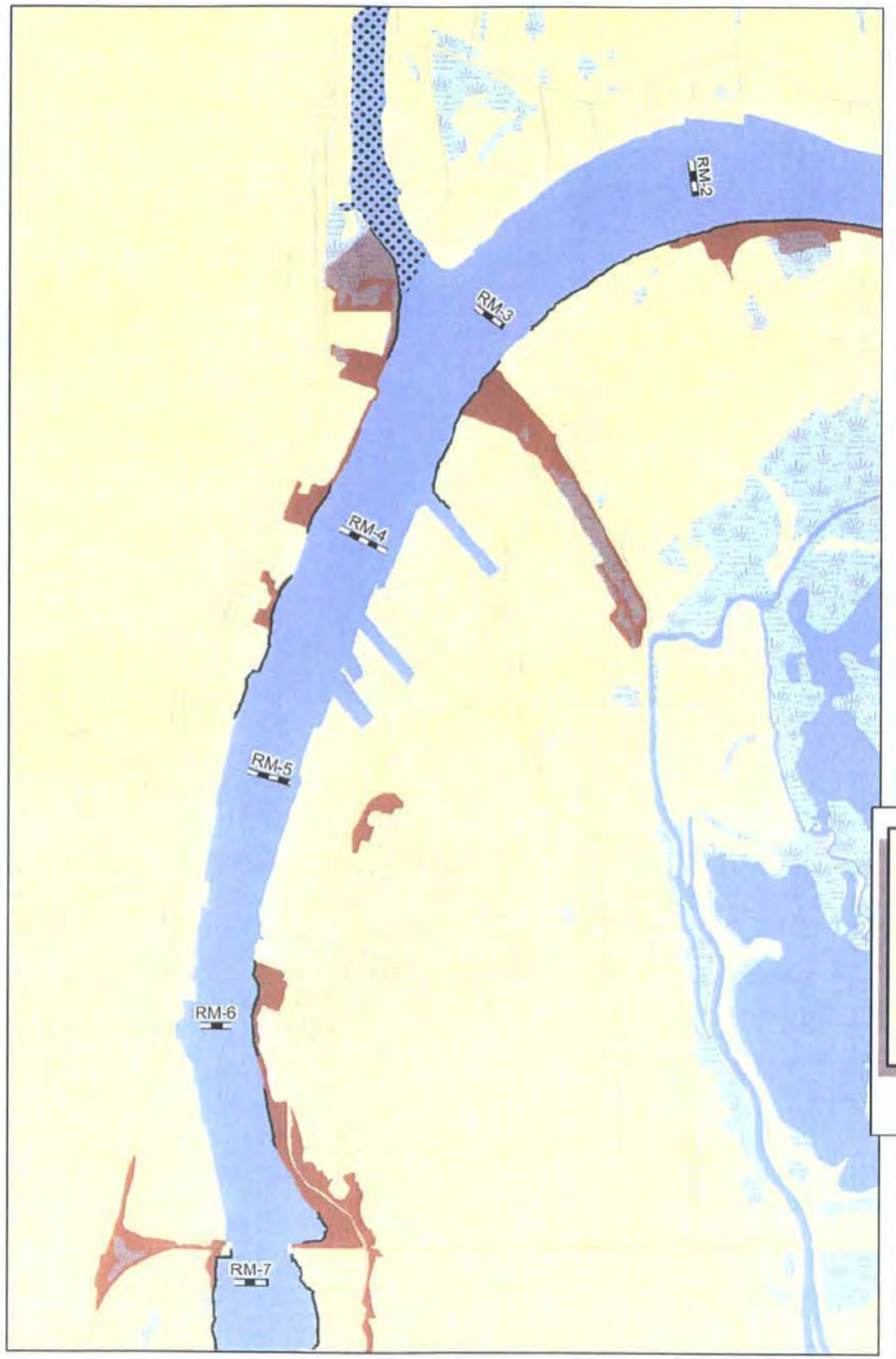


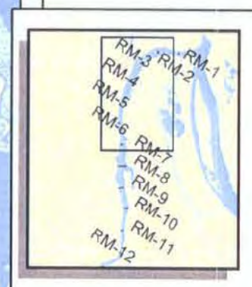
River Miles 2-7

Sandpiper habitat
Insufficient habitat data
Willamette River Inventory sites
River miles
Wetlands
Railroads
Streets

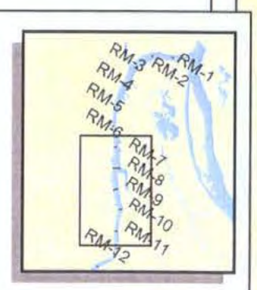
Characteristics of spotted sandpiper habitat

- Shallow gravelly or sandy beaches*

* Csuti et al. 1997



RM 2-7

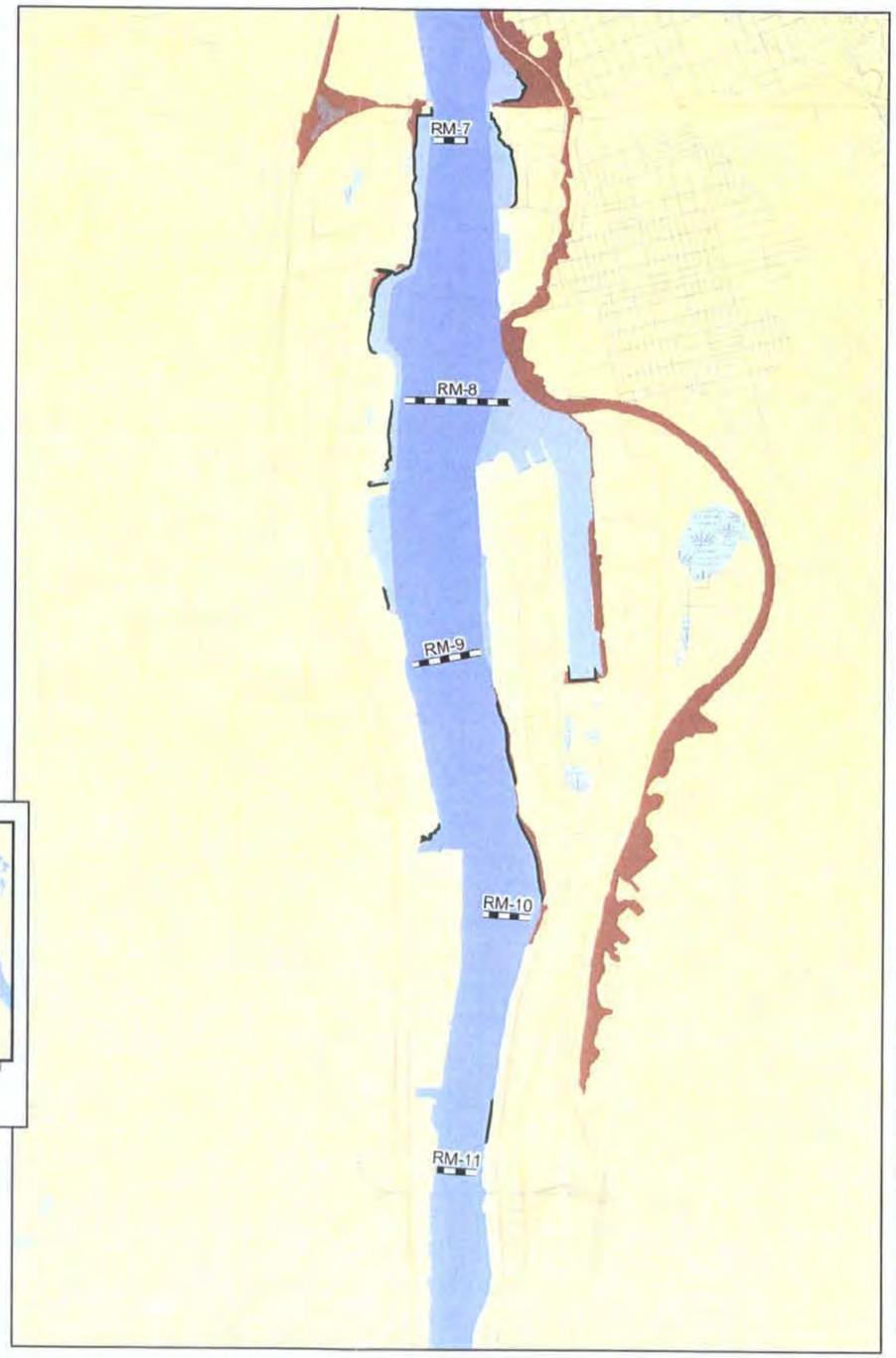


RM 7-11

N

0 0.25 0.5 1 mi

0 0.5 1 2 km



River Miles 7-11

Figure 2-9. Spotted sandpiper habitat

Windward

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W:\Projects\Portland Harbor ERA\Data\GIS

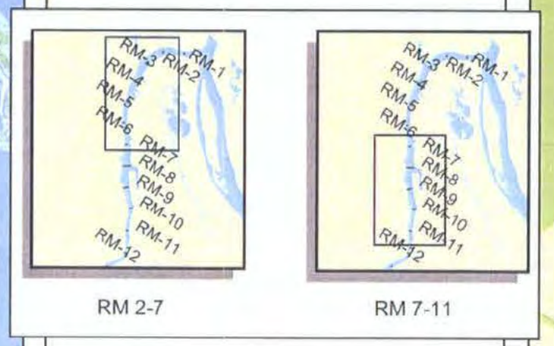
River Miles 2-7

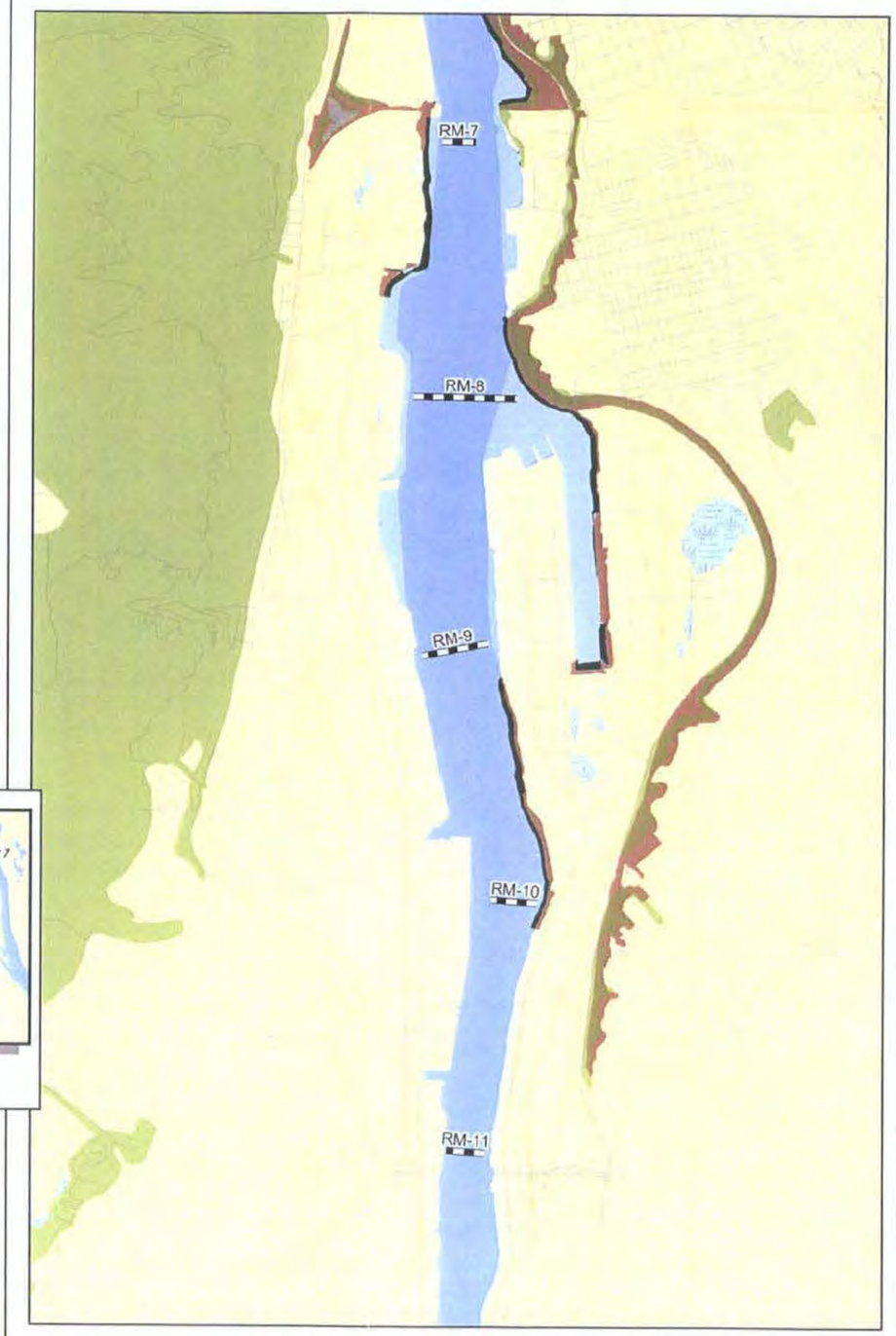
Mink habitat
Insufficient habitat data
Forest
River miles
Wetlands
Willamette River Inventory sites
Railroads
Streets

Characteristics of mink habitat

- Wooded river banks and beaches*
- Connection to forests or wetlands*

* Csuti et al. 1997





River Miles 7-11

N

0 0.25 0.5 1 mi

0 0.5 1 2 km

Figure 2-10. Mink habitat

Wind Ward

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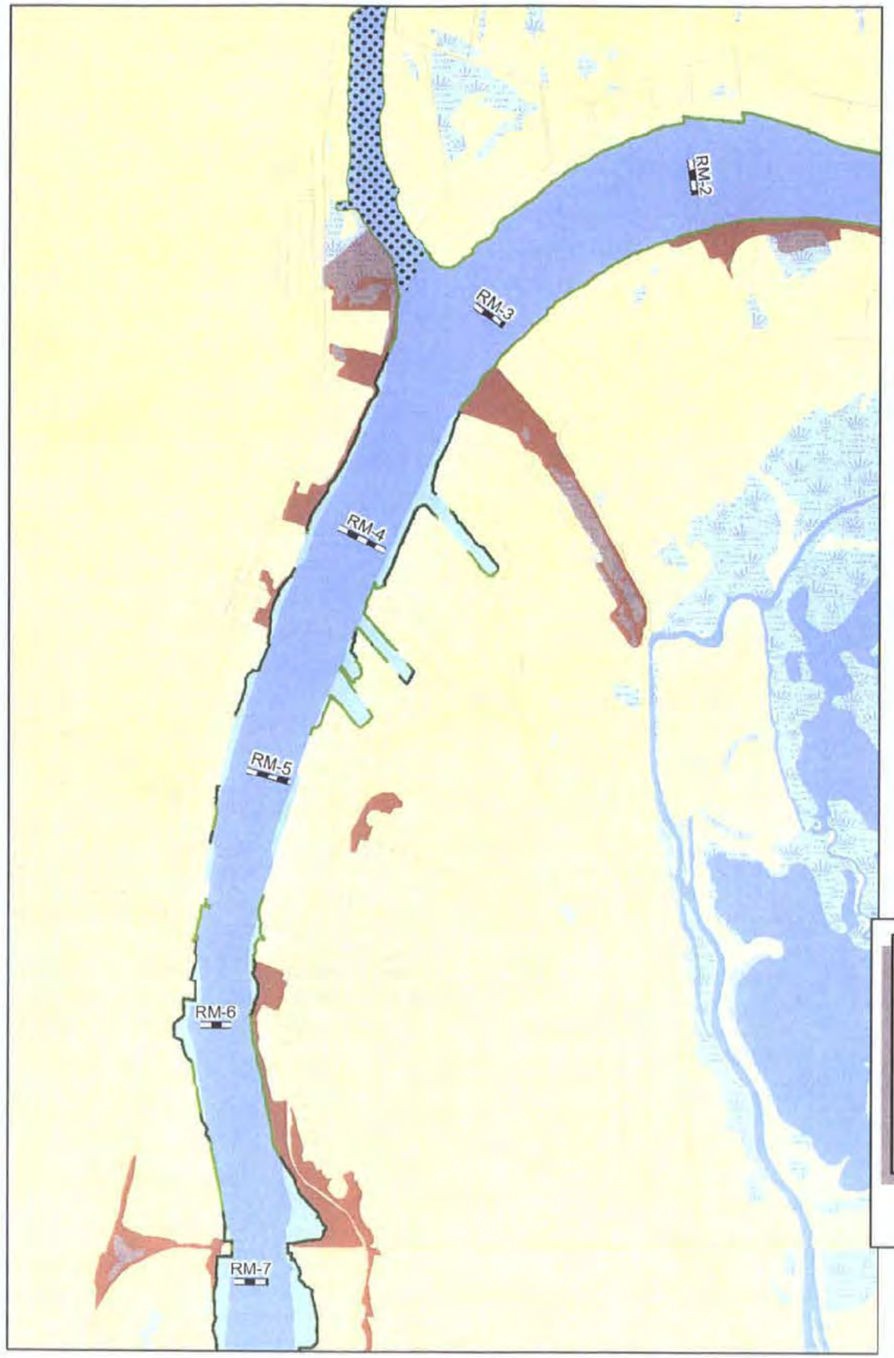


River Miles 2-7

Preferred amphibian habitat
Amphibian habitat, Rd1 results
Insufficient habitat data
Wetlands
Quiescent areas
Willamette River Inventory sites
Railroads
Streets
River miles

Amphibian habitat based on Rd1 preliminary results*

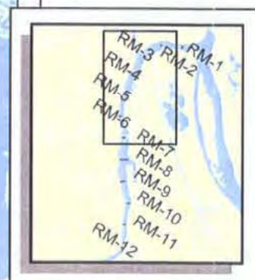
- Vegetated banks

Preferred amphibian habitat

- Quiescent backwater**
- Vegetated banks with connection to wetlands**
- Natural bank conditions or riprap**

*General amphibian habitat determined by the location of amphibians observed during Round 1 surveys.Amphibians were observed on both natural or anthropogenically altered banks, but were not found on banks without vegetation.

** Hayes (2002); Corkran (2002); Hennings (2002); Csuti et al. (1997); Altman et al. (1997), Adolfson et al. (2000)



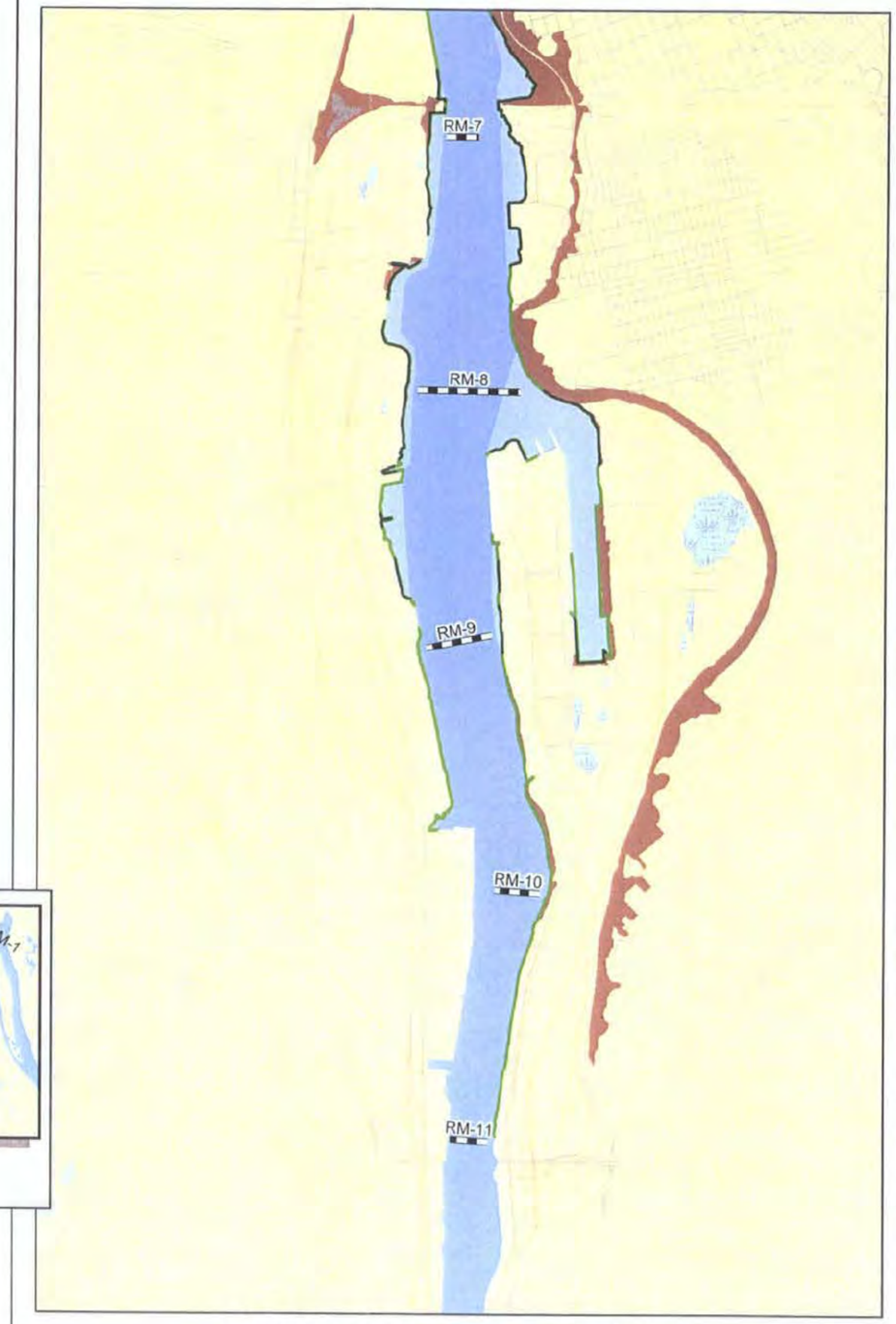
RM 2-7

RM 7-11

N

0 0.25 0.5 1 mi

0 0.5 1 2 km



River Miles 7-11

Figure 2-11. Amphibian habitat

Windward

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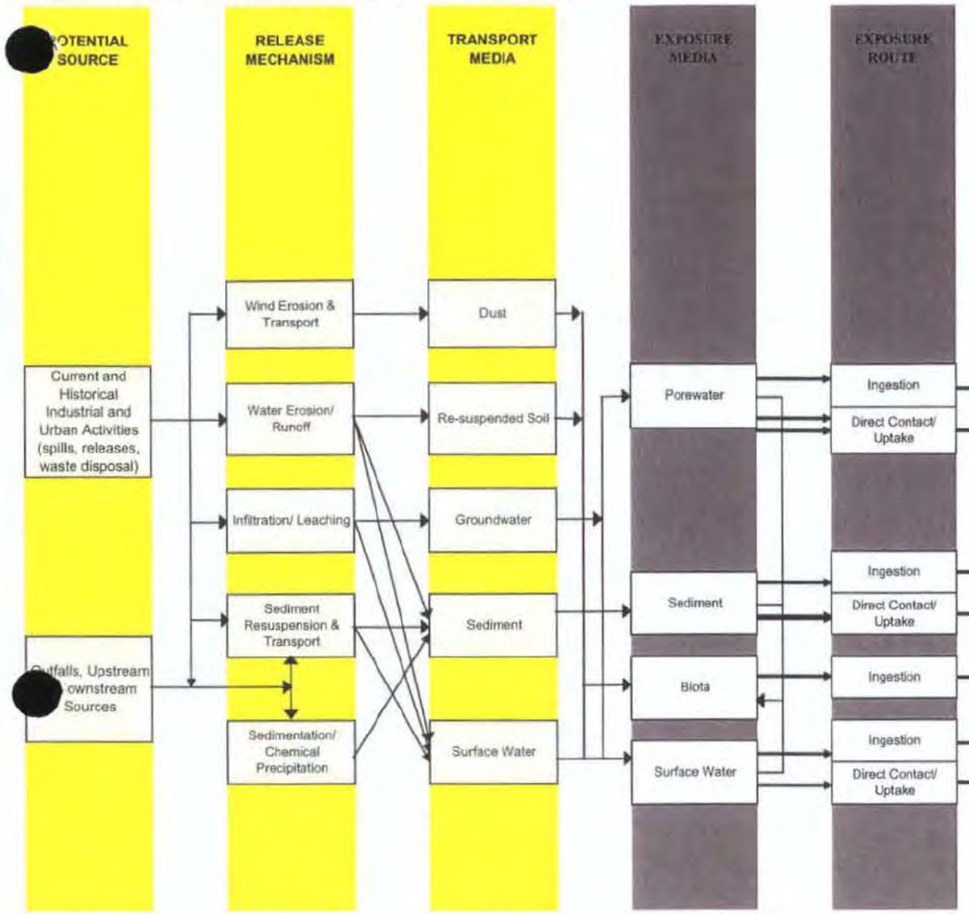
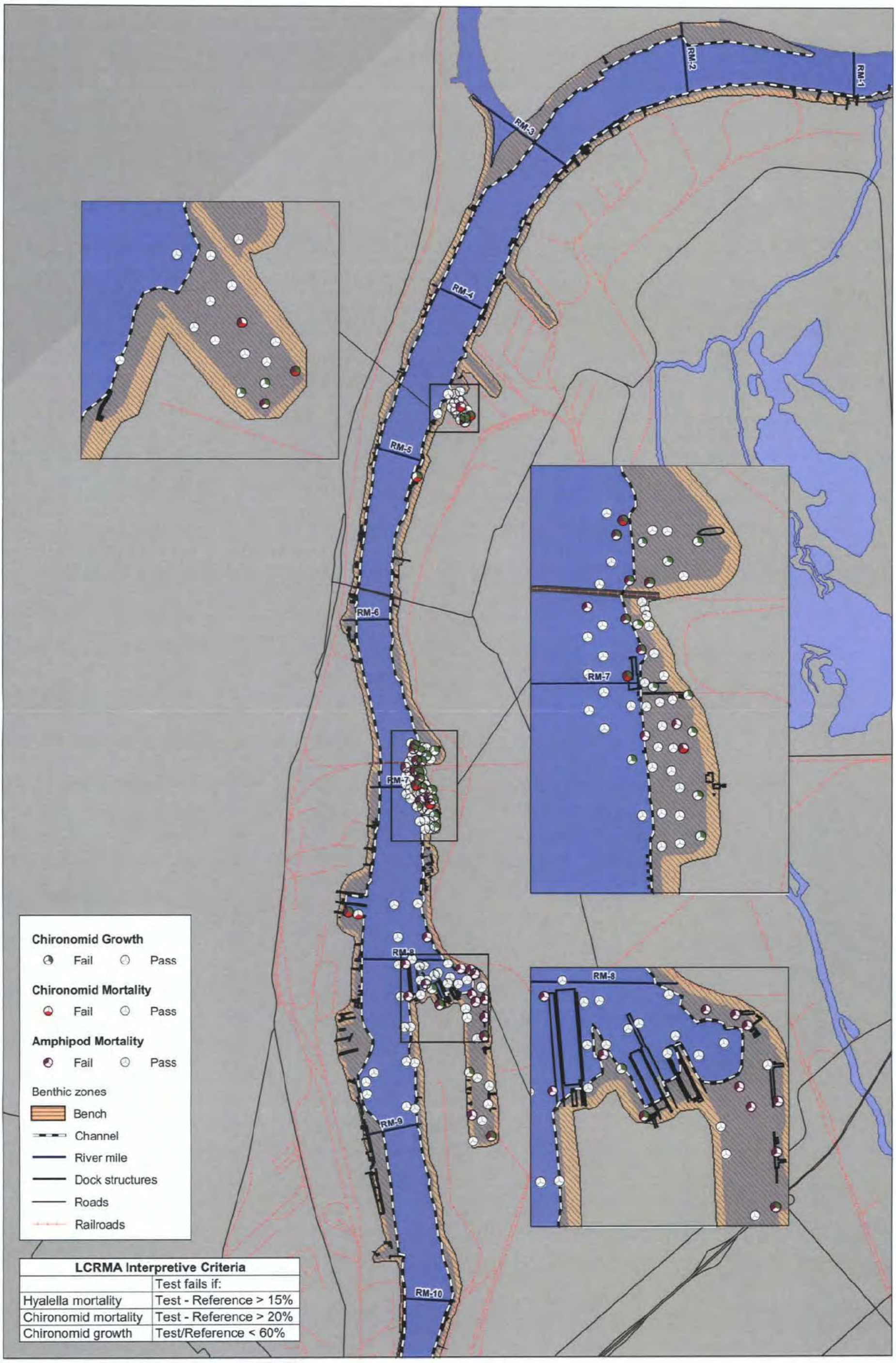
Figure 2-12. Preliminary ecological conceptual site model



RECEPTOR																
Ecological																
Plants	Invertebrates			Fish							Amphibians/ Reptiles	Birds				Mammals
Aquatic Plants	Infauna	Epifauna	Macrofauna	Omnivore/ Herbivore	Carnivore			Piscivore		Detritivore	Amphibians	Piscivore		Diving carnivore	Sediment probing invertivore	Carnivore
			Crayfish	Largescale sucker	Sculpin	Peamouth	Juvenile Chinook salmon	Smallmouth bass	Northern pikeminnow	Pacific lamprey ammocoete		Osprey	Bald Eagle	Hooded merganser	Spotted Sandpiper	Mink
na	◇	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
□	◇	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
na	◆	◆	◆	◆	◆	◇	◇	•	•	◆	◇	•	•	◆	◆	◆
◆	◆	◆	•	◆	◆	•	•	•	•	◆	◇	•	•	•	◇	•
na	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
na	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	•	•	•	•	•

◆ Complete and major
• Complete and minor
◇ Complete and uncertain
□ Incomplete
"na" not applicable



LCRMA Interpretive Criteria	
	Test fails if:
Hyalella mortality	Test - Reference > 15%
Chironomid mortality	Test - Reference > 20%
Chironomid growth	Test/Reference < 60%

Figure 3-1. Lower Willamette River historical bioassay results (Windward interpretation)

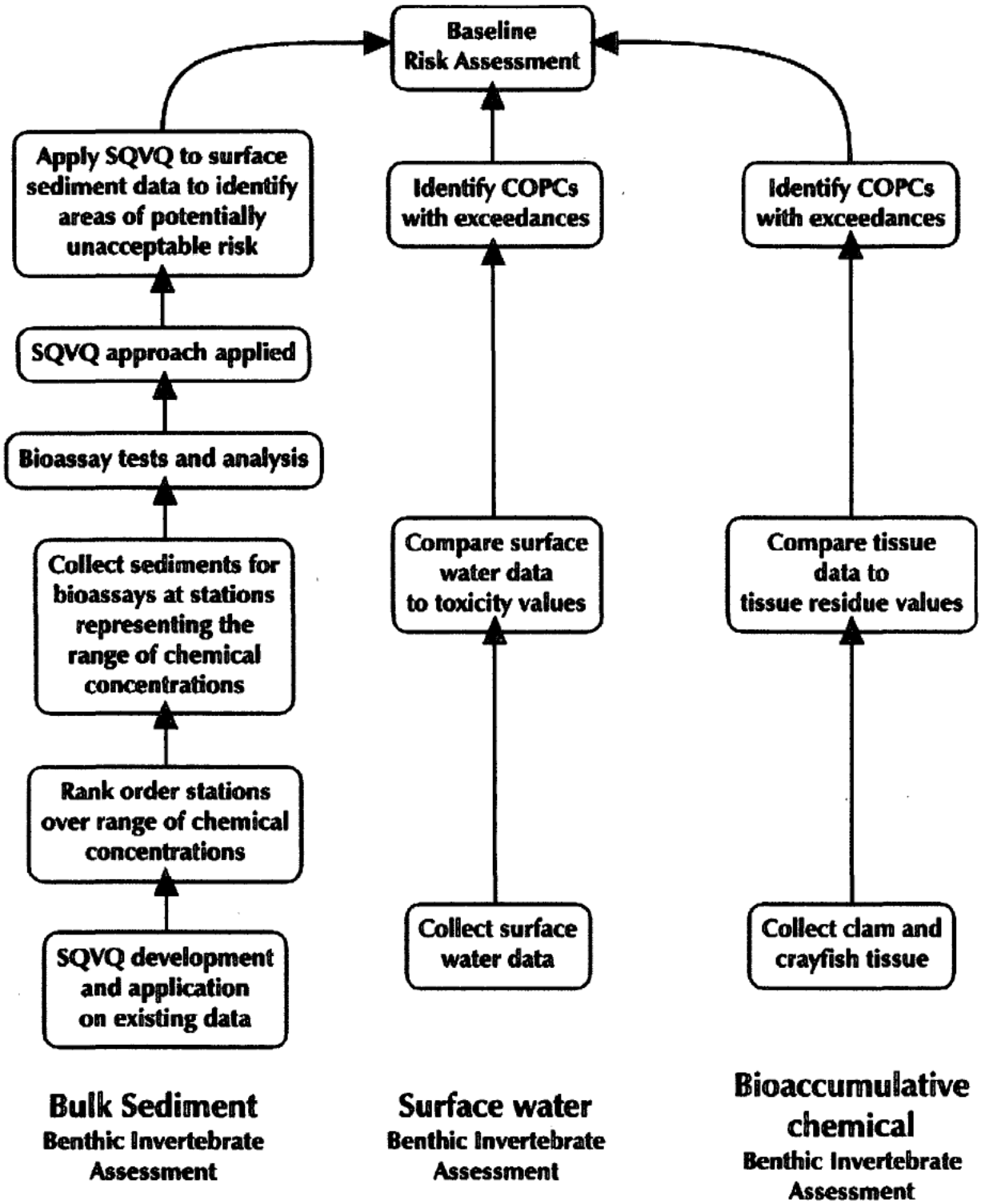


Figure 5-1. Assessment of benthic community

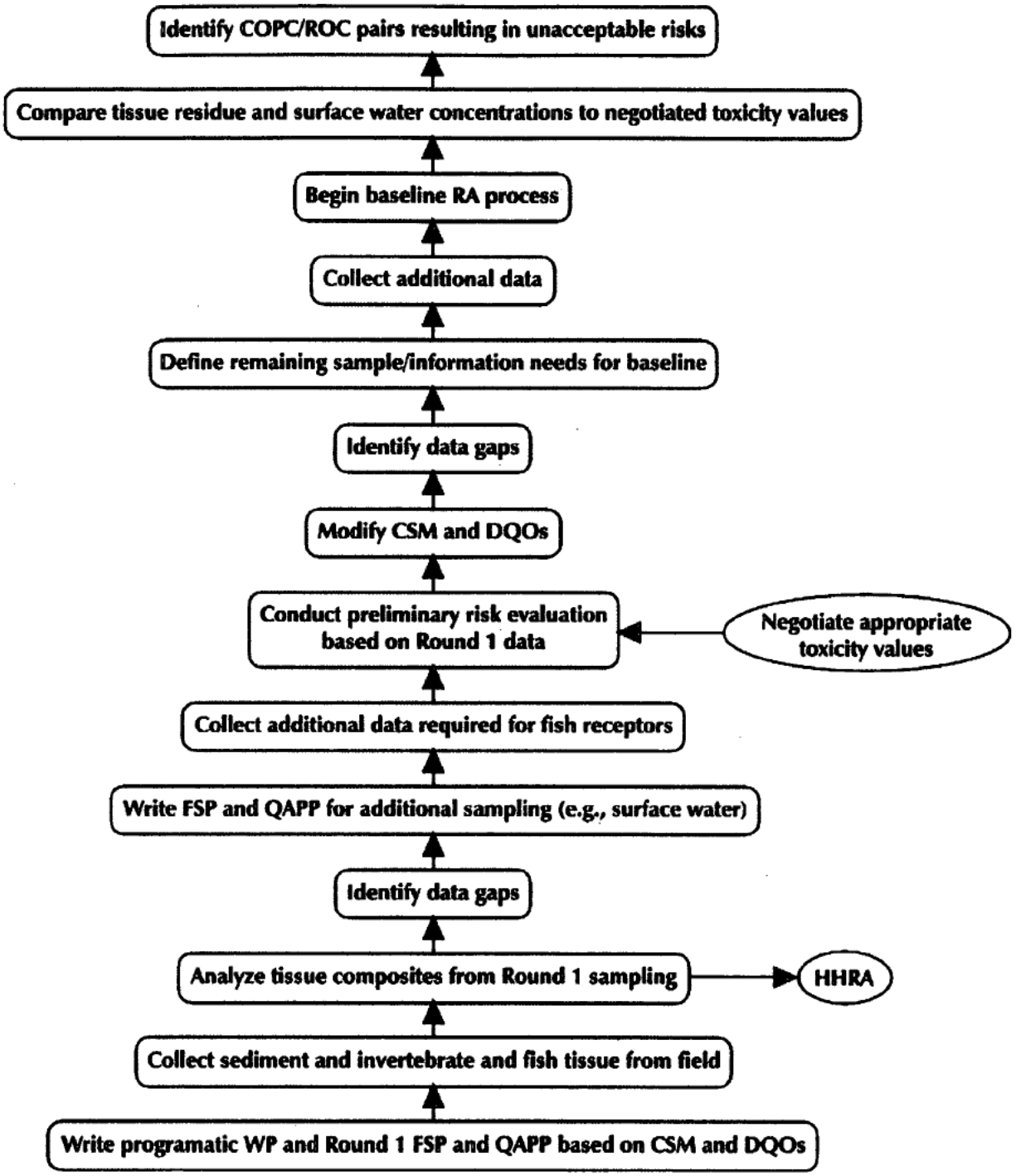


Figure 5-2. Fish receptor assessment

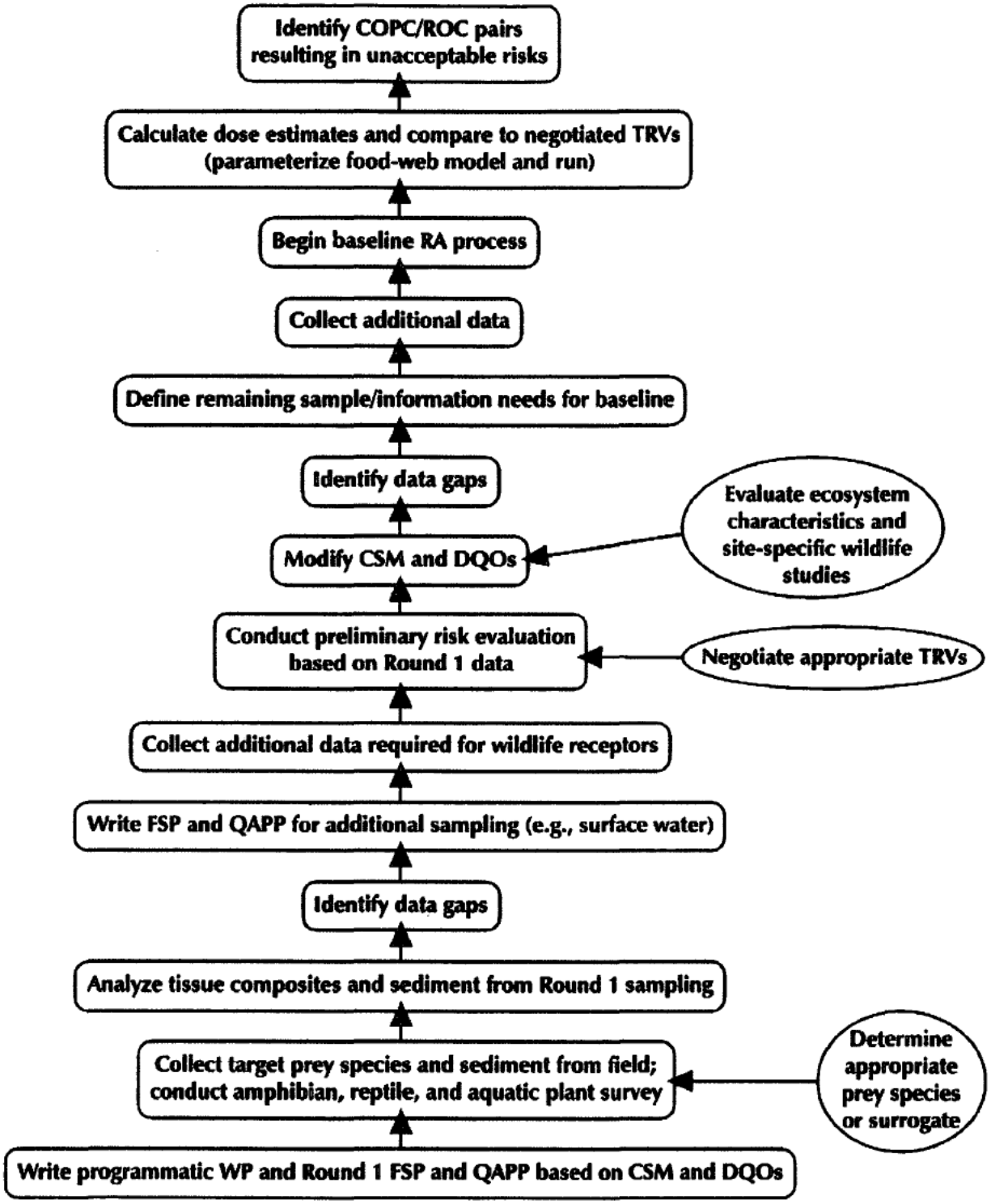


Figure 5-3. Wildlife receptor assessment

Portland Harbor RI/FS
Round 1 Work Plan
Revised Draft Final

APPENDIX B:
ECOLOGICAL RISK ASSESSMENT APPROACH

ATTACHMENTS B1 THROUGH B9

Prepared for

LWG
LOWER WILLAMETTE GROUP
Portland, OR

For submittal to

US Environmental Protection Agency
Region 10
Seattle, WA

November 13, 2003

Prepared by:

Windward environmental LLC
200 West Mercer Street, Suite 401 • Seattle, Washington • 98119

Table of Contents

ATTACHMENT B1: BENTHIC MACROINVERTEBRATE COMMUNITY SAMPLING **1**
SUBATTACHMENTB1A: EPIBENTHIC SAMPLING FIELD REPORT 23

ATTACHMENT B2: AQUATIC PLANT AND AMPHIBIAN/REPTILE RECONNAISSANCE SURVEY **31**
SUBATTACHMENT B2A: PHOTOGRAPHS 46

ATTACHMENT B3: LAMPREY AMMOCOETE AND BENTHIC INFAUNAL BIOMASS RECONNAISSANCE SURVEYS OF THE LOWER WILLAMETTE RIVER **49**

ATTACHMENT B4: PROPOSED PROCESS FOR ASSESSMENT OF BENTHIC RISKS AT THE PORTLAND HARBOR SUPERFUND SITE **55**

ATTACHMENT B5: ECOTOXICOLOGICAL PROFILES **64**

ATTACHMENT B6: PORTLAND HARBOR ROUND 1 FISH TRV SELECTION **83**

ATTACHMENT B7: A REVIEW OF AQUATIC FOOD WEB MODELS FOR POTENTIAL APPLICATION TO THE PORTLAND HARBOR SUPERFUND SITE **88**

ATTACHMENT B8: FISH STOMACH CONTENT SCREENING **100**

ATTACHMENT B9: PORTLAND HARBOR ROUND 1 BIRD AND MAMMAL TRV SELECTION **107**

ATTACHMENT B1: BENTHIC MACROINVERTEBRATE COMMUNITY SAMPLING

1.0 INTRODUCTION

Benthic invertebrates serve various functions in large river ecosystems. They often comprise a significant portion of the heterotrophic biomass in a river system (Jahn and Anderson 1986), and therefore serve as a principal food resource for higher-trophic-level consumers. Invertebrates also control energy flow by acting as the principal processor of organic matter (Merritt et al. 1984).

Benthic invertebrates utilize various habitat types within a large river ecosystem. These habitats can generally be divided into soft and hard substrates, with soft substrates supporting an infaunal community and hard substrates an epifaunal community. These habitats are typically quite different in their community structure and function.

To date, limited studies have been conducted to quantify the infaunal and epibenthic community in the Lower Willamette River. Hjort et al. (1984) studied the epibenthic community associated with reveted banks well upstream from the ISA; Ward et al. (1988) collected benthic samples from hard and soft substrate from 5 stations in the ISA; Tetra Tech (1994) sampled the infaunal community from six stations in the LWR as part of an assessment of the entire Willamette River; Dames and Moore (1998) sampled the infaunal community from several stations near Swan Island; and Landau (2000) collected epibenthic and infaunal invertebrates from hard and soft substrates around Ross Island. The above studies suggest that oligochaete worms and chironomid larvae (midges) dominate the benthic macroinvertebrate community in the LWR.

Benthic communities vary spatially; so more sampling was needed to characterize the infaunal and epibenthic communities within the ISA (RM 3.5 to 9.2). Therefore, in support of the Portland Harbor ecological risk evaluation, the lower Willamette Group (LWG) conducted separate surveys of the infaunal and epibenthic macroinvertebrate communities of the lower Willamette River (LWR).

In October of 2002, Striplin Environmental Associates collected grab samples of the infaunal community from 22 stations between RM 2.4 and 9.8 of the LWR. Direct quantitative sampling of the epibenthic macroinvertebrate community, however, is more difficult. Artificial substrates that can be colonized by epibenthic macroinvertebrates are one accepted methodology for collecting a surrogate sample of an epibenthic community (ASTM 1997). Therefore, in order to sample the epibenthic macroinvertebrate community, Windward Environmental deployed artificial substrates between river mile 3.5 and 9.2 of the LWR in the summer of 2002. As specified in the Round 1A Sampling and Analysis Plan (SAP) (Striplin et al. 2002b) and the Round 1 Field Sampling Plan (Striplin et al. 2002a), these surveys will be used to develop an understanding of the potential exposure pathways to fish and other wildlife associated with benthic communities in the ISA.

2.0 OBJECTIVES

The objective of these studies was to develop a better understanding of the structure of the epibenthic and infaunal macroinvertebrate communities for use in the preliminary risk evaluation. Understanding which organisms are present and their relative abundances will allow for a more accurate description of potential exposure pathways to fish and other wildlife associated with benthic habitats in the LWR and greater refinement of the conceptual site model.

3.0 METHODS

This section describes the field methods used obtain samples of the infaunal and epibenthic invertebrate communities and the laboratory methods used to enumerate and identify the macroinvertebrate species present.

3.1 Field Methods

3.1.1 Epibenthic community collection

3.1.1.1 Artificial substrate deployment

Hester-Dendy multiplate samplers were used as an artificial substrate to characterize the composition of the epibenthic community at ten stations within the lower Willamette River ISA and at two upstream reference stations (Figure 1). Four of the stations within the ISA were located in protected backwater areas and six were at locations adjacent to the river channel. One reference station was located adjacent to the river channel and one was located in a more protected, shallow embayment.

EPA-style, round Hester-Dendy multiplate samplers were used. This style sampler consists of fourteen 3-in.-diameter plates made of tempered hardboard. The plates are separated by spacers to allow for a range of species to colonize the open substrate. Each sampler provides a surface area of 0.116 m^2 for colonization.

Three separate arrays of multiplate samplers, with seven samplers per array, were deployed at each of 12 stations, for a total of 252 multiplate samplers (Figure 2). At each station, one array was for the assessment of epifaunal community structure, the second array was for tissue analysis, and the third array was a backup array in case of sampler loss. The sampler arrays were randomly selected for the various analyses just prior to recovery. Because at least five replicate multiplate samplers are necessary to ensure statistical precision and accuracy (ASTM 1997), each array consisted of seven multiplate samplers to allow for potential sampler loss while still retaining an adequate number for statistical precision. Where more than five replicate multiplate samplers remained at the time of recovery, five were randomly chosen for processing.

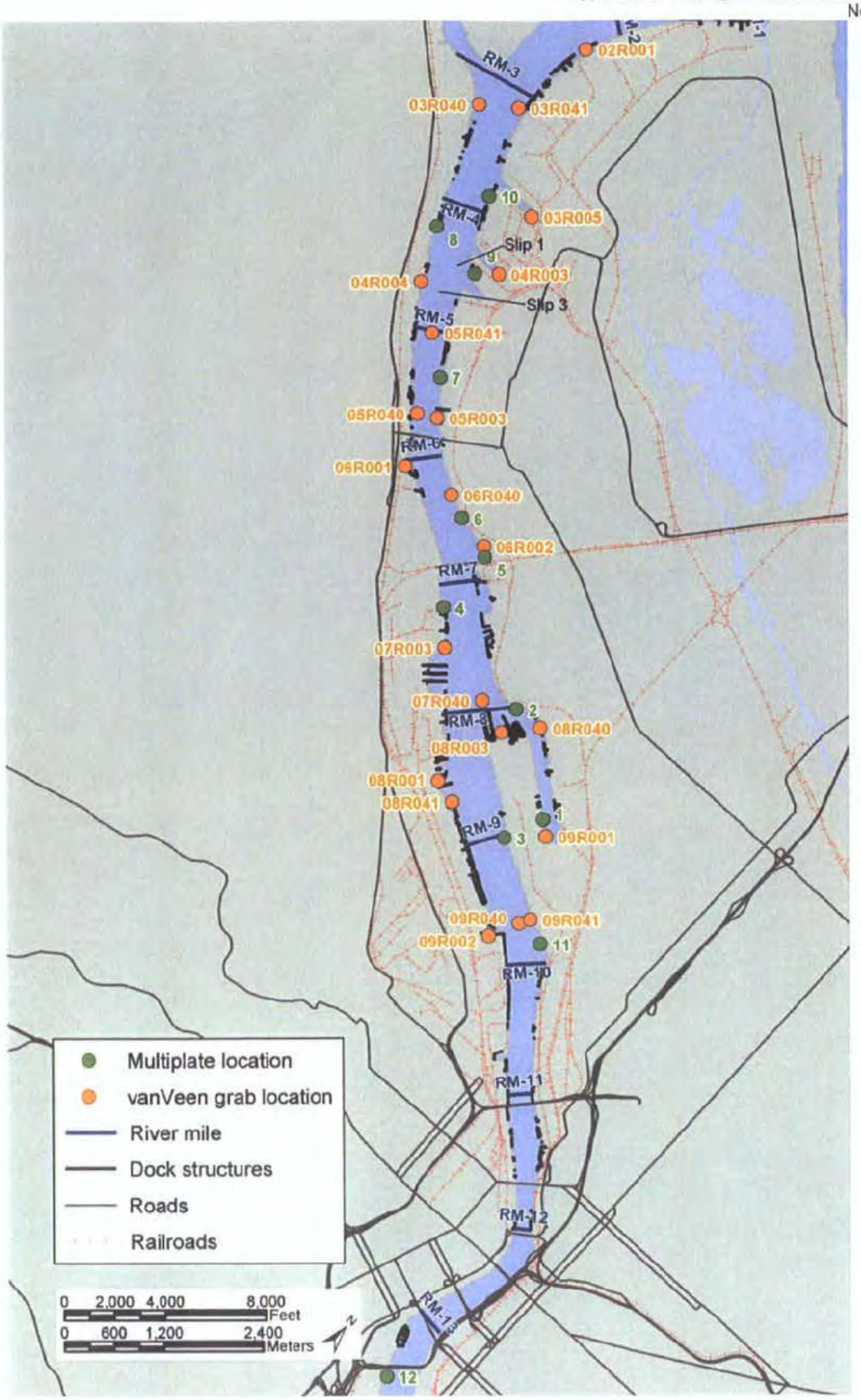


Figure 1. Locations of benthic community samples

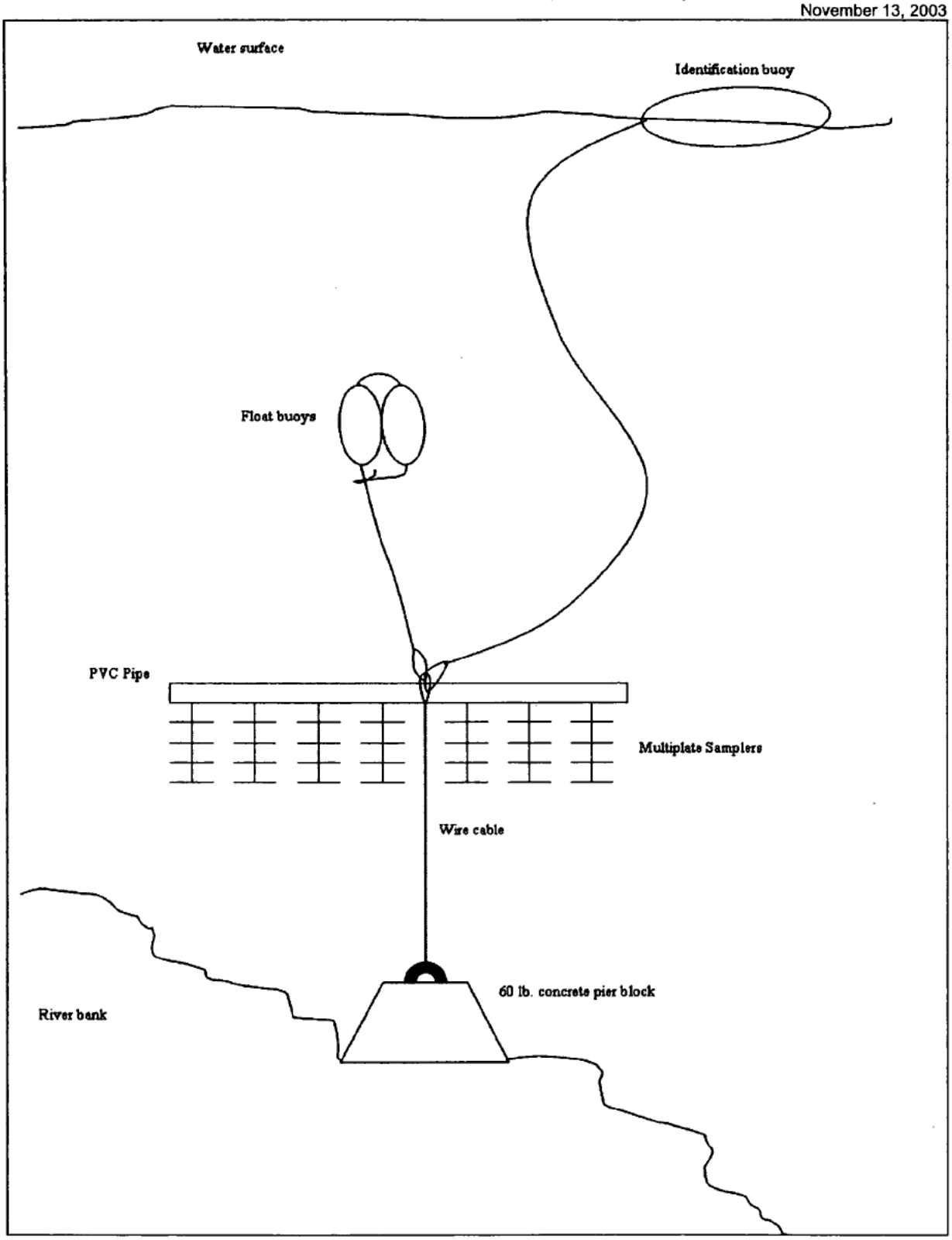


Figure 2. Design scheme for an array of 7 multiplate samplers

Multiplate sampler arrays were anchored with a double-buoy system (Figure 2) to maintain the samplers at a constant distance of ~1 meter above the river-bottom to prevent excessive siltation if the river depth fluctuated during the deployment. Each identification buoy and float buoy was labeled with the sample station number (1-12) and the array replicate identification (A, B, or C) for easy identification during retrieval. Each individual multiplate sampler on an array was also labeled with the station number, array identification, and multiplate sampler replicate number (1-7). The samplers were deployed on July 15th and 16th, 2002 and were retrieved six weeks later on August 27th and 28th, 2002. A hand-held global positioning system (GPS) unit was used to determine the geographic coordinates of each sample station at the time of deployment. Station coordinates are presented in Table 1.

Table 1. Multiplate sampler location and deployment information

Station #	LWG #	Location		Date Deployed	Date Retrieved
		Lat. (N)	Long. (W)		
LWG01	08R034	45° 33.77'	122° 42.63'	7/15/02	8/28/02
LWG02	08R033	45° 34.19'	122° 43.51'	7/15/02	8/28/02
LWG03	09R027	45° 33.51'	122° 42.78'	7/16/02	8/28/02
LWG04	07R024	45° 34.36'	122° 44.66'	7/15/02	8/27/02
LWG05	06R028	45° 34.79'	122° 44.69'	7/15/02	8/27/02
LWG06	06R027	45° 34.88'	122° 45.10'	7/15/02	8/27/02
LWG07	05R020	45° 35.47'	122° 46.14'	7/15/02	8/27/02
LWG08	04R025	45° 36.19'	122° 47.12'	7/16/02	8/28/02
LWG09	04R026	45° 36.13'	122° 46.56'	7/16/02	8/28/02
LWG10	03R030	45° 36.57'	122° 46.95'	7/16/02	8/28/02
LWG11	09R028	45° 33.15'	122° 41.86'	7/16/02	8/27/02
LWG12	13R001	45° 30.36'	122° 40.20'	7/16/02	8/27/02

3.1.1.2 Artificial substrate retrieval

Before retrieval, array replicates were randomly assigned for taxonomic identification, tissue analysis, or archiving, and 5 multiplate replicates on the array chosen for taxonomic identification were randomly chosen for preservation. During sampler retrieval, the array selected for taxonomic identification was collected first. Samplers were suspended just above water level and the five replicates selected for preservation were immediately clipped into individual Ziploc bags. The multiplate samplers were immediately preserved in approximately 500 mL of 95% denatured alcohol and triple bagged to prevent loss of preservative. Each sampler was then labeled with station location and identification number, retrieval date, and multiplate sample identification. The multiplate samplers were placed in coolers and shipped overnight to Ecoanalysts, Inc. in Moscow, Idaho for sorting and taxonomic identification.

Of the thirty-six arrays deployed in the lower Willamette, only one array (station LWG06) was vandalized. It was found pulled up on shore and, therefore, was not used. Every other array was found in its original deployment location with at least 6 multiplate samplers still attached. Five of the 35 remaining arrays were missing one multiplate sampler, but all other arrays retained all seven multiplate samplers. Detailed notes from the deployment and retrieval are included in the field report in subattachment B1A, and a list of the array and multiplate replicates assigned for taxonomic analysis is presented in Table 2.

Table 2. Multiplate arrays and replicates randomly selected for taxonomic analysis

Station #	LWG #	Taxonomic Array	Multiplate Sampler Replicates Used
LWG01	08R034	B	2, 3, 4, 6, 7
LWG02	08R033	A	1, 2, 3, 5, 7
LWG03	09R027	B	1, 3, 4, 5, 7
LWG04	07R024	C	1, 2, 3, 4, 6
LWG05	06R028	A	1, 3, 5, 6, 7
LWG06	06R027	B	1, 2, 3, 4, 5
LWG07	05R020	B	1, 3, 4, 5, 6
LWG08	04R025	A	3, 4, 5, 6, 7
LWG09	04R026	C	1, 2, 4, 5, 7
LWG10	03R030	A	1, 4, 5, 6, 7
LWG11	09R028	C	1, 4, 5, 6, 7
LWG12	13R001	A	1, 2, 3, 6, 7

3.1.2 Infaunal community collection

Infaunal benthic community sampling was conducted from October 22 to October 25, 2002. Samples were collected from 22 stations within the lower Willamette ISA using a 0.1 m^2 van Veen grab sampler. The van Veen sampler captures sediment and associated fauna from a 0.1 m^2 area and 15 cm depth. Twelve of the 22 stations were co-located with pre-assigned sediment and fish sampling stations in shallow, nearshore locations used for the round 1 preliminary risk evaluation. The other 10 stations were nearshore and in-channel stations used to collect additional sediment chemistry data (Figure 1).

The shipboard global positioning system (GPS) was used to locate each sample station (Table 3 presents the station coordinates, see the Round 1 Field Sampling Report (2003) for more details on navigation). Upon arrival at each station, benthic community samples were taken with the first casts of the van Veen sampler. The water depths for each benthic community grab are presented in Table 3. If the benthic ecologist onboard determined the grab was acceptable for processing, its entire contents were emptied onto a 0.5 mm sieve. Site water was used to gently wash the sediments through the sieve and the material retained was rinsed into

labeled polyethylene bags. Excess water was removed and the sample was immediately preserved in 88.3% denatured ethanol. Samples were placed in coolers and stored in the LWG field lab until transported to the SEA offices in Olympia, WA.

Table 3. Infaunal benthic community composite sample information

LWG Sample #	Station #	Date Sampled	Station Type	Water Depth (m)	Location of Station	
					Lat. (N)	Long. (W)
LWG0102R001BNS015	02R001	10/24/02	Co-located	6.2	45° 37.7075	122° 47.2134
LWG0103R005BNS015	03R005	10/24/02	Co-located	3.5	45° 36.6561	122° 46.5207
LWG0103R040BNS015	03R040	10/25/02	Channel	4.5	45° 36.9698	122° 47.5990
LWG0103R041BNS015	03R041	10/25/02	Channel	14.1	45° 37.1277	122° 47.3016
LWG0104R003BNS015	04R003	10/23/02	Co-located	8.5	45° 36.2345	122° 46.3883
LWG0104R004BNS015	04R004	10/23/02	Co-located	2.9	45° 35.8512	122° 46.8809
LWG0105R003BNS015	05R003	10/23/02	Co-located	3.0	45° 35.2607	122° 45.9065
LWG0105R040BNS015[a]	05R040[a]	10/25/02[a]	Channel[a]	17.3[a]	45° 35.1930	122° 46.0721
LWG0105R041BNS015	05R041	10/25/02	Channel	24.1	45° 35.6520	122° 46.4793
LWG0106R001BNS015	06R001	10/23/02	Co-located	0.8	45° 34.8805	122° 45.8211
LWG0106R002BNS015	06R002	10/23/02	Co-located	na	45° 34.8417	122° 44.7672
LWG0106R040BNS015	06R040	10/25/02	Channel	5.7	45° 34.9480	122° 45.3164
LWG0107R003BNS015	07R003	10/22/02	Co-located	na	45° 34.1721	122° 44.3976
LWG0107R040BNS015	07R040	10/25/02	Channel	19.1	45° 34.0798	122° 43.8033
LWG0108R001BNS015	08R001	10/22/02	Co-located	0.9	45° 33.4930	122° 43.5999
LWG0108R003BNS015	08R003	10/22/02	Co-located	na	45° 34.0079	122° 43.4654
LWG0108R040BNS015	08R040	10/25/02	Channel	8.9	45° 34.2039	122° 43.2237
LWG0108R041BNS015	08R041	10/25/02	Channel	7.9	45° 33.4520	122° 43.3679
LWG0109R001BNS015	09R001	10/24/02	Co-located	4.4	45° 33.6986	122° 42.5022
LWG0109R002BNS015	09R002	10/22/02	Co-located	na	45° 32.9596	122° 42.2679
LWG0109R040BNS015	09R040	10/25/02	Channel	23.3	45° 33.1567	122° 42.1336
LWG0109R041BNS015	09R041	10/25/02	Channel	2.5	45° 33.2250	122° 42.0804

a: Sample was never processed in the lab

na: not available

Once the community samples were preserved, additional grabs were taken at each station as needed to obtain sediment for chemical analyses. See the Round 1 Field Sampling Report (2003) for additional details on the sediment chemistry samples.

3.2 Laboratory Methods

3.2.1 Epibenthic community samples

Immediately prior to sorting, each multiplate sampler was disassembled in a bucket partially full of water. Attached invertebrates were lightly scrubbed off of the multiplate sampler components into the bucket of water and the cleaned components were set aside. The entire contents of the bucket were then emptied onto a 500-µm mesh sieve and rinsed while ensuring that invertebrates remained on the sieve. The

contents of the sieve were then rinsed into a gridded, Caton type sample splitter with 70% ethanol. The sample sorter consisted of 8 equally sized grid cells and the contents of the sample were evenly distributed across all 8 cells prior to sorting.

A target count of 500 organisms per sample was specified prior to sorting. Such fixed-count methods have been shown to provide unbiased representations of larger samples (Barbour and Gerritsen 1996). Any subsample needed to consist of at least five hundred organisms to be considered representative of the community from each sampler. The necessary number of grid cells were sorted to achieve the target count of 500 and invertebrates from those cells were placed into one of three vials containing Oligochaeta, Chironomidae, and 'other.' When sorting was complete, the individual vials were labeled and the sorting time, number of organisms, and percent of total sample sorted were noted. The sorted samples were stored until taxonomic enumeration. An additional sorting quality assurance step was completed for each sampler to ensure that each species met a standard removal rate of 90%. The sorting step was repeated for any sampler that failed the QA check.

Chironomidae and 'other' vials were identified at Ecoanalysts' laboratory. The contents of an individual vial were emptied into a Petri dish and invertebrates were sorted to the lowest practical taxonomic level under a dissecting scope. The number of each taxon was recorded and at least one specimen from each taxon was preserved in labeled 1-dram vials containing 70% ethanol for quality assurance and future reference. A second taxonomist verified the accuracy of the identification of all preserved specimens. Finally, 10% of all samples were randomly selected for complete re-identification by a second taxonomist for quality assurance. If necessary, any differences in identification were resolved by sending the specimen to an external expert. Quality assurance checks for both general identification and chironomid identification are reported in Table 4.

Table 4. Multiplate sampler taxonomy QA results

Site	% Similarity
General Identification:	
LWG 03B-MP07	99.58
LWG 05A-MP06	100.00
LWG 09C-MP05	99.17
Chironomid Identification:	
LWG 03B-MP04	96.47
LWG 05A-MP06	94.98 [a]
LWG 09C-MP05	96.55 [b]

[a] QA differences were the result of an *Ablabesmyia* sp. misidentified as a *Larsia* sp. and misidentification of early instar *Dicrotendipes* sp. and *Glyptondipes* sp. larvae in the QA data.

[b] QA differences were the result of a *Phaenopsectra* sp. misidentified as *Sergentia* sp. in the QA data

Oligochaete samples were mounted on viewing slides and labeled. All oligochaete slides were shipped to the oligochaete taxonomic specialist for identification and enumeration.

Bryozoans were noted on many of the multiplates during retrieval, but they were not initially quantified during the above processing. However, residues from the sieving and sorting steps above were retained for all samples, and technicians examined the residues under a microscope to note the presence or absence of bryozoans from each multiplate sampler. However, quantification of bryozoan abundance was not possible at this point.

3.2.2 Infaunal community samples

The preserved van Veen grab samples were shipped to Marine Taxonomic Services (Corvallis, OR) for sorting. In the laboratory, the contents of each sample bag were rinsed into a gridded, Caton sample splitter. The contents of the sample were evenly distributed across eight equally sized grid cells, which allows for subsampling. The entire contents of each of these samples, however, were sorted and identified. Invertebrates from each sample were sorted into one of three vials containing oligochaetes, chironomids (dipterans), and "general." Once complete, the individual vials were labeled, preserved, and stored until shipment of all samples to Ecoanalysts, Inc. for taxonomic identification and enumeration.

Chironomidae and "general" vials were identified at the Ecoanalysts' laboratory in Moscow, ID. The contents of an individual vial were emptied into a Petri dish under a dissecting scope and invertebrates were identified to the lowest practical taxonomic level. The number of each taxon was recorded and at least one specimen from each taxon was preserved in labeled 1-dram vials with 70% ethanol for quality assurance and future reference. A second taxonomist verified the identification of each specimen archived. Finally, one of the samples was completely re-identified (09R040) by a different taxonomist for quality assurance. The quality assurance step yielded 100% similarity for both the chironomid and "general" identifications.

Oligochaete samples were mounted on viewing slides and labeled at the Ecoanalysts' Moscow, ID laboratory. The slides were shipped to the oligochaete taxonomic specialist for identification and enumeration.

The benthic community from the sample at station 05R040 was never quantified. Examination in the laboratory revealed that the sample was coated in tar, and sorting was not possible.

4.0 RESULTS

A total of 78 taxa from 7 phyla, 12 classes, 18 orders, and 31 families of benthic invertebrates were identified from both the epibenthic and infaunal communities in the LWR. The complete list of taxa collected by both methods is included in Table 5 (tables with landscape orientation are found following the main text of this report).

4.1 Epibenthic Community

Sixty-three taxa representing at least 7 phyla, 11 classes, 15 orders, and 23 families were found colonizing artificial substrates placed in the ISA (Table 5). Chironomids, or midges, were the most diverse taxonomic group represented with 27 taxa. Oligochaete worms were the next most diverse taxonomic group encountered with at least 12 taxa identified. Other taxa found were crustaceans (isopods, ostracods, and amphipods), caddisflies, mites, and flatworms. Bryozoans were found on multiplates at all 12 stations. In fact, bryozoans were very common and were found on 54 of the 60 multiplates examined. Because they were never quantified, bryozoan abundance is not included in any of data summarized below. The complete list of organisms identified from each sampler replicate is available from Windward Environmental LLC.

Chironomids and oligochaetes were the most abundant taxonomic groups collected. Crustaceans (almost exclusively amphipods from the genus *Corophium*) were also locally abundant, and outnumbered oligochaetes and chironomids at several stations. Together, these three groups consistently accounted for more than 95% of the organisms present on each sampler.

Taxonomic richness (the total number of taxa present) for each station is reported in Table 6. Stations 8 and 10 had the greatest numbers taxa. A total of 36 species were counted at these open channel sites and almost half of them (17 and 16, respectively) were chironomids. The least diverse community was found at Station 2. Twenty-one species were found at this backwater station and, like Stations 8 and 10, almost half of them were chironomids. In fact, chironomids consistently accounted for approximately half of the overall taxonomic richness at all multiplate stations.

The greatest total abundance of organisms was found at multiplate Station 1 (Table 7). This is a backwater site located in Swan Island Lagoon and its community was dominated by oligochaetes and chironomids. The other taxa at this station only accounted for about 1% of the organisms found. The station with the lowest abundance was Station 2, located at the mouth of Swan Island Lagoon. Chironomids dominated the benthic community at this station and accounted for more than two-thirds of the organisms collected.

Overall abundance and taxa richness at the two reference stations fell within the ranges observed at the ten stations in the ISA (Tables 6 and 7). Taxa richness was identical at both reference stations, but they differed in the type and abundance of organisms collected. Station 12 was an open channel site and was dominated by crustaceans. Station 11 was in a more backwater location and had lower overall abundance than Station 12. Station 11 was highly dominated by oligochaetes.

Table 5. Taxa identified on multiplate samplers and van Veen grab samples in the Lower Willamette River, 2002

Phylum	Class	Order	Family	Genus Species	Common Name	Type of Sample
Bryozoa					'moss animals'	multiplate
Platyhelminthes	Turbellaria				flatworm	multiplate, van Veen
Nematoda					roundworm	multiplate, van Veen
Nemertea				*Protostoma* sp.	ribbon worm	multiplate, van Veen
Annelida	Oligochaeta	Haplotaxida	Tubificidae	*Aulodrilus limnobius*	tubificid worm	van Veen
				A. pigueti	tubificid worm	multiplate, van Veen
				A. pluriseta	tubificid worm	van Veen
				Branchiura sowerbyi	tubificid worm	van Veen
				Limnodrilus hoffmeisteri	tubificid worm	multiplate, van Veen
				Quistradrilus multisetosus	tubificid worm	van Veen
			Enchytraeidae sp.		enchytraeid worm	multiplate, van Veen
			Naididae	*Chaetogaster sp.*	naidid worm	multiplate, van Veen
				Dero sp.	naidid worm	multiplate, van Veen
				Nais barbata	naidid worm	multiplate
				Nais pardalis	naidid worm	multiplate
				Nais variabilis	naidid worm	multiplate
				Pristina leidyi	naidid worm	multiplate
				Pristina/Pristinella sp.	naidid worm	multiplate
				Slavina appendiculata	naidid worm	multiplate
				Stylaria lacustris	naidid worm	multiplate
		Lumbriculidae			lumbricud worm	van Veen
	Hirudinea	Euhirudinea	Erpobdellidae sp.		leech	van Veen
	Polychaeta	Canalipalpata	Sabellida	*Manayunkia speciosa*	sabellid worm	multiplate, van Veen
Mollusca	Gastropoda	Basommatophora	Physidae	*Physa sp.*	snail	multiplate
			Ancylidae	*Ferrissia sp.*	limpet	multiplate
			Planorbidae	*Menetus opercularis*	button sprite	multiplate
	Bivalvia	Veneroida	Corbiculidae	*Corbicula sp.*	asiatic clam	multiplate, van Veen
			Sphaeriidea	*Pisidium* sp.	fingernail clam	van Veen

Phylum	Class	Order	Family	Genus Species	Common Name	Type of sample
Arthropoda	Crustacea	Isopoda	Asellidae	*Caecidotea sp.*	isopod	multiplate, van Veen
		Ostracoda sp.			ostracod	multiplate, van Veen
		Amphipoda sp.			amphipod	multiplate
			Hyallelidae	*Hyallela sp.*	amphipod	multiplate
			Corophiidae	*Corophium sp.*	amphipod	multiplate, van Veen
			Gammaridae sp.		amphipod	van Veen
				Anisogammarus sp.	amphipod	multiplate
	Insecta	Odonata	Gomphidae	*Stylurus* sp.	dragonfly	van Veen
		Diptera	Chironomidae	*Alabesmyia sp.*	midge	multiplate
				Billia sp.	midge	multiplate
				Bryophaenocladius sp.	midge	van Veen
				Chironomini sp.	midge	multiplate
				Chironomus sp.	midge	multiplate, van Veen
				Cladopelma sp.	midge	van Veen
				Cladotanytarsus sp.	midge	multiplate
				Corynoneura sp.	midge	multiplate
				Cricotopus bicinctus gr.	midge	multiplate
				Cricotopus sp.	midge	multiplate
				Cryptochironomus sp.	midge	multiplate, van Veen
				Demeijerea sp.	midge	multiplate
				Dicrotendipes sp.	midge	multiplate, van Veen
				Endochironomus sp.	midge	multiplate
				Eukiefferiella brevicalcar gr.	midge	multiplate
				Glyptotendipes sp.	midge	multiplate
				Harnischia sp.	midge	van Veen
				Nanocladius sp.	midge	multiplate
				Parachironomus sp.	midge	multiplate
				Paracladopelma sp.	midge	van Veen
				Parakiefferiella sp.	midge	multiplate

Phylum	Class	Order	Family	Genus Species	Common Name	Type of Sample
				Paralauterborniella sp.	midge	multiplate
				Paratanytarsus sp.	midge	multiplate
				Phaenopsectra sp.	midge	multiplate, van Veen
				Polypedilum sp.	midge	van Veen
				Procladius sp.	midge	multiplate, van Veen
				Pseudochironomus sp.	midge	multiplate
				Rheotanytarsus sp.	midge	multiplate
				Stenochironomus sp.	midge	multiplate
				Tanytarsus sp.	midge	multiplate
				Thienemanniella sp.	midge	multiplate
				Thienemanninyia gr. sp.	midge	multiplate
				Xenochironomus xenolabis	midge	multiplate
		Trichoptera sp.	Hydroptilidae sp.	*Hydroptila* sp.	caddisfly	multiplate
			Leptoceridae	*Oecetis* sp.	caddisfly	van Veen
			Polycentopodidae sp.	*Polycentropus* sp.	caddisfly	multiplate
	Arachnida	Acari sp.			mite	multiplate
		Hydrachnida	Arrenuridae	*Arrenus* sp.	water mite	van Veen
			Hygrobatidae	*Hygrobates* sp.	water mite	multiplate, van Veen
			Lebertiidae	*Lebertia* sp.	water mite	van Veen
			Limnesiidae	*Limnesia* sp.	water mite	multiplate, van Veen
			Unionicolidae	*Unionicola* sp.	water mite	van Veen

Table 6. Epibenthic community: number of species found within each major taxonomic group at each of the 12 multiplate sampler locations

STATION #	LWG01	LWG02	LWG05	LWG09	LWG06	LWG10	LWG08	LWG03	LWG04	LWG07	LWG11	LWG12
LWG #	08R034	08R033	06R028	04R026	06R027	03R030	04R025	09R027	07R024	05R020	09R028	13R001
STATION TYPE	OFF CHANNEL	OFF CHANNEL	OFF CHANNEL	OFF CHANNEL	CHANNEL	CHANNEL	CHANNEL	CHANNEL	CHANNEL	CHANNEL	REF.	REF.
Chironomids (midge)	10	10	11	11	12	16	17	13	16	10	13	13
Crustaceans	2	2	3	3	2	3	4	2	3	2	3	2
Oligochaetes	5	4	5	5	4	7	8	7	5	4	6	6
Trichoptera (caddisfly)	3	3	4	2	4	3	2	3	2	3	4	3
Flatworms	1	1	1	1	1	1	1	1	1	1	1	1
Nematodes	1	1				1				1		
Polychaetes					1	1	1		1	1		
Mites				1		1	1	1	2	1		
Bivalves			1	1	1	1	1	1	1		1	1
Gastropods	1			1	1	1	1	1		1		
Nemertea						1						
Major Taxonomic Groups	**7**	**6**	**6**	**8**	**8**	**11**	**11**	**8**	**8**	**9**	**7**	**6**
Total Richness (# of taxa present)	**23**	**21**	**25**	**25**	**26**	**36**	**36**	**29**	**31**	**24**	**26**	**26**

Table 7. Epibenthic community: mean number of individuals from each taxonomic group found on multiplate samplers at each of 12 stations (n=5)

STATION #	LWG01		LWG02		LWG05		LWG09		LWG06		LWG10		LWG08		LWG03	
LWG #	08R034		08R033		06R028		04R026		06R027		03R030		04R025		09R027	
STATION TYPE	OFF CHANNEL		OFF CHANNEL		OFF CHANNEL		OFF CHANNEL		CHANNEL		CHANNEL		CHANNEL		CHANNEL	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Common Taxa																
Chironomids (midges)	573.0	16.2	235.2	15.1	215.8	4.6	194.0	49.5	144.0	11.9	150.4	17.3	93.4	3.5	129.8	15.0
Crustaceans	0.4	0.2	22.0	4.2	36.6	4.5	84.6	11.0	223.8	30.1	36.6	5.1	231.0	17.9	234.7	36.6
Oligochaetes	598.2	55.9	81.6	28.2	172.0	53.6	508.0	153.8	280.6	68.8	384.8	73.0	84.8	22.6	275.1	41.4
Caddisflies	2.6	0.9	1.4	0.6	12.4	2.9	1.8	0.8	4.4	0.8	3.1	1.5	1.0	0.8	2.7	0.4
Flatworms	9.8	4.3	0.6	0.6	3.0	0.8	6.2	3.3	20.1	10.6	8.7	2.7	0.6	0.2	8.7	2.7
Uncommon Taxa																
Nematodes	0.4	0.4	0.2	0.2							0.9	0.7				
Polychaetes									4.0	4.0	0.3	0.3	0.2	0.2		
Mites							0.2	0.2			0.2	0.2	0.2	0.2	0.3	0.3
Bivalves					0.2	0.2	0.2	0.2	4.3	1.3	5.1	3.1	6.2	1.8	0.7	0.5
Gastropods	1.4	1.4					0.2	0.2	0.2	0.2	5.1	3.4	0.2	0.2	1.1	0.3
Nemertea											0.2	0.2				
Mean Abundance (per sampler)	**1,185.8**		**341.0**		**440.0**		**795.1**		**681.4**		**603.2**		**417.6**		**653.0**	
Mean Abundance per area (m^{-2})	**10,222**		**2,939**		**3,793**		**6,854**		**5,874**		**5,200**		**3,600**		**5,629**	

STATION #	LWG04		LWG07		LWG11		LWG12	
LWG #	07R024		05R020		09R028		13R001	
STATION TYPE	CHANNEL		CHANNEL		REF; BACK		REF; CHAN	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Common Taxa								
Chironomids (midges)	209.9	21.5	97.6	10.1	110.5	14.9	169.8	26.7
Crustaceans	65.6	9.4	305.4	62.4	136.7	18.2	500.6	41.6
Oligochaetes	241.0	76.0	260.5	56.5	539.2	125.7	252.5	74.4
Caddisflies	4.2	1.7	1.4	0.7	4.2	1.3	4.4	2.7
Flatworms	4.6	2.6	8.6	3.5	0.7	0.5	4.5	1.9
Uncommon Taxa								
Nematodes			0.4	0.4				
Polychaetes	0.3	0.3	5.6	4.4				
Mites	0.4	0.2	0.2	0.2				
Bivalves	2.0	1.0			0.3	0.3	1.2	1.2
Gastropods			0.4	0.4				
Nemertea								
Mean Abundance (per sampler)	**527.9**		**680.0**		**756.6**		**933.0**	
Mean Abundance per area (m^{-2})	**4,551**		**5,862**		**5,611**		**8,042**	

4.2 Infaunal Community

Forty-four taxa representing 6 phyla, 10 classes, 16 orders, and 24 families were collected in sediments from the 21 stations processed in the ISA (Table 5). Dipterans (true flies) and oligochaetes were the most diverse taxonomic groups represented with 10 and 12 taxa, respectively. All dipterans present were members of the chironomid family (midges) while two orders and four families of oligochaetes were present. Other taxa found were bivalves, crustaceans, arachnids (mites and water mites), nematodes, polychaetes, and trichopterans (caddisflies). The complete list of organisms identified from each sample is available from Windward Environmental LLC.

Chironomids, oligochaetes, and bivalves were the most common taxonomic groups found. Chironomids were found in all 21 samples while oligochaetes and bivalves were present in 20 and 19 samples, respectively. Abundance varied greatly between samples, but oligochaetes, on average, were the most abundant.

Taxonomic richness varied by more than a factor of 3 and is presented in Table 8. Sample stations 06R002, 02R001, and 04R004 had the highest richness with 21, 19, and 19 taxa identified from each sample, respectively. All three stations were co-located sediment stations in relatively shallow water. The stations with the lowest richness were stations 09R041, 09R001, and 03R005. All three had 6 taxa only. Stations 09R001 and 03R005 were co-located sediment stations while station 09R041 was a channel site.

Abundance of organisms varied widely across stations (Table 9). There was a difference of two orders of magnitude between the station with the highest abundance and the station with the lowest abundance. The greatest total abundance of organisms was found at stations 08R001 and 06R040. The community at station 08R001 was almost entirely composed of oligochaetes (48% of the community) and chironomids (50% of the community). The most abundant taxa at station 06R040, oligochaetes and bivalves, made up fewer than 80% of the station's community. The most depauperate communities were found at stations 03R005 and 09R001. Only 7 organisms were collected at station 03R005; 38 were collected at station 09R001.

Table 8. Infaunal community: number of species found within major taxonomic groups at each van Veen sample station

STATION #	02R001	03R005	03R040	03R041	04R003	04R004	05R003	05R041	06R001	06R002	06R040	07R003	07R040	08R001	08R003	08R040	08R041	09R001	09R002	09R040	09R041
Oligochaetes	6	1	2	5	5	5	4	5	5	6	3	6	5	4		5	5	4	5	5	3
Chironomids (midges)	3	1	2	1	3	5	5	2	4	5	4	2	1	3	2	3	1	2	5	2	2
Bivalves	1	1	2	1	2	2	2	1		2	2	1	1	2	2	1	1		2	1	1
Crustaceans	2	1	1		2	1	1	1		2	1			3	2				1	1	
Arachnids (mites)	4	2	1		1	4				2	2			2	1	2				1	
Polychaetes	1		2	1	1					1	1	1	1						2		
Nematodes	1			1	1	1			1	1	1			1	1	1	1		1		
Platyhelminthes									1												
Nemerteans			1								1										
Hirudinea (leeches)	1			1															1		
Odonata (dragonflies)					1					1											
Trichoptera (caddisflies)			1			1				1											
Total Richness	**19**	**6**	**12**	**10**	**16**	**19**	**12**	**9**	**11**	**21**	**15**	**10**	**8**	**15**	**8**	**12**	**8**	**6**	**17**	**10**	**6**

Table 9. Infaunal community: number of individuals from each taxonomic group at each of the 21 van Veen sample stations

STATION #	02R001	03R005	03R040	03R041	04R003	04R004	05R003	05R041	06R001	06R002	06R040	07R003	07R040	08R001	08R003	08R040	08R041	09R001	09R002	09R040	09R041
Oligochaetes	53	1	40	88	96	88	93	67	94	65	203	300	52	345		152	79	32	236	249	108
Chironomids (midges)	9	1	5	26	5	107	20	15	48	186	43	4	30	358	3	52	32	6	18	28	4
Bivalves	51	1	53	9	26	10	32	43		80	258	5	3	13	6	9	5		9	13	5
Crustaceans	16	1	11		5	10	1	1		4	54			3	149				7	1	
Arachnids (mites)	13	3	1		1	4				4	2			2	1	2				1	
Polychaetes	5		65	1	12					3	20	1	1						2		
Nematodes	18			5	1	10			7	4	7			1	3	2	1		1		
Platyhelminthes									1												
Nemerteans			1								3										
Hirudinea (leeches)	1			8															2		
Odonata (dragonflies)					2					1											
Trichopterans (caddisflies)			11			5				2											
Total Abundance (per sample)	**166**	**7**	**187**	**137**	**148**	**234**	**146**	**126**	**150**	**349**	**590**	**310**	**86**	**722**	**162**	**217**	**117**	**38**	**275**	**292**	**117**
Total Abundance per area (m^2)	**1,660**	**70**	**1,870**	**1,370**	**1,480**	**2,340**	**1,460**	**1,260**	**1,500**	**3,490**	**5,900**	**3,100**	**860**	**7,220**	**1,620**	**2,170**	**1,170**	**380**	**2,750**	**2,920**	**1,170**

5.0 CONCLUSIONS

The invertebrate community collected on the multiplate samplers suggests that the epibenthic community in the ISA is more diverse and more abundant than the infaunal invertebrate community. The total number of taxa collected on the multiplate samplers was greater than in the van Veen grab samples. Also, the richness and abundance for each sample was larger on the multiplates than in the grab samples even though both sampled similar surface areas (approximately 0.1 m^2). Richness and abundance also varied less across multiplate sample stations than the grab stations.

The organisms collected during the infaunal and epibenthic surveys conducted by the LWG were consistent with the type of species expected for a deep, pelagic river like the Lower Willamette. According to the River Continuum Concept, the invertebrate community in deep rivers is likely to be dominated by the collector feeding group (Vannote et al. 1980). Collectors include both gatherers, organisms that forage for organic matter in the sediments, and filterers, organisms that filter organic matter out of the water column (Cummins and Klug 1979). The dominant taxa in the infaunal and epibenthic communities (oligochaetes and chironomids) collected in the LWR belong to the collectors feeding group.

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SUBATTACHMENTB1A: EPIBENTHIC SAMPLING FIELD REPORT

1.0 MULTIPLATE DEPLOYMENT (JULY 15–16, 2002)

July 15, 2002

Weather conditions: clear, calm, warm

Shannon Pierce (SP, Windward) and Pam Sparks (PS, Striplin) remained on shore (at the Swan Island boat ramp and the St John's boat ramp) assembling and labeling all the components of the arrays to be deployed on this day.

Station 2 (08R033)

09:30

Frank Dillon (FD, Windward) and Bob Complita (BC, Windward) deployed 3 arrays along the north shore of Swan Island Lagoon, west of the Coast Guard station.

Station 1 (08R034)

10:30

FD and BC deployed 3 arrays along the southern end of the western shore of Swan Island Lagoon.

Station 5 (06R028)

11:50

FD, BC, and Derek Pelletier (DP, Windward) deployed 3 arrays between pilings along the southern shore of Willamette Cove.

Station 4 (07R024)

13:45

BC and DP deployed 3 arrays on the western shore of the main channel of the Willamette, north of the northernmost Atofina pier.

Station 6 (06R027)

14:40

BC and DP deployed 3 arrays along the eastern shore of the main channel, at the northern tip of Willamette Cove.

Station 7 (05R020)

15:10

BC and DP deployed 3 arrays along the eastern shore of the main channel, north of the St. John's Bridge.

Array A was placed in shallower water than arrays B and C (~5-10 feet shallower).

Off the river for the day by 14:00.

July 16, 2002

Weather conditions: clear, calm, warm

PS and SP remained on shore at the St. John's boat ramp assembling and labeling all the components of the arrays to be deployed this day.

Station 9 (04R026)

10:45

DP and BC deployed 3 arrays on the eastern shore of the Terminal 4 lagoon (just north of the main slip).

Array B has a wrongly labeled set of white, flotation buoys. They are labeled as 8-B rather than 9-B. The array B multiplate samplers are labeled correctly.

Station 8 (04R025)

11:05

DP and BC deployed 3 arrays on the western shore of the main channel, just off of the GATX property.

Station 10 (03R030)

12:00

DP and BC deployed 3 arrays on the western shore of the main channel, between a helper barge and the shore near the Schnitzer property.

Arrays at Station 8

Station 3 (09R027)

14:30

DP and BC deployed 3 arrays along the eastern shore of the main channel, just south of the freighters and barges docked at Swan Island.

Station 11 (09R028)

15:00

DP and BC deployed 3 arrays along the eastern shore of the main channel, just south of the ISA. Water was quite shallow in the area so arrays were deployed ~50 yards off shore.

Station 11 is a reference station. The nearby shore is largely sandy beach.

Arrays at station 11 (reference)

Station 12 (13R001)

16:15

DP and BC deployed 3 arrays along the western shore of the main channel, just south of the I-5 bridge and north of pilings.

Station 12 is a reference station. The nearby shore is mostly riprap and unclassified fill.

Off the river for the day by 16:45.

Arrays at station 12 (reference)

2.0 MULTIPLATE RETRIEVAL (AUGUST 27-28, 2002)

August 27, 2002

Weather conditions: clear, calm, hot

DP, PS, and SP remained in the fish processing laboratory (located at Atofina Chemicals) to process the samplers once they were retrieved.

FD, BC, and Kim Gould (KG, Fishman) worked on the boat, retrieving the samplers.

Station 4 (07R024)

09:25 arrived at station

Array C (LWG-04-C-MP) was retrieved for benthic community analysis. It was the furthest upstream of the 3 arrays. Multiplate (MP) 01, 02, 03, 04, and 06 were kept and preserved in alcohol for analysis.

MP 05 was missing. MP 07 was not preserved, quota of 5 multiplate samplers was filled.

Array A (LWG-04-A-MP) was retrieved for tissue analysis. It was the middle array of the 3 arrays. All 7 multiplate samplers were retrieved for tissue analysis.

Array B (LWG-04-B-MP) was collected as an extra array. It was the most downstream array and was not needed since the other 2 arrays were still present. Six multiplate samplers were retrieved, one was missing.

10:05 left the station

Station 5 (06R028)

10:10 arrived at station

Array A (LWG-05-A-MP) was retrieved for benthic community analysis. It was the middle array of the 3 arrays. MP 05, 03, 01, 07, and 06 were kept and preserved in alcohol for analysis.

MP 04 was missing. MP 02 was not preserved, quota was filled.

Array B (LWG-05-B-MP) was retrieved for tissue analysis. It was the furthest upstream of the 3 arrays. All 7 multiplate samplers were retrieved for tissue analysis.

Array C (LWG-05-C-MP) was collected as an extra array. It was the most downstream array and was not needed since the other 2 arrays were still present. Six multiplate samplers were retrieved, one was dropped.

10:40 left the station.

Station 6 (06R027)

12:30 arrived at station

Array B (LWG-06-B-MP) was retrieved for benthic community analysis. It was the most upstream of the arrays. MP 05, 03, 02, 01, and 04 were kept and preserved in alcohol for analysis.

MP 07 and 06 were retrieved but not preserved, quota was filled.

Array C (LWG-06-C-MP) was retrieved for tissue analysis. It was the most downstream of the arrays. All 7 multiplate samplers were retrieved for tissue analysis.

Array A (LWG-06-A-MP) was missing, but was not needed. It was found vandalized and pulled up on the shore in Willamette Cove. The sample was not used.

13:10 left the station.

FD departed for Seattle, leaving KG and BC in the boat.

Station 7 (05R020)

13:15 arrived at station.

Array B (LWG-07-B-MP) was retrieved for benthic community analysis. It was the middle of the three arrays. MP 04, 05, 06, 01, and 03 were kept and preserved in alcohol for analysis.

MP 02 and 07 were retrieved but not preserved, quota was filled.

Array C (LWG-07-C-MP) was retrieved for tissue analysis. It was the most downstream of the 3 arrays. All 7 multiplate samplers were retrieved for tissue analysis.

Array A (LWG-07-A-MP) was collected as an extra array. It was the most upstream array and was not needed since the other 2 arrays were still present. All 7 multiplate samplers were retrieved.

14:10 left the station.

Station 12 (13R001)

15:20 arrived at station.

Array A (LWG-12-A-MP) was retrieved for benthic community analysis. It was the most upstream of the 3 arrays. MP 03, 02, 01, 07, and 06 were kept and preserved in alcohol for analysis.

MP 04 and 05 were retrieved but not preserved, quota was filled.

Array B (LWG-12-B-MP) was retrieved for tissue analysis. It was the middle of the three arrays. All 7 multiplate samplers were retrieved for tissue analysis.

Array C (LWG-12-C-MP) was collected as an extra array. It was the most downstream array and was not needed since the other 2 arrays were still present. All 7 multiplate samplers were retrieved.

16:05 left the station.

Station 11 (09R028)

16:20 arrive at station

Array C (LWG-11-C-MP) was retrieved for benthic community analysis. It was the most downstream of the 3 arrays. MP 06, 01, 04, 05, and 07 were kept and preserved in alcohol for analysis.

MP 03 and 02 were retrieved but not preserved, quota was filled.

Array A (LWG-11-A-MP) was retrieved for tissue analysis. It was the most upstream of the three arrays. All 7 multiplate samplers were retrieved for tissue analysis.

Array B (LWG-11-B-MP) was collected as an extra array. It was the most upstream array and was not needed since the other 2 arrays were still present. All 7 multiplate samplers were retrieved.

17:00 left the station, off the river for the day.

August 28, 2002

Weather: clear, calm, hot

BC and SP remained in the lab processing the samples that were retrieved. DP and KG were in the boat collecting the samplers.

Station 10 (03R030)

09:00 arrived at station

Array A (LWG-10-A-MP) was retrieved for benthic community analysis. It was the most upstream of the 3 arrays. MP 01, 04, 05, 06, and 07 were kept and preserved in alcohol for analysis.

MP 03 and 02 were retrieved but not preserved, quota was filled.

Array B (LWG-10-B-MP) was retrieved for tissue analysis. It was the most downstream of the three arrays. All 7 multiplate samplers were retrieved for tissue analysis.

Array C (LWG-10-C-MP) was collected as an extra array. It was the middle array and was not needed since the other 2 arrays were still present. All 7 multiplate samplers were retrieved.

09:35 left the station.

Station 8 (04R025)

09:40 arrived at station.

Array A (LWG-08-A-MP) was retrieved for benthic community analysis. It was the most upstream of the 3 arrays. MP 03, 04, 05, 06, and 07 were kept and preserved in alcohol for analysis.

MP 01 and 02 were retrieved but not preserved, quota was filled.

Array C (LWG-08-C-MP) was retrieved for tissue analysis. It was the most downstream of the three arrays. All 7 multiplate samplers were retrieved for tissue analysis.

Array B (LWG-08-B-MP) was collected as an extra array. It was the middle array and was not needed since the other 2 arrays were still present. All 7 multiplate samplers were retrieved.

10:25 left the station.

Station 9 (04R026)

10:30 arrived at station

Array C (LWG-09-C-MP) was retrieved for benthic community analysis. It was the most upstream of the 3 arrays. MP 02, 01, 04, 05, and 07 were kept and preserved in alcohol for analysis.

MP 03 and 06 were retrieved but not preserved, quota was filled.

Array A (LWG-09-A-MP) was retrieved for tissue analysis. It was the middle of the three arrays. All 7 multiplate samplers were retrieved for tissue analysis.

Array B (LWG-09-B-MP) was collected as an extra array. It was the most downstream array and was not needed since the other 2 arrays were still present. All 7 multiplate samplers were retrieved.

11:15 left the station

Station 1 (08R034)

13:20 arrived at station.

The arrays were located amidst the pilings and were difficult to retrieve.

Array B (LWG-01-B-MP) was retrieved for benthic community analysis. It was the southernmost of the 3 arrays. MP 02, 03, 04, 06, and 07 were kept and preserved in alcohol for analysis.

MP 05 was missing. MP 01 was not preserved, quota was filled.

Array A (LWG-01-A-MP) was retrieved for tissue analysis. It was the middle of the three arrays. All 7 multiplate samplers were retrieved for tissue analysis.

Array C (LWG-01-C-MP) was collected as an extra array. It was the most northern array and was not needed since the other 2 arrays were still present. All 7 multiplate samplers were retrieved.

14:15 left the station.

Station 2 (08R033)

14:30 arrived at station.

Array A (LWG-02-A-MP) was retrieved for benthic community analysis. It was the easternmost of the 3 arrays. MP 02, 01, 03, 05, and 07 were kept and preserved in alcohol for analysis.

MP 06 and 04 were retrieved but not preserved, quota was filled.

Array B (LWG-02-B-MP) was retrieved for tissue analysis. It was the middle of the three arrays. All 7 multiplate samplers were retrieved for tissue analysis.

Array C (LWG-02-C-MP) was collected as an extra array. It was the westernmost of the three arrays and was not needed since the other 2 arrays were still present. Six multiplate samplers were retrieved, MP07 was missing.

15:00 left the station.

Station 3 (09R027)

16:20 arrived at station

Array B (LWG-03-B-MP) was retrieved for benthic community analysis. It was the most downstream of the 3 rays. MP 01, 03, 04, 05, and 07 were kept and preserved in alcohol.

MP 02 and 06 were retrieved but not preserved, quota was filled.

Array A (LWG-03-A-MP) was retrieve for tissue analysis. It was the most upstream of the arrays. All 7 multiplate samplers were retrieved for tissue analysis.

Array C (LWG-03-C-MP) was collected as an extra array. It was the middle of the three arrays and was not needed since the other 2 arrays were still present. All 7 multiplate samplers were retrieved.

17:00 left the station, off the river for the day.

ATTACHMENT B2: AQUATIC PLANT AND AMPHIBIAN/REPTILE RECONNAISSANCE SURVEY

1.0 INTRODUCTION

Few data exist on the aquatic plant community and the presence of amphibians and reptiles along the Lower Willamette River (LWR) in the initial study area (ISA). To further develop the Portland Harbor Conceptual Site Model, a better understanding is needed of significant and complete exposure pathways. Therefore, an aquatic plant and amphibian/reptile reconnaissance level survey was conducted on June 26-28, 2002 to determine the presence or absence of these species throughout the ISA. As specified in the Round 1A Sampling and Analysis Plan (SAP) (Striplin 2002), this reconnaissance survey will be used to determine whether aquatic plants, amphibians or reptiles should be included in the ecological risk assessment. This study was designed to be a qualitative survey to determine presence/absence of amphibians/reptiles and plants in the ISA. However, the presence of some amphibians may not have been recorded due to the survey being performed in late June after the hatching of egg masses. This study was not meant to be a quantitative estimation of amphibian/reptile or plant abundance or a quantitative survey of available amphibian/reptile or plant habitat.

2.0 OBJECTIVES

There were three objectives of the reconnaissance survey:

- To determine the presence or absence of amphibians and/or reptiles in the ISA by surveying potential amphibian and reptile habitat for evidence of amphibians or reptiles (e.g. egg masses, tadpoles, mature frogs or reptiles)
- To determine the presence or absence of aquatic plants throughout the ISA by locating potential areas of aquatic plant establishment and surveying these areas for submersed and emergent macrophytes
- To determine if aquatic plants, amphibians, and reptiles should be included in the ecological risk assessment and if so, what are the likely areas within the ISA where significant and complete exposure pathways exist

3.0 METHODS

Aquatic plant and amphibian/reptile surveys were conducted at twenty-one sampling sites located throughout the ISA. Sampling locations were selected based on bank condition and amphibian/reptile habitat quality. The majority of the sampling locations were selected before going out in the field and were selected to ensure that all representative bank conditions in the ISA were sampled at least twice. The most common bank types occurring in the ISA were riprap, unclassified fill, natural bank and river beach, and seawall (Figure 1). Many sampling sites coincided with the presence of in-water or shoreline structures that were considered to represent possible habitat. In addition, all designated habitat areas in the ISA identified by the Willamette River Inventory (Adolfson et al. 2000) were included in the survey (e.g. Harborton Forest and Wetlands and Willamette Cove).

Approximately one third of the sample locations were selected while in the field based on visual observations of potential aquatic plant and amphibian/reptile habitat.

Surveys were conducted June 26 through June 28, 2002. At each sampling site, the location coordinates were recorded using GPS (Magellan GPS ColorTRAK). A general site description of the bank conditions, including slope of the bank, substrate, and presence of upland vegetation, was also recorded. Digital photos were taken at each site (Subattachment B2A). A set time period of 30-45 minutes was spent at each site identifying plant species and looking for evidence of amphibians and reptiles according to the methods described below. This time period defined the area sampled at each site.

3.1 Aquatic Plant Survey

The plant survey focused on identifying submersed and emergent aquatic plant communities in the ISA. The methods for surveying the submersed plant community were based on the *Washington Department of Ecology Aquatic Plant Sampling Protocol* (Parsons 2001). Since the turbidity of the LWR made it difficult to visually assess the submersed plant community, a sampling rake was used to assess the presence of submersed plants at each sampling location. This rake was constructed from a thatch rake, also known as a double-sided rake. The rake handle was cut off and a 15-m rope was tied to the head of the rake. The rake was tossed overboard into the water approximately 4.5-6.0 m from shore at an approximate depth range of 2.4-3.0 m. The rake was dragged across the substrate surface for approximately 2.0-3.0 m and retrieved to collect any plants. Any plant material collected by the rake was inspected for submersed plant species. The depth of each throw was recorded and a general description of the relative rate of flow, turbidity, and substrate was also recorded.

The emergent plant community was surveyed in line transects approximately 15-20 m in length that ran parallel to the shore. This survey included plants growing in water and plants growing on the shore that may be exposed to high water. Only species that were growing within a noticeable high-water mark on shore (e.g. obvious sedimentation) were included. The width of the transect ranged from 5-15 m perpendicular to the water, depending on the slope of the site. Approximately 30-45 minutes were spent at each site observing and identifying plants. Most plants were identified to the species level; however, grass and sedge species that did not have any flowering structures present were identified to the genus level. Any common plants that were not identified at the site were collected and identified later with the help of plant identification guidebooks (Cooke 1997; Guard 1995; Hitchcock and Cronquist 1973) and a local plant expert, Toni Pennington (2002). A general description of the location was recorded and included substrate, relative bank slope, and depth of water where the emergent vegetation furthest from shore was located.

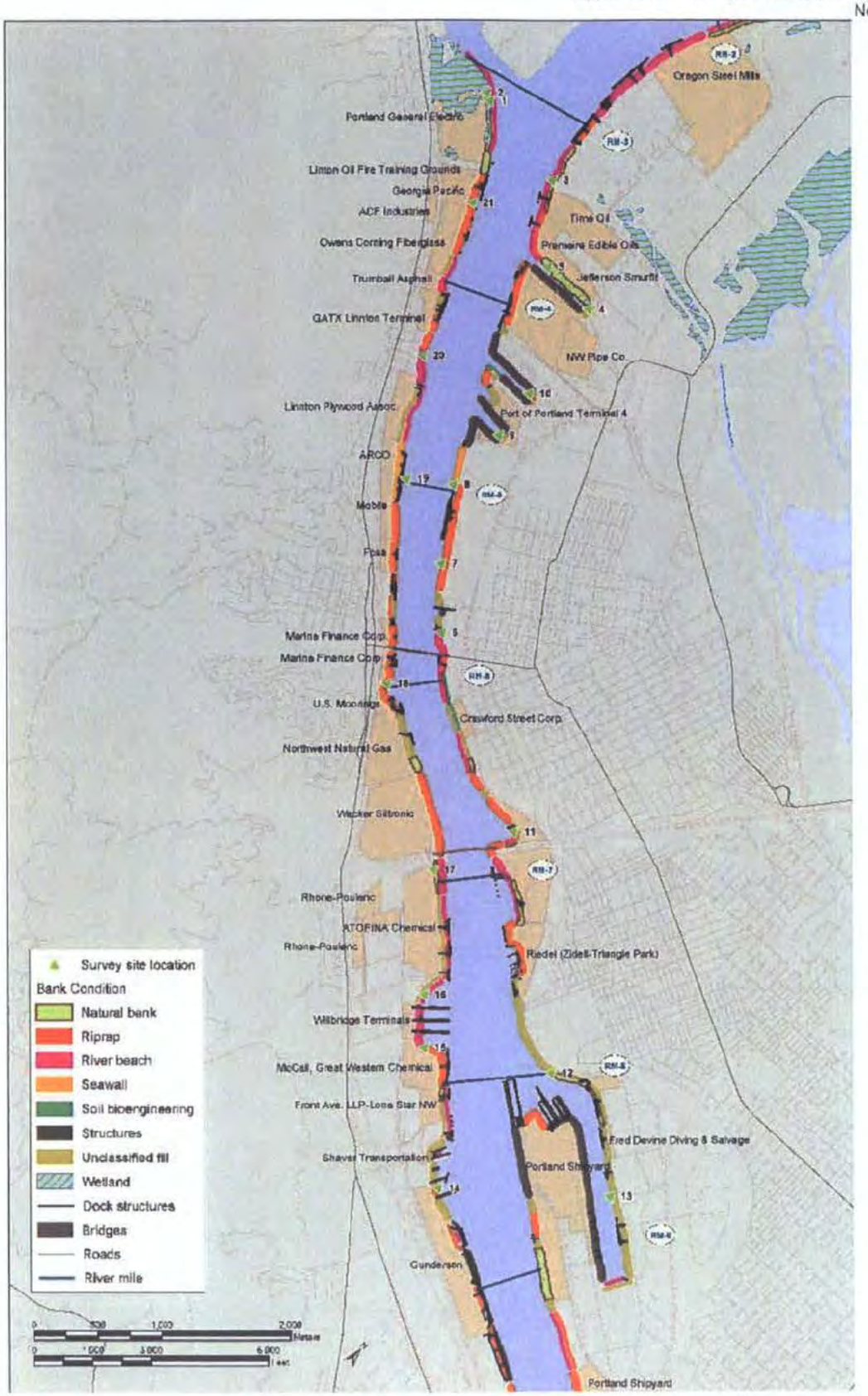

Figure 1. Lower Willamette River aquatic plant and amphibian/reptile survey site locations

3.2 Amphibian and Reptile Survey

The amphibian and reptile survey focused on identifying amphibian/reptile presence by locating adult or juvenile amphibians/reptiles visually or auditorily or by locating amphibian egg masses. The methods employed for visually locating amphibians/reptiles or egg masses were based on the methods of Heyer et al. (1994) and discussions with amphibian expert, James Word (2002). At each sampling location, two bank transects were surveyed by walking approximately 15-20 m, turning over rocks, looking in and under logs, and searching through vegetation. A strip extending approximately 0.3 m from either side of the transect line was also surveyed. The first transect was located parallel to the water line, at the water line. During this transect a small, fine mesh net was used to sample shallow waters and pool areas for presence of tadpoles and egg masses. The second transect was conducted approximately one meter from the high water line. Approximately 30-45 minutes were spent at each sampling site, looking for evidence of amphibian/reptile presence. At each site, notes were taken in a field notebook to record evidence of amphibians/reptiles observed and the location description of any evidence found. If possible, pictures were taken of amphibians/reptiles observed. Observed amphibian/reptiles were identified in the field using a field guide (Corkran and Thoms 1996) and then identifications were confirmed by examination of the pictures taken by an amphibian expert, James Word. In addition to the daytime visual survey, nighttime frog call methods were tested after sunset on 6/26/02. Three locations in the ISA (Site 1, 12, and 13) were sampled by the following methods:

- Positioning research vessel as close to shore as possible, without anchoring, and turning off engine to allow for a few minutes of silence
- Playing a CD recording (Davidson 1995) of frogs calling for approximately 1 minute for each type of frog call used[1]
- Listening for approximately 2 minutes between each type of recording for responses from amphibians present
- Repeating the above two steps

The sampling location and any responses obtained were recorded in the field notebook. These methods were only employed for one night, as it was found that more results were gained by the daytime visual survey. Auditory surveys are typically successful during the breeding season, which for common species in this system (e.g. red-legged frogs, bullfrogs, and Pacific tree frog) would occur in late winter or early spring (Corkran and Thoms 1996). The success of this auditory survey may have been limited due to its timing in late June. All methods used were consistent with commonly employed methods for reconnaissance level surveys

[1] Frog call recordings were a chorus of red-legged frogs and Pacific tree frogs and a chorus of bullfrogs.

(Hendricks and Reichel 1998; National Parks Assoc. of NSW and NSW National Parks and Wildlife Service 2001).

4.0 RESULTS

In general, the four bank conditions on which the majority of the sampling sites were located included riprap, unclassified fill, natural bank, and river beach due to the occurrence of available habitat in these areas. Other more developed bank types such as seawall and over-water structures were also visited, but did not support aquatic plant communities, and therefore did not provide suitable amphibian or reptile habitat. Results of the plant and amphibian/reptile surveys are presented in Table 1. This table includes a physical description of each site and the plants, amphibians, and reptiles observed. The survey looked for evidence of salamanders but none was found. It was not possible to identify the species of the egg masses.

Table 1. Summary results of reconnaissance survey

Site	Latitude (N)	Longitude (W)	Site Description	Dominant Plant Type	Amphibians/ Reptiles Observed?
1	45 37 03	122 47 47	Upland natural bank drops off sharply to low sloping vegetated beach and shallow water. Patches of emergent vegetation occurred from waterline to 11in of water. Contains small still water habitats among emergent vegetation.	Reed canary grass*, purple loosestrife*, alfalfa, sedges*, common horsetail	no
2	45 37 04	122 47 50	Upland natural bank drops off sharply to low sloping vegetated beach and shallow water. Large patches of emergent vegetation occurred from waterline to 0.8 m of water. Contains small still water habitats among emergent vegetation. Much woody debris.	Reed canary grass*, common rush*, horsetail, sedges*, water moss, red osier dogwood*, bird's foot trefoil	2 Northern red-legged frog
3	45 36 59	122 47 11	Upland natural bank drops off to low sloping sandy beach. Much woody debris. No emergent vegetation present.	Columbia river willow*, reed canary grass*	1-Northern red-legged frog
4	45 36 41	122 46 30	Steep highly vegetated natural bank that drops off quickly into deeper water. Narrow strip of emergent vegetation present from edge of bank to 0.8 m of water.	Cattail*, reed canary grass*, sedges*, bird's foot trefoil, yellow water-flag iris*, common rush*	egg mass
5	45 36 42	122 46 51	Steep riprapped bank with little woody debris and very few plants. No emergent vegetation present.	Himalayan blackberry	no
6	45 35 15	122 45 50	Low sloping sandy beach with some vegetation and woody debris. No emergent vegetation present.	Columbia river willow*	no
7	45 35 28	122 46 07	Steep riprapped bank that drops off quickly into deeper water. Sparsely vegetated with large woody debris. No emergent vegetation present.	Himalayan blackberry, reed canary grass*, St. John's wort	no
8	45 35 45	122 46 23	Seawall. No plants present at water's edge.		no
9	45 36 02	122 46 23	Steep rocky bank that is sparsely vegetated and drops off quickly into very deep water (4.5-6 m). No emergent vegetation present. Abundant large woody debris present on bank and floating near shore.	Himalayan blackberry, common velvet grass, St. John's wort	call-unidenti-fiable

Site	Latitude (N)	Longitude (W)	Site Description	Dominant Plant Type	Amphibians/ Reptiles Observed?
10	45 36 15	122 46 25	Steep vegetated bank at end of slip that drops off quickly into deeper waters. Emergent vegetation present in narrow band at edge of bank.	Reed canary grass*, grass spp., common rush*, cattail*, sedges*, St. John's wort	egg mass
11	45 34 50	122 44 42	Low sloping sandy beach with some vegetation, woody debris, and concrete pilings. Emergent vegetation present at edge of rocky outcrop.	Black cottonwood, common rush*	no
12	45 34 11	122 43 33	Very steep rocky bank with large woody debris. Narrow strip of emergent vegetation in shallow water.	Oregon ash*, sedges*, smartweed*	no
13	45 33 58	122 42 47	Low sloping sandy beach with some vegetation and woody debris. Emergent vegetation present in shallow water. Abundant dead willow seedlings.	Smartweed*, red osier dogwood*, cattail*	call-Pacific tree frog
14	45 33 30	122 43 35	Narrow rocky outcrop extending out from steep bank. Narrow strip of shallow water, drops off quickly into deeper water. Few emergent plants.	Bird's foot trefoil, Himalayan blackberry, St. John's wort, oxeye daisy, Douglas' spiraea*	no
15	45 33 54	122 44 13	Steep sandy beach with some large woody debris. No emergent vegetation present.	Himalayan blackberry, Scot's broom, common wetland asters*, common groundsel	no
16	45 34 04	122 44 26	Low sloping sandy beach adjacent to backwater marsh. Some large woody debris. No emergent vegetation present on beach except large trees. Additional backwater area with outfall has very steep banks that drop off quickly to deep waters. Few emergent plants are located on the fringe of this backwater area.	Oregon ash*, thistle, bird's foot trefoil, horsetails. *In marsh*: cattail*, common rush*, reed canary grass*. *In outfall area*: common rush*	no
17	45 34 29	122 44 54	Low sloping sandy beach with some large woody debris. Few emergent plants present at waterline and in shallow waters near shore.	smartweed*, purple loosestrife*, bird's foot trefoil	no
18	45 34 56	122 45 52	Steeply sloped riprap covered bank that drops off quickly to deeper waters. Abundant large woody debris. Very narrow shallow water habitat. No emergent vegetation present. Abundant vegetation present above high water line.	Himalayan blackberry, reed canary grass*, sweet clover, bird's foot trefoil, Scot's broom	no
19	45 35 38	122 46 37	Seawall with outfall.	Himalayan blackberry	no
20	45 36 04	122 47 03	Low sloping sandy beach with dense vegetation and some woody debris. Emergent vegetation, including live and standing dead plants, present in shallow water.	Reed canary grass*, Columbia river willow*	no
21	45 36 41	122 47 27	Steeply sloped riprap covered bank that drops off quickly to deeper waters. Some large woody debris. No emergent vegetation present. Some vegetation present above high water line.	Himalayan blackberry, willows	no

*Indicates aquatic plant species. See Table 2 for more detail.

4.1 Aquatic Plant Survey

This survey identified twenty-six plant species, most of which were obligate and facultative wetland plant species, as defined by the *National List of Plant Species That Occur in Wetlands* (Reed 1996; Table 2).

Table 2. List of plant species found in the LWR

Species[a]	Indicator Status[b]
Aster spp. (common wetland asters)[c]	FAC/FACW
Carex spp. (sedge)	FACW/OBL
Cirsium arvense (Canada thistle)*	FAC-
Cornus sericea (red-osier dogwood)	FACW
Cystisus scoparius (Scots broom)*	NOL
Dipsacus fullonum (teasel)*	FAC
Equisetum arvense (common horsetail)	FAC
Fontinalis antipyretica (water moss)	NOL
Fraxinus latifolia L. (Oregon ash)	FACW
Holcus lanatus L. (common velvet grass)*	FAC
Hypericum perforatum (St. John's wort)*	NOL
Iris pseudacorus (yellow water-flag iris)*	OBL
Juncus effusus (common rush)	FACW
Leucanthemum vulgare (oxeye daisy)*	NI (no indicator)
Lotus corniculatus (bird's foot trefoil)*	FAC
Lythrum salicaria (purple loosestrife)*	OBL
Medicago falcata L. (alfalfa)*	NOL
Melilotus alba Mill. (sweet clover)*	NOL
Phalaris arundinacaea (reed canary-grass)*	FACW+
Polygonum spp. (smartweed)	FACW/OBL
Populus balsamifera var. *trichocarpa* (black cottonwood)	FAC
Rubus discolor (Himalayan blackberry)*	FACU
Salix fluviatilis Nutt. (Columbia River willow)	OBL
Senecio vulgaris L. (common groundsel)*	FACU
Spiraea douglasii (Douglas' spiraea)	FACW
Typha latifolia (cattail)	OBL

[a] Exotic species are identified by * following the common name. [c] The Aster spp. were garden varieties not *Aster curtus* or *Aster vialis*.

[b] Indicator status refers to the likelihood of that species occurring in regional wetlands and are defined as follows:

- "Obligate Wetland (OBL). Occur almost always (estimated probability >99%) under natural conditions in wetlands.
- Facultative Wetland (FACW). Usually occur in wetlands (estimated probability 67%-99%), but occasionally found in non-wetlands.
- Facultative (FAC). Equally likely to occur in wetlands or non-wetlands (estimated probability 34%-66%).
- Facultative Upland (FACU). Usually occur in non-wetlands (estimated probability 67%-99%), but occasionally found in wetlands (estimated probability 1%-33%).
- Obligate Upland (UPL). Occur in wetlands in another region, but occur almost always (estimated probability >99%) under natural conditions in non-wetlands in the region specified.
- Not on list (NOL). [This species is not included on the Reed (1996) list.]

A positive or negative sign denotes which end of the reported range of probability that species is likely to regionally occur." (Reed 1996) For example, the probability that reed canary grass (FACW+) occurs in Pacific Northwest wetlands is closer to 99% than 67%.

The aquatic plant community was dominated by emergent hydrophytes that are able to live with their roots in water or muddy substrates. No submersed plants were found offshore in waters 2.4-3 m deep; however, a few submersed plants were identified close to the waterline near shore. These submersed plants included water moss, grasses, and sedge species.

The 21 sites sampled in this survey can be separated into three major types of aquatic plant habitat: 1) rocky or riprapped banks dominated by scrub-shrub wetland vegetation; 2) sandy beach where no emergent macrophytes were present in the water; and 3) sandy or rocky banks with emergent macrophytes present in the water (Figure 2). Below is a brief description of each habitat type and the dominant plant species that occurred in each type.

4.1.1 Rocky or riprapped banks

The rocky or riprapped bank type was usually located on fairly steep banks with no or very narrow shallow water habitat present (Table 1, Figure 2). These areas were usually exposed to heavy wave action and strong currents. Usually, there were no emergent macrophytes present at these locations; however, a few sites did have a few grasses at the water's edge. Dominant plant species at these sites included Himalayan blackberry (exotic), Columbia River willow, and reed canary grass (exotic).

4.1.2 Sandy beaches with no emergent macrophytes

The sandy beach bank type with no emergent vegetation present was usually adjacent to steep uplands that were either riprapped or developed (Table 1, Figure 2). These bank types were frequently located in areas that were exposed to heavy wave action. In addition, relative current and turbidity of the river adjacent to these banks were frequently higher than more protected areas of the river. Plants were usually located 1 m or so upland from the waterline at these sites. Dominant plant species in this habitat type included Columbia River willow, Oregon ash, Himalayan blackberry (exotic), and common horsetail.

4.1.3 Sandy beaches with emergent macrophytes

The sandy or rocky bank habitat type with emergent vegetation present was a common occurrence along the main stem of the LWR in the ISA (Figure 2). Similar to the sandy beach bank type, these bank types were also adjacent to steep uplands; however, these banks were either of sandy or rocky substrate. These bank types were located in more protected areas in the ISA, such as at the end of slips or in Swan Island Lagoon (Table 1). Common emergent plant species included smartweed, sedges, common rush, and cattails. Red osier dogwood, reed canary grass (exotic), horsetail, and willows are other common species that occurred occasionally in water, but were more frequently located higher on the bank and may be water-covered during high water periods.

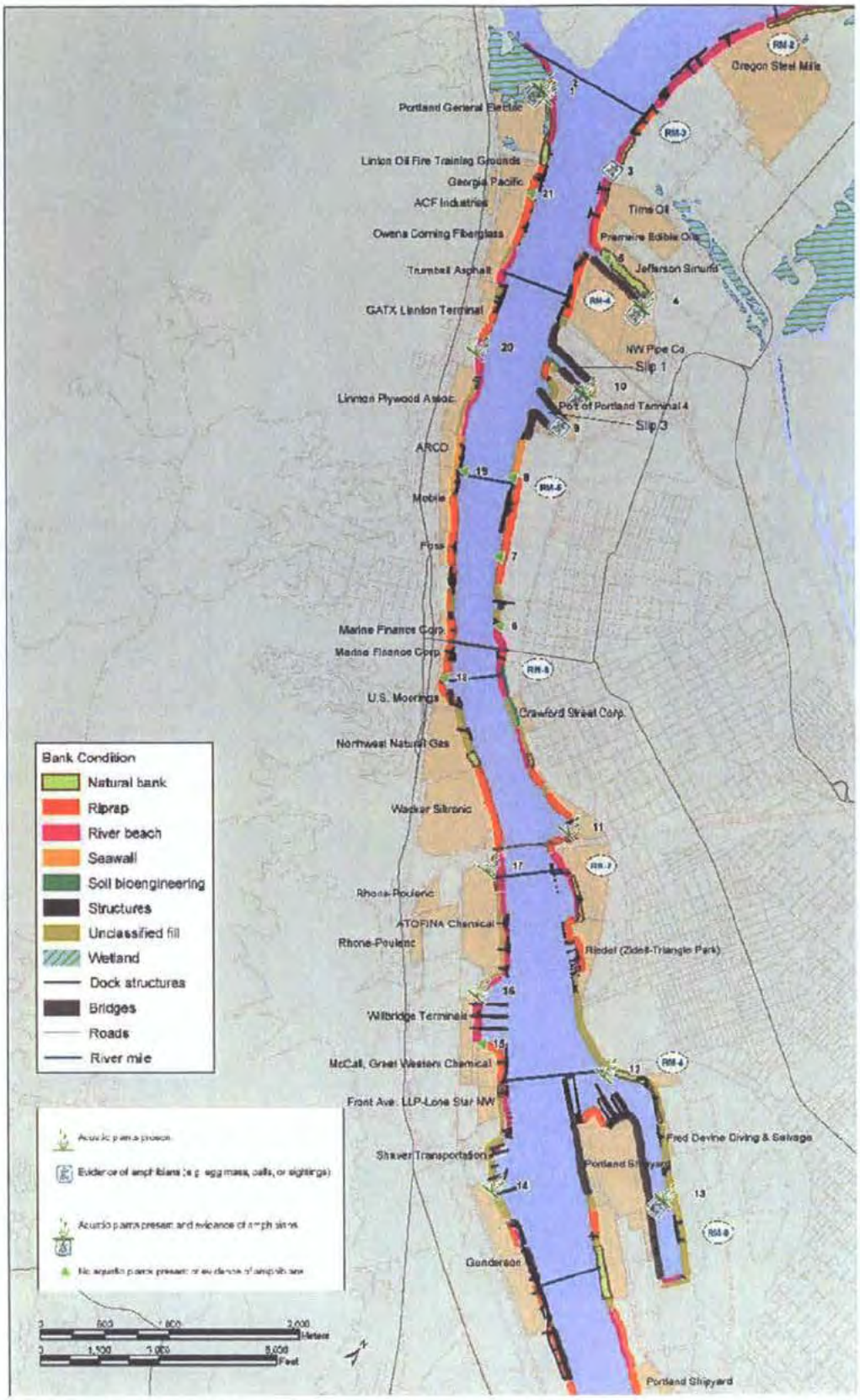

Figure 2. Location of aquatic plants and amphibians at survey sites in the lower Willamette River

4.1.4 Other types of sites

Three sampling sites did not fall into these three bank type categories. Site 12 was different from the rest of the sampling sites in that it was located at the edge of Waud Bluff at the northwestern shore of Swan Island Lagoon (Table 1, Figure 2). The upland of this sampling site was undeveloped, but very steep. The shoreline of this site was also very steep, and grass covered with a rocky substrate and a narrow shallow water area. Dominant plants at this site included Oregon ash and grass species. Also, a few sedge species and smartweed were growing in the shallow water habitat.

In addition, two seawall sites (Site 8 and 19) were included in this survey (Table 1, Figure 2). No shallow water habitat occurred at these sites and no submersed or emergent vegetation were observed at these sites. However, at Site 19, Himalayan blackberry was growing around an outfall in the seawall (see photo in Subattachment B2A).

4.2 Amphibian and Reptile Survey

Evidence of amphibian presence was observed at 6 of the 21 sampling locations (Figure 2, Table 1). No reptiles were found. The evidence of amphibian presence can be separated into the three major types of habitat identified and described in Section 4.1. In addition, frogs were heard calling in multiple habitat types, but not in response to the frog call recordings. Because no responses to the frog call recordings were heard, the nighttime frog call survey was terminated after the first night (6/26/02). Below is a brief description of the evidence of amphibians that was found in each type. Figure 3 presents those areas where amphibian sensitive life stages may occur.

4.2.1 Rocky or riprapped banks

Evidence of amphibians were found at three sites characterized as rocky or riprapped banks. These sites were all located at the end of slips (Site # 4, 9, and 10; Figure 2) and were thus protected from heavy wave action. Amphibian egg masses were found among the emergent vegetation at the end of the Burgard Yard slip and Terminal 4 Slip 1 (Site 4 and 10). The very steep natural bank at the Burgard Yard was thickly vegetated with emergent vegetation (Photograph: Site 4.jpg). The habitat at Site 10 was also a very steep natural bank, however it was less densely vegetated. This site also had abundant floating woody debris (Photographs: Site 10a.jpg and Site 10b.jpg). Windward was not able to identify the egg mass to genus. A frog call was incidentally heard at the location inside Terminal 4 Slip 3 (Site 9). The call was not identifiable to genus, however.

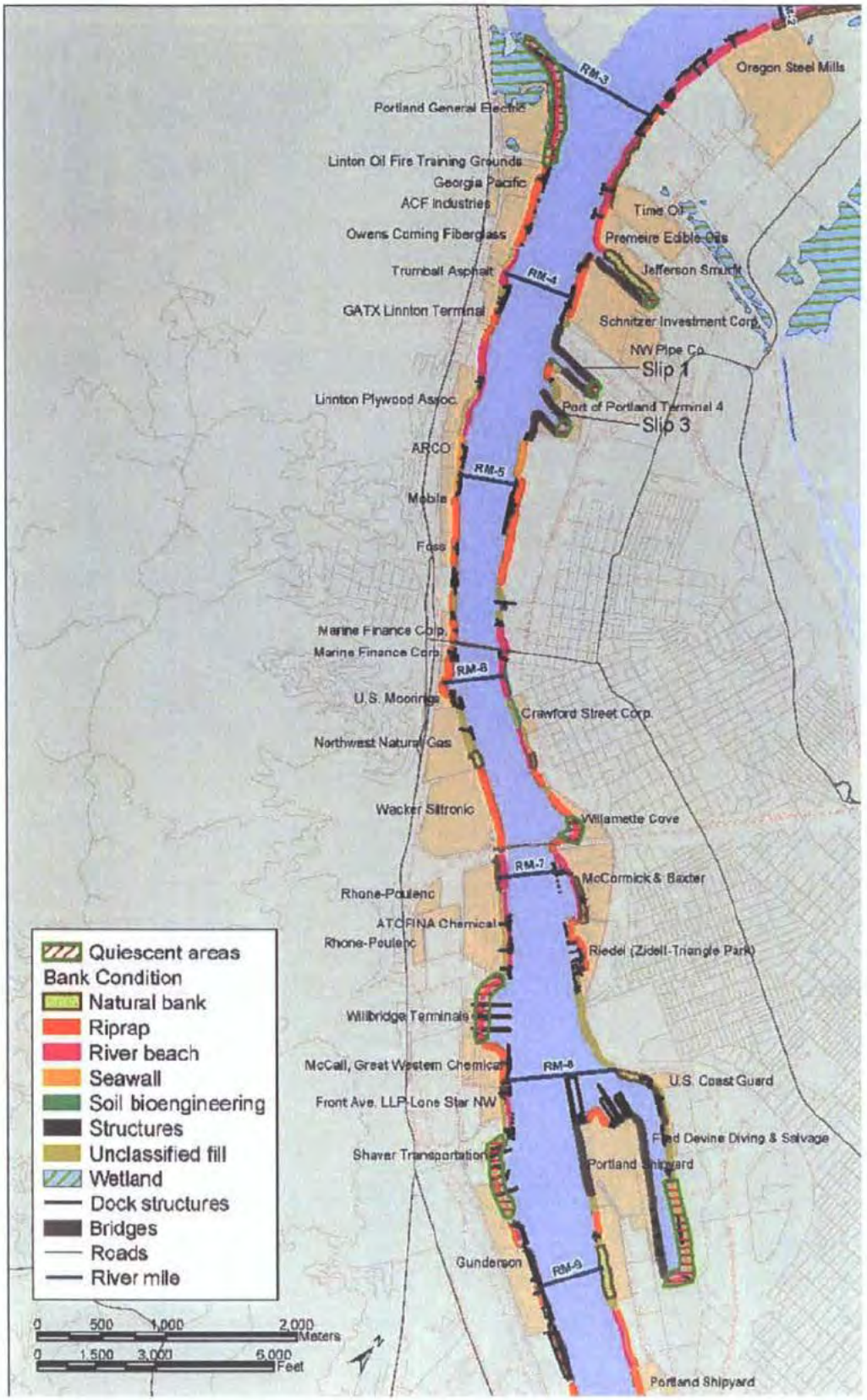

Figure 3. Areas that could potentially support amphibian sensitive life stages in the lower Willamette River

4.2.2 Sandy beaches with no emergent macrophytes

One northern red-legged frog (*Rana aurora*) was found at Site 3, which is characterized as sandy beach with no emergent vegetation present (Table 1, Figure 2). This location contained a large, gently sloping beach with considerable large woody debris stranded on the beach (Photograph: Site 3). The frog was found sitting on top of a large stranded log.

4.1.3 Sandy beaches with emergent macrophytes

Evidence of amphibians was found at one site characterized as sandy beach bank type with emergent vegetation present. Two northern red-legged frogs were found at Site 2, the Harborton Forest and Wetlands area (Table 1, Figure 2). This area has a low sloping beach with large woody debris and thickly vegetated uplands (Photograph: Site 2.jpg). The area is also protected from wave action by a large log raft anchored approximately 30-50 m from shore, which creates calmer water than other parts of the mainstem Willamette. This area also contains small areas of pooling water due to emergent vegetation and the undercut banks and large woody debris. One of the frogs observed was found on sedge in a small pool of water (Photograph: Site 2-Red-legged frog-a.jpg). The other frog found at this location was in a patch of St. Johns wort on the beach. The third red-legged frog was observed on the eastern side of the river.

4.2.4 Multiple habitat types (frog call survey results)

Frog calls were heard throughout the Swan Island Lagoon. One calling Pacific tree frog (*Hyla regilla)* was heard in the Lagoon during the 6/26/02 frog call survey (site 13, Figure 2). Other Pacific tree frogs were heard in the Lagoon on various occasions over the three sampling days. Pacific tree frogs live in diverse habitats (Corkran and Thoms 1996). Because the calling frogs were not visually observed, it is not possible to know if they are using mainstem Willamette R. habitat, however, the highly limited availability of other suitable habitats, such as terrestrial ponds and wet meadows, makes this unlikely. Habitat in the Swan Island Lagoon is largely developed. The southern side of the Lagoon is made of industrial structures, docks, and moored vessels, which surround a small amount of sloping, bank habitat. The bank consists of small beach areas and unclassified fill with some vegetation. The northern side of the lagoon is bulkhead and there is no visible bank habitat.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The presence of emergent macrophytes and visual or auditory accounts of amphibian presence suggest that amphibians and aquatic plant habitat are present in the ISA. With the exception of Site 8 (seawall), plants were present at every sampling site. However, many of these plants were emergent or plants more typical of disturbed upland areas. The high level of development and human activity in the ISA tend to favor disturbance-tolerant species. For example, many species were either invasive, exotic species such as reed canary grass and Himalayan blackberry, or native species

that are common in disturbed areas, such as cattails and common rush. In addition, emergent macrophytes were most often observed most often at protected areas on the river, such as at the end of the Burgard Yard slip, in Swan Island Lagoon, and in Willamette Cove. In contrast, emergent plants were not as common on rocky or riprapped banks, which supported a scrub-shrub plant community. The lack of submersed plants at some of the sites may be related to the water fluctuations and high turbidity of the navigational channel (Pennington 2002). Protected areas in the ISA appear to support more plants. This is likely due to the decreased wave action in these areas.

This survey suggests that habitat in the ISA can and does support an amphibian community. Amphibians appear to be especially prevalent in off-channel backwater areas. Amphibian presence was most often detected in areas with emergent vegetation, but emergent vegetation does not appear to be necessary for amphibian presence, as shown by the red-legged frog found at site 3. Figure 3 displays areas in the ISA that Windward believes have the potential to support amphibian breeding and rearing habitat based on the reconnaissance survey outlined in this report and knowledge of amphibian life history and habitat needs. These areas are characterized by calmer waters than the rest of the ISA because they are protected inside slips or other structures, contain some degree of aquatic vegetation, and contain beaches or natural banks. Reptiles were not observed in the ISA. The methods used to locate presence/absence are common survey techniques, however, absence of reptiles in this one survey does not indicate reptiles will never utilize the ISA. However, because amphibians are more common, more sensitive, and there is toxicity data for them (or other more protective aquatic species), we propose to assess amphibians (or other aquatic species) as a surrogate for reptiles. Thus, protection of reptilian species will be ensured through protection of more sensitive aquatic species.

In conclusion, the results of this reconnaissance survey indicate that aquatic plants and amphibians are present in the ISA and could have potentially complete exposure pathways. The potential exposure is most likely greater in the quiescent areas (Figure 3) where more sensitive life stages are likely to be found. These areas will be the focus of any qualitative evaluations or data collection needed for a quantitative risk assessment.

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SUBATTACHMENT B2A: PHOTOGRAPHS[2]

Photograph: Site 2.jpg

Photograph: Site 2-Red-legged frog-a.jpg

[2]. Selected photographs cited in the text are included in this subattachment, which is published as a separate document; the full folio of 30 site photographs is available from Windward on request.

Photograph: Site 3.jpg

Photograph: Site 4.jpg

Photograph: Site 10a.jpg

Photograph: Site 10b.jpg

ATTACHMENT B3: LAMPREY AMMOCOETE AND BENTHIC INFAUNAL BIOMASS RECONNAISSANCE SURVEYS OF THE LOWER WILLAMETTE RIVER

September 16-17, 2002
and
October 8-9, 2002

REVISED DRAFT FINAL
November 13, 2003

Prepared for:
Lower Willamette Group

Prepared by:
Striplin Environmental Associates, Inc. (Olympia, WA)
and
Windward Environmental, LLC (Seattle, WA)

LWG SURVEY – SEPTEMBER 16-17, 2002

INTRODUCTION

On 16 and 17 September 2002, a field team consisting of Striplin Environmental Associates (SEA), Windward Environmental, Ellis Ecological, and Fishman Environmental personnel visited 21 of the 22 co-located sediment and tissue sampling stations, originally identified in the June 2002 LWG Field Sampling Plan (SEA 2002) and as modified during the subsequent fishing efforts. The main objective of this reconnaissance survey was to determine whether juvenile lamprey (ammocoetes) could be collected using backpack electroshockers or surface grab samplers in adequate numbers to allow for tissue chemical analyses. Also, because lamprey collection techniques included sediment grab sampling, an ancillary objective was to assess the apparent biomass and composition of the soft-bottom, benthic infaunal community to determine whether adequate biomass of infauna were present to allow for tissue chemical analysis.

Ammocoetes are the larval form of fish from the family Petromyzontidae (lampreys). Four species of lamprey are native to the Willamette River. The Pacific lamprey, and the river lamprey, are anadromous species. Whereas, the western brook lamprey, and the Pacific brook lamprey are resident species. Lamprey ammocoetes in the Willamette River remain burrowed in the freshwater sediment until maturity (up to 7 years) filter-feeding on phytoplankton and detritus (Kostow 2002; Moore and Mallat 1980). Lamprey are poor swimmers and anadromous forms are believed to outmigrate during spring flooding (Jackson et al. 1997).

METHODS

Sampling was conducted on-foot (backpack electrofishing) and from a 20' boat equipped with a davit and electronic capstan for sediment grab deployment and retrieval. As warranted based on each station's physical setting, shoreline habitats, and accessibility, beach electroshocking for lamprey ammocoetes and beach and subtidal sediment sampling (hand-held spoons, Ekman and van Veen grab samplers) for lamprey ammocoetes, soft-bottom benthos, and bivalves were conducted. Sediments were sieved through both 1.0 mm and 0.5 mm screens at a subset of stations and representative benthic infauna specimens were retained for latter examination in the laboratory, although no attempt was made to quantitatively sample the benthos. Infaunal organisms were identified to major taxonomic categories following the survey and bivalves were identified to the genus level.

RESULTS

Table 1 lists the stations visited during this reconnaissance in chronological order and the major site-specific observations. Table 1 also provides a summary of the benthic

infauna data, and conclusions on whether adequate benthic biomass might be collected at a given location to allow for chemical analyses of composite invertebrate tissue samples. Table 2 provides details on the lamprey ammocoetes electrofishing efforts and results at each station. Figure 1 shows the locations where collection of benthos and lamprey ammocoetes was attempted.

CONCLUSIONS AND RECOMMENDATIONS

Lamprey

The backpack electroshocking was only successful at collecting lamprey ammocoetes at one (04R004) of the sixteen stations sampled. Two lamprey ammocoetes were collected at this site and one specimen was released and subsequently re-found with the electroshocker. This suggests that the electroshocking approach is successful at finding lamprey ammocoetes when they are present. Electroshocking was not attempted at several stations without apparent suitable habitat, i.e., steep-sloped rip-rapped shorelines.

Other methods evaluated for catching lamprey ammocoetes included grab sampling and hand-scooping of beach sediments in areas that appeared to be suitable habitat. Beach and/or subtidal sediments were collected and sieved at 15 of the target stations. No lamprey ammocoetes were collected in the sediment grab samples. A small epibenthic dredge was mobilized for this reconnaissance but nearshore sediment dredging was not attempted at any station because of the shallow-water levels, uneven bottom terrain, and nearshore structures (dolphins, piers, etc.). Given the apparent low abundance of lamprey ammocoetes in the area surveyed in mid-September, the probability of collecting lamprey ammocoetes in a sediment grab sample seems quite low.

Overall, because numerous, apparently high quality habitat locations were sampled with both standard electrobackpacking and sediment sampling equipment without finding lamprey, it is doubtful that other methods would yield sufficient quantities of lamprey at this time of the year to allow tissues analyses. It is possible that sampling in other seasons, e.g., spring, would yield different results.

Benthos

Sediments were collected and sieved at 15 of the target co-located stations. Soft-bottom benthos observed consisted of oligochaetes, bivalves, chironomids, and amphipods. Oligochaetes and chironomids were present in low abundances in most fine-grained (silts) areas. Amphipods were observed only at downriver locations (RM 2-3). The bivalve, *Corbicula*, was widespread in areas with an obvious sand fraction. With the exception of these bivalves at certain locations where there were individual clams equal to or greater than about 3 cm in length, the tissue biomass of the soft-bottom infaunal assemblage appeared to be extremely low as a result of both relatively low abundances and the small size of individuals (e.g., most specimens

passed through the 1.0-mm screen but were retained on the 0.5-mm screen). As an example, the sieving of one-half of the 0.1-m^2 van Veen grab sample at 08R002 (about a one hour effort by three field staff) produced a total of 20 oligochaetes, up to about 3 cm in length, and 9 chironomids. The entire biomass of this sample was too low to be accurately weighed, but it was certainly no more than a fraction of a gram. In studies in Lake Erie, Soster et al. (2001) report that oligochaetes (tubificids) less than 3 cm in length average less than 1 mg each (dry weight).

Based on this reconnaissance effort, the only soft-bottom benthic organism that could potentially provide sufficient biomass for laboratory tissue analyses is the exotic bivalve, *Corbicula*. At several locations (02R001, 03R001, 05R001, 06R002, 07R003), *Corbicula* may be abundant and large enough to provide sufficient biomass for tissue chemical analyses with a reasonable effort (e.g., 1-2 days per site). In addition, large specimens of the mussel, *Margaritifera*, were collected at Station 05R002, but their origin at this location is uncertain because it is just off a public boat ramp and these specimens may have been transported and disposed there from elsewhere on the river.

UMATILLA TRIBAL BIOLOGISTS LAMPREY SURVEY – OCTOBER 8-9, 2002

INTRODUCTION

On 8 and 9 October 2002, a field team consisting of two lamprey biologists from the Umatilla tribe, Aaron Jackson and Brandon Trelor, as well as Striplin Environmental Associates (SEA), Windward Environmental, Ellis Ecological, Fishman Environmental personnel, and Hellen Hilman of NOAA visited 11 Lower Willamette sites. The objective of this reconnaissance survey was to assess whether juvenile lamprey (ammocoetes) could be found in the Lower Willamette using techniques/backpack electroshocking equipment specifically designed for that purpose.

METHODS

Sampling was conducted either on-foot (backpack electrofishing) or from a small outboard aluminum boat. Sites were selected based on previous collection of lamprey ammocoetes and presence of fine sediments in the shallow intertidal zone. An ABP-2 electroshocker specifically designed by the University of Wisconsin for collecting lamprey ammocoetes was used. Each site was shocked until the Umatilla Biologists were satisfied that no lamprey were present. A setting of 125 volts with 3 pulses per second and a 25% duty cycle is normally used to withdraw larvae from the substrate. Once larvae emerge from the substrate, a setting of 30 pulses per second was to be

applied to stun and capture. However, because lamprey were not present, capture methods were not employed.

Habitat quality at each site was qualitatively assessed based on substrate characteristics as either Type 1, Type 2, or unsuitable:

Type 1 - Preferred ammocoete habitat where ammocoetes can easily burrow. Consists of fine sediments with some organic matter. Some cover, such as detritus or aquatic vegetation, is optimal.

Type 2 – Acceptable, but not preferred ammocoete habitat. Substrate that is soft enough for larvae to burrow but with little fine organic matter and some gravel present.

Unsuitable – Habitat that larvae cannot burrow into.

RESULTS

Table 3 provides details on the lamprey ammocoete electrofishing efforts and results at each station. Figure 1 shows the locations where lamprey ammocoete collection was attempted.

CONCLUSIONS AND RECOMMENDATIONS

The backpack electroshocking was not successful at collecting lamprey ammocoetes at any of the 11 stations sampled. Aaron Jackson suggested that additional sampling in June or July may yield better results.

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ATTACHMENT B4: PROPOSED PROCESS FOR ASSESSMENT OF BENTHIC RISKS AT THE PORTLAND HARBOR SUPERFUND SITE

NOTE:

The benthic approach was revised and submitted to EPA on May 20, 2003

1.0 INTRODUCTION

Figure 1 presents a proposed process for assessing risks to the infaunal benthic community within the Portland Harbor Superfund Site. The proposed process is intended to evaluate risks associated with whole sediment, and not intended to assess potential risks related to the bioaccumulation of persistent compounds by benthic invertebrates, or to assess risks that might be associated with exposure to contaminated groundwater. The assessment process relies principally on surface sediment chemistry and whole sediment toxicity tests to identify areas that may contain contaminants in sediments at concentrations high enough to result in unacceptable risks. The proposed methodology for assessing risks will be to determine whether a predictive site-specific relationship can be developed between sediment chemistry and toxicity using a discrete data set that can then be applied to the entire Portland Harbor Site. A number of recently completed projects provide examples of how predictive relationships can be developed using discrete, site-specific data sets (Ingersoll et al. 2001; Field et al. 2002; MacDonald et al. 2002; SAIC and Avocet 2002).

As an overview, the steps in the proposed process include:

- Use of existing surface sediment chemistry to identify ranges of sediment contamination and to rank order stations based on their relative degree of contamination.
- Use of standard whole sediment toxicity tests to assess the toxicity of a subset of sediment stations that represent the range of sediment contamination in Portland Harbor as identified using the existing surface sediment chemistry data.
- Use of the toxicity test results, along with synoptically collected sediment chemistry data, to determine whether a predictive relationship can be developed between sediment chemistry and toxic responses.
- Apply the predictive relationship to surface sediment chemistry data (existing and all new data) to map areas within Portland Harbor that have the potential to pose unacceptable risk to benthic communities.

Assessment of Benthic Community Risk

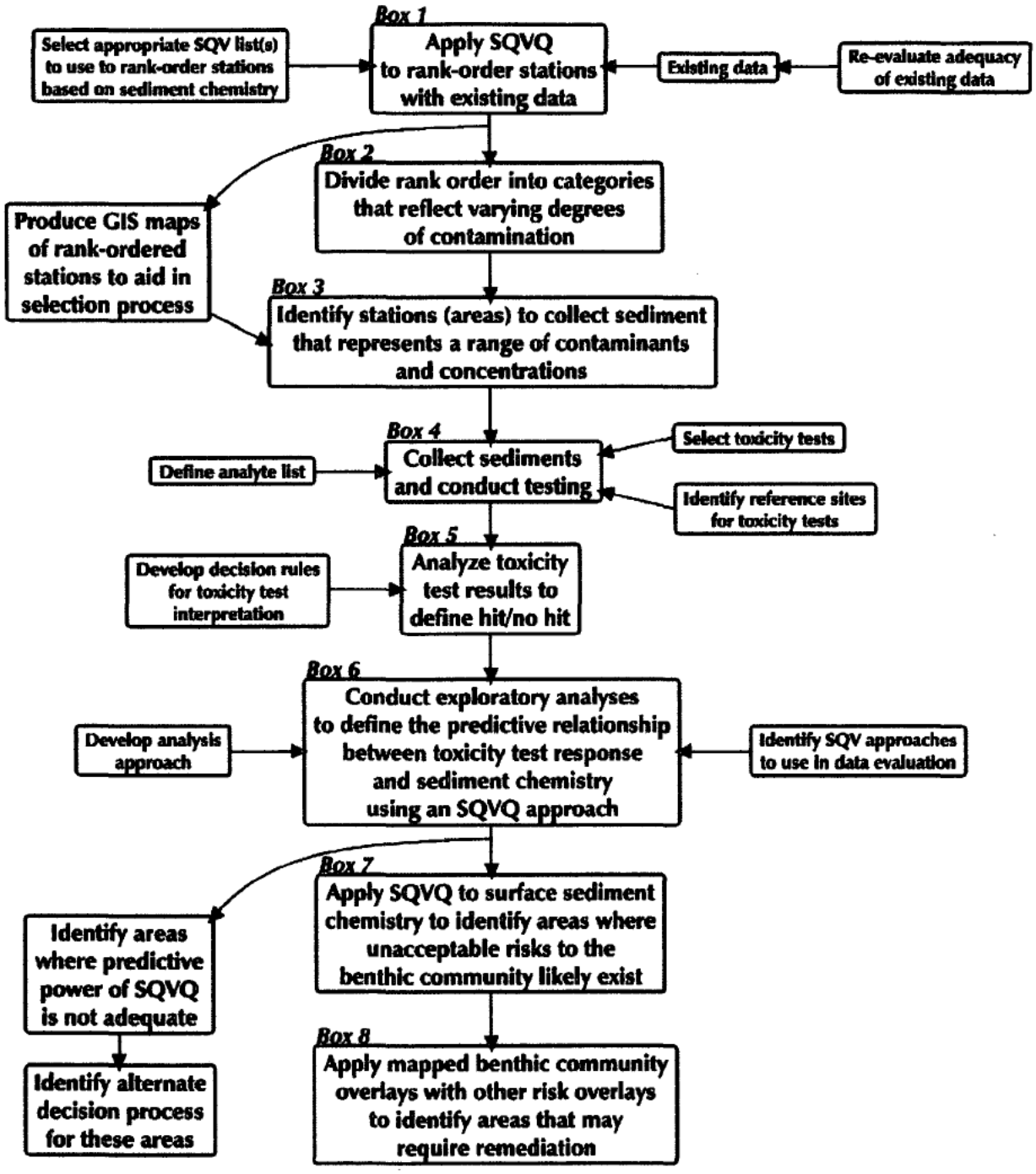

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Figure 1. Proposed process

2.0 ASSESSMENT PROCESS

The following presents a discussion of each of the steps in the proposed process for assessing risks to the infaunal benthic community.

Box 1: Apply SQVQ to rank order existing surface sediment chemistry stations

The first task in the proposed process will be to rank order the existing sediment chemistry stations based on their relative level of contamination. The ranking would be accomplished using a sediment quality value quotient (SQVQ). The SQVQ for a given station would be determined using the following steps:

1. Divide the concentration of each chemical in a sediment sample by the SQV (e.g., TEL, PEC, AET, etc; for an overview of the various methodologies for developing SQVs please refer to MacDonald et al. [2000] and SAIC and Avocet [2002]) for that chemical to determine the quotient for that chemical in the sample. This process would be done for each SQV set of chemicals separately (e.g., TEL only, PEC only, AET only, etc) such that a quotient would be developed for each chemical in the SQV set of chemicals.
2. Sum the individual quotient for each chemical at a site that exceeds the SQV and divide the sum by the number of SQVs used to determine the quotient (the number of chemicals that exceeded the SQV).

There are two subtasks that will need to be undertaken before the existing surface sediment chemistry data can be rank ordered. First, the existing sediment chemistry data set will be re-evaluated for its quality and acceptability in conducting the proposed task. Specifically, data sets that have been designated as Category 2 for earlier RI activities will be reviewed to determine if they can be used for this specific use. It may be possible to relax the established data quality requirements for this activity in order to increase the number of surface sediment chemistry stations that are included in the rank order process. In addition, both Category 1 and Category 2 data from dredging projects in which the sediment has been removed, or data having high detection limits might be removed for this task. A technical memorandum will be produced that provides a summary and analysis of the types of data categorized as Category 2 and a recommendation on whether any of the data should be included for rank ordering.

In addition to defining the size of the data set, the appropriate numeric sediment quality values (SQVs) that would be used to determine each surface sediment chemistry station's SQVQ will need to be selected. Options for SQVs include threshold effects limits (TELs), Probable Effects Concentrations (PECs), and Apparent Effects Thresholds (AETs). SQVQs can be calculated for all the chemicals measured for which there is a SQV, or they can be calculated for only a select set of chemicals that are found to be the most reliable predictors of toxicity. Various authors provide approaches to determining the predictive reliability of SQVs (Fairey et al. 2001; SAIC and Avocet 2002). A technical memorandum will be produced that evaluates and

recommends which SQVs should be used for rank ordering. Based on an initial screen of SQVs, we recommend that a number of SQVs be used to develop the SQVQs. The rank orders resulting from the various SQVs would be compared, with the one that best represents the distribution of sediment chemistry data being selected to construct the final rank order. The technical memorandum will provide draft decision rules on how to select the SQV that best represents the sediment chemistry distribution.

Box 2: Divide rank order into categories

Once the rank ordering is complete, the order will be broken into categories that represent a distribution from low to high based on SQVQs (e.g., use categories that represent the 0–25th; 25th–50th; 50th–75th; and 75th–100th percentiles). The purpose for dividing the rank order into categories is to aid in the selection of areas from which sediments will be collected for toxicity testing.

Box 3: Identify areas to collect sediment for toxicity testing

In order to maximize the degree to which the resulting toxicity test data set is predictive, toxicity tests will need to be conducted on sediments that represent the full range of sediment contamination found in Portland Harbor (Field et al. 2002). Since spatial distribution of samples across the Site may be an important factor in station selection, the stations will be plotted using GIS.

Box 4: Collect sediment and conduct testing

A field sampling plan (FSP) and quality assurance project plan (QAPP) will be produced that outline the procedures to be used in collecting sediment, conducting the toxicity testing, and chemically analyzing splits of the sediment samples and interpreting the resulting data. Subtasks that need to be accomplished prior to writing the FSP and QAPP include:

- Defining the analyte list for sediment chemistry
- Selecting the appropriate toxicity tests and test endpoints
- Identifying appropriate reference sites for collecting reference sediment to be used during the toxicity testing.

All three of these subtasks would be the subject of a technical memorandum that discusses the range of options and provides recommendations.

Box 5: Analyze toxicity test results

The toxicity test response data will be statistically analyzed to define whether the observed test response represents a toxic "hit" or whether the response represents a "no hit" when compared to the appropriate reference sediment results. A technical memorandum will be prepared discussing the decision rules for test interpretation and will provide a recommendation on the decision framework to be used.

Box 6: Determine whether a predictive relationship can be developed between toxicity test results and sediment chemistry

Once the "hit" status of the toxicity tests has been determined, the next step will be to determine whether the predictive relationship can be developed between observed toxic responses and sediment chemistry. This evaluation process will require an iterative analysis of the paired sediment chemistry/toxicity responses that make up the data set. Various SQVQ approaches will be evaluated to determine which one best predicts the observed chemistry/toxicity data generated for Portland Harbor. The analysis will focus on which SQVQ best minimizes both false positives (e.g., predictions of toxicity when the sediment is, in fact, not toxic) and false negatives (e.g., predictions of an absence of toxicity when the sediment is, in fact, toxic). Procedures for evaluating the predictive performance of the various SQVQs has been recently summarized by SAIC and Avocet (2002), Ingersoll et al. (2001), and Fairey et al. (2001). In a recently completed assessment of benthic community risks at the Calcasieu Estuary site, two SQVQ approaches, one based on the PEC and one based on the logistic regression model were found to be effective in predicting toxicity (Gouguet 2002). This work, along with other examples, will be summarized in a technical memorandum to provide aid in focusing discussions. For our purposes in Portland Harbor several alternatives will likely be evaluated, including relying on existing SQVs or developing site-specific SQVs (e.g., application of the logistic regression model or some other approach).

Given the widely dissimilar sources of some contaminants in Portland Harbor that could have a significant effect on bioavailability (e.g., different sources of PAHs), any portion of the Portland Harbor data set where the predictive power of the SQVQ is not adequate will be removed from the data set and an alternative decision process will be used to determine the significance of the observed toxic responses. In such cases, a site-specific approach will be developed to determine risks to the benthic community. The site-specific approach would likely include an evaluation of the types of chemicals present, their bioavailability, the relative toxicity of the chemicals, and factors that may be confounding the relationship sediment chemistry and toxicity.

Box 7: Apply SQVQ to surface sediment chemistry to identify areas of risk to the benthic community

Once any additional surface sediment chemistry data have been collected the SQVQ approach will be applied to the data set to determine the station-specific SQVQ. These station-specific SQVQs will, in turn, be mapped using spatial analysis tools in order to identify areas that have the potential to pose an unacceptable risk to the benthic community.

Box 8: Apply mapped benthic community overlays with other risk overlays to identify areas that may require remediation

As a final step in the baseline risk assessment, areas that represent risks to various human and ecological receptors will be placed on a single map to provide a mosaic of areas that may require remediation based on unacceptable risk.

The completion of this step is not the last step in the risk assessment process. It is anticipated that the multiple lines of evidence developed as part of the risk assessments will be used in risk characterization portion of the risk assessment process, and would also be applied in a risk management decision.

3.0 DELIVERABLES

Technical Memoranda (TM):

- TM 1: Evaluation of Available Surface Sediment Chemistry Data (to be completed as part of Box 1)
- TM 2: Evaluation of Available SQVs and Their Use in Rank Ordering Existing Sediment Chemistry Data (to be completed as part of Box 1)
- TM 3: Identification of Sampling Stations for Toxicity Testing (to be completed as part of Box 3)
- TM 4: Assessment and Selection of Toxicity Tests, Test Endpoints, and Test Interpretation Procedures (to be completed as part of Box 4)
- TM 5: Identification of Sites for the Collection of Reference Sediment (to be competed as part of Box 4)

Reports (R):

- R 1: Field Sampling Plan and Quality Assurance Project Plan (to be completed as part of Box 4)
- R 2: Data Report (to be competed as part of Box 5)
- R 3: Results of Exploratory Analyses to Define the Predictive Relationship Between Toxicity Test Results and Sediment Chemistry (to be completed as part of Box 6)

4.0 SCHEDULE

To meet overall project objectives of incorporating an assessment of risks to the benthic community in the draft baseline risk assessment that is due in May, 2004, the following schedule is proposed (Figure 2):

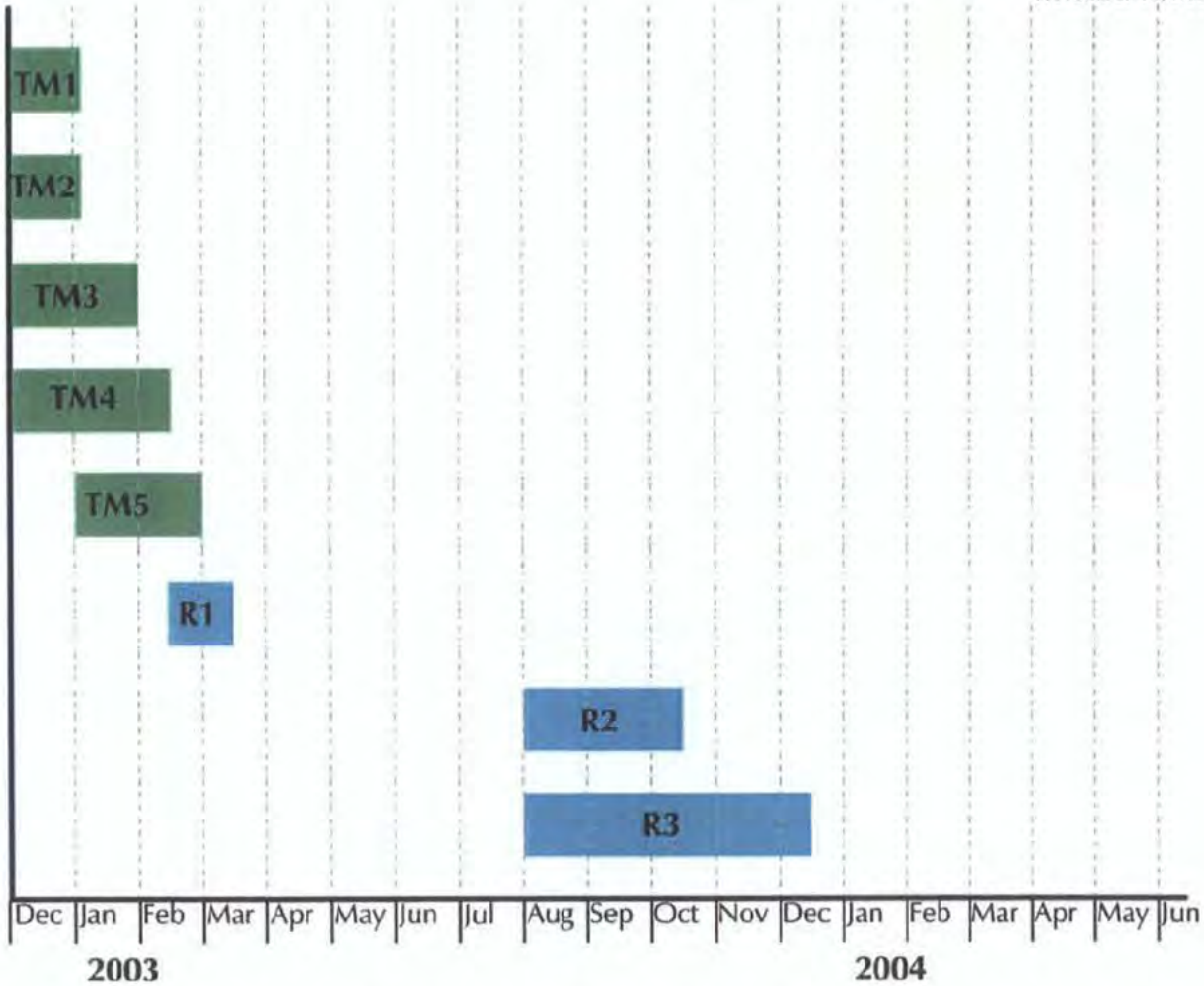

Figure 2. Proposed schedule for deliverables from assessment of benthic community risks

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ATTACHMENT B5: ECOTOXICOLOGICAL PROFILES

1.0 INTRODUCTION

The historical dataset for the ISA was evaluated in order to identify the classes of compounds that have been previously measured in the sediment, tissues, and surface water collected within the ISA and to ensure that the analytical methods selected for the Round 1 samples were appropriate and inclusive of the wide range of analytes previously measured in ISA samples. The selected target analytes represented the following chemical classes: metals, organometals, PAHs, PCBs, dioxins and furans, pesticides, herbicides, and volatile organic compounds. Brief summaries of the types of impacts reported in the literature for each COPC group (e.g., metals) on benthic invertebrates, fish, and wildlife will be provided below.

2.0 METALS

2.1 Benthic Organisms

Toxicity of metals to benthic organisms ranges widely, from a slight reduction in growth rate to mortality. Oligochaetes and mollusks are generally less sensitive to metals than other aquatic phyla (Leland and Kuwabara 1985). The most sensitive life stages of benthic organisms are the embryonic and larval stages. The speciation and bioavailability of metals determine their relative toxicity. TBT has been observed to cause imposex in snails and suppression of regeneration in echinoderms (Eisler 1989; Gibbs et al. 1990). Mercury adversely affects reproduction, growth, behavior, metabolism, blood chemistry, osmoregulation, and oxygen exchange in benthic organisms (Eisler 1987b).

2.2 Fish

Fish are exposed to metals through their gills and through ingestion pathways. The larval stages are generally most sensitive. Transition metals, such as cadmium, lead, copper, and zinc, are more toxic in their free divalent state than in particulate or complexed forms (Wong et al. 1978). Commonly observed effects of transition metals and metalloids include reductions in growth, survival, and fecundity (Jarvinen and Ankley 1999). Biochemical and histopathological effects have also been reported (e.g., James and Wigham 1986). Mercury can adversely affect fish reproduction, growth, behavior, metabolism, blood chemistry, osmoregulation, and oxygen exchange. Responses to chronic exposure to mercury include emaciation, brain lesions, cataracts, diminished responses to change in light intensity, inability to capture food, abnormal motor coordination, erratic behavior, and death (Armstrong 1979; Hawryshyn et al. 1982; both as cited in Eisler 1987b). Tributyltin inhibits mitochondrial and oxidative phosphorylation in fish, causing sluggishness, loss of appetite, altered body pigmentation, air gulping, loss of positive rheotaxis, increased rate of opercular movements, damaged gills, cornea, and epithelial cells of the bile duct, and increases in blood hemoglobin, erythrocyte numbers, and hematocrit (Chliamovitch and Kuhn 1977; Thompson et al. 1985, both as cited in Eisler 1989).

2.3 Wildlife

Birds—Avian dietary toxicity studies have been conducted with a wide range of metals. The observed toxicity of the metals depends on the level of metallothioneins in the bird. Sublethal effects can include reproductive and behavioral modifications. Teratogenic effects have been documented in chicken embryos after eggs were injected with chromium (Ridgeway and Karnofsky 1952; Gilani and Marano 1979, as cited in Eisler 1986). Methylmercury is more toxic to birds than inorganic mercury, and young birds are more sensitive than older birds (Eisler 1987b). Sublethal mercury poisoning can cause adverse effects on growth, development and reproduction, blood and tissue chemistry, metabolism, and behavior. Muscular incoordination, falling, slowness, fluffed feathers, calmness, withdrawal, hyporeactivity, hypoactivity, and drooping eyelids have been observed in birds exposed to mercury (Eisler 1987b). Very little information is available on the effects of tin and organotins on birds. Triorganotins are considered to be the most toxic. Possible effects of triorganotin poisoning include tremors, ataxia and lethargy, and degeneration and necrosis of the large neurons of the pons, medulla oblongata, gray matter of the spinal cord, and cells of the cerebral cortex (Eisler 1989).

Mammals— Methylmercury and lead can biomagnify within food chains and expose higher trophic level mammals in aquatic systems. Organomercury compounds, especially methylmercury, are the most toxic mercury species for mammals. Mercury causes teratogenic, mutagenic, and carcinogenic effects in mammals. The kidney is the primary organ affected by mercury poisoning in adult mammals and the brain is the primary target organ in fetuses (Suzuki 1979; Khera 1979, both as cited in Eisler 1987b). At low concentrations, mercury can affect reproduction, growth and development, behavior, blood and serum chemistry, motor coordination, vision, hearing, histology, and metabolism (Eisler 1987b). Larger mammals such as seals appear to be more resistant to mercury than smaller mammals such as mink and river otters (Eisler 1987a). The reasons for these differences in sensitivity are unknown, but may be related to differences in metabolism and detoxification. Lead modifies the function of and structure of kidney, bone, the central nervous system, and the hematopoietic system, and produces adverse biochemical, histopathological, neuropsychological, fetotoxic, teratogenic, and reproductive effects (Eisler 1988). Food-chain biomagnification of lead may be important for carnivorous marine mammals, such as the California sea lion and harbor seal (Eisler 1980). Tributyltin is highly toxic to mammals. It causes chromosomal aberrations and reduction in thymus weight (Snoeij et al. 1985; Dixon and Prosser 1986, both as cited in Eisler 1989).

3.0 PESTICIDES

3.1 Benthic Organisms

The mechanisms by which organochlorine pesticides cause toxicity include narcosis (nonspecific toxicity) and more specific mechanisms that result in enhanced toxicity,

such as respiratory uncouplers, acetylcholine esterase (AChE) inhibitors, and central nervous system convulsants (Lipnick 1993; McCarty and Mackay 1993).

Relatively little information is available relating sediment-associated pesticides with toxicity to benthic organisms, although some studies with DDT have been conducted (Nebeker 1988). Most sediment guidelines for pesticides have been developed from samples that contain a myriad of other contaminants, any of which may have contributed to the adverse effects associated with those samples.

3.2 Fish

Exposure of fish to organochlorine pesticides can result in narcosis (nonspecific toxicity) and more specific toxicity, such as respiratory uncouplers, acetylcholine esterase (AChE) inhibitors, and central nervous system convulsants (Lipnick 1993; McCarty and Mackay 1993). Additionally, the DDT metabolites DDD and DDE have been shown to be acutely toxic to a number of fish species. In addition to its toxic effects, DDT bioaccumulates significantly in fish and other aquatic species, leading to long-term exposure. A half-life for elimination of DDT from rainbow trout was estimated to be 160 days (EXTOXNET 1996).

Recent research suggests that organophosphate and carbamate insecticides may harm fish by blocking synaptic transmission by inhibiting neuronal acetylcholinesterase (Ferenczy et al. 1997; Sturm et al. 1999), which may have adverse effects on fish behavior such as predator avoidance and homing behavior. A study by Scholz et al. (2000) reported that the organophosphate pesticide diazinon inhibited olfactory-mediated alarm responses in chinook salmon.

The Washington State Pesticide/ESA Task Force is currently undertaking a systematic evaluation to identify pesticides that may cause harm or are potentially limiting to recovery of ESA-listed salmonids. This process will evaluate the potential of pesticides to cause direct harm to salmonids, harm through impairment of behavioral patterns, and harm through reduction of prey. Pathways to be considered include surface water, diet, sediment, and groundwater intrusion. The evaluation is just beginning at this time so the results were not available for incorporation into this risk assessment. Thus far, research involving pesticides and salmon has focused on water column issues.

3.3 Wildlife

Birds—Birds are generally less sensitive to dieldrin than aquatic organisms, although they can have increased exposure because they are higher in the food chain and dieldrin can biomagnify. Gamma-BHC is slightly to moderately toxic to birds; eggshell thinning and reduced egg production have occurred in birds exposed to gamma-BHC (EXTOXNET 1996).

There has been much concern over chronic exposure of bird species to DDT and effects on reproduction, especially eggshell thinning and embryo mortality. The mechanism

associated with eggshell thinning is not fully understood, although it is believed predatory birds may be more sensitive to these effects. Laboratory studies on avian reproduction have demonstrated the potential for DDT and DDE to cause subtle changes in courtship behavior, delays in pairing and egg laying, and decreases in egg weight in ring doves and Bengalese finches (EXTOXNET 1996).

Mammals—Some organochlorine pesticides such as o,p'-DDT, kepone, and methoxychlor have estrogenic activity in wildlife. Many of these compounds, including o,p'-DDT and kepone, have been shown to act by binding to the estrogen receptor. However, other organochlorine compounds can exert estrogenic or anti-estrogenic effects by other mechanisms (Carey et al. 1998). The overall impact of such estrogenic activity is typically disruption of normal reproductive functioning.

In addition, several chlorinated pesticides are known to affect mammalian immune system function. These pesticides include hexachlorobenzene, mirex, lindane, chlordane, dieldrin, and DDT and its metabolites (Carey 1994). The immunotoxic effects of these compounds have been demonstrated in several species and include loss of resistance to infections. In most cases, the mechanism of action for these compounds is not well known.

4.0 PAHs

4.1 Benthic Organisms

Effects of PAHs on benthic invertebrates include inhibited reproduction, delayed emergence, sediment avoidance, and mortality (Eisler 1987a; Landrum et al. 1991). In a study of PAH toxicity to the amphipod *Diporeia*, the mechanism identified as most likely responsible for observed acute toxic responses to PAHs was narcosis (Landrum et al. 1991). Generally, aquatic invertebrates are less able to metabolize PAHs than aquatic vertebrates, although rates of PAH metabolism vary widely within and between phyla (Meador et al. 1995). Thus, invertebrates tend to be more sensitive to PAHs due to acute lethality by narcosis than other organisms that actively metabolize these compounds.

4.2 Fish

In most fish, PAHs are rapidly metabolized and excreted following uptake, so PAH tissue concentrations are generally low. The major route of elimination is through excretion into bile. Biotransformation and excretion rates can vary widely among fish species (Meador et al. 1995). Fish exposed to PAHs may be induced to produce higher levels of enzymes capable of transforming PAHs to more excretable, but occasionally more carcinogenic, metabolites (O'Connor and Huggett 1988).

Low-molecular-weight polycyclic aromatic hydrocarbons (LPAHs) such as naphthalene, fluorene, phenanthrene, and anthracene are acutely toxic to fish and other aquatic organisms. Acute lethality increases with increasing alkyl substitution on the lower molecular weight compounds (Van Luik 1984). Many of the high-molecular-

weight polycyclic aromatic hydrocarbons (HPAHs), such as chrysene and benzo(a)pyrene, are less acutely lethal but demonstrably carcinogenic, mutagenic, or teratogenic to a wide variety of organisms including fish (Moore and Ramamoorthy 1984; Eisler 1987a). Elevated exposure of PAHs has been reported to result in reproductive impairment, immune dysfunction, increased incidence of liver lesions, and other histopathological endpoints (Malins et al. 1987; Johnson et al. 1988; Varanasi et al. 1992; Baumann et al. 1996). Fin erosion and liver abnormalities have also been observed in fish exposed to extracts from PAH-contaminated sediments (Fabacher et al. 1991). Other studies report sublethal effects on the cellular immune system (reduced macrophage activities) in fish exposed to PAH-contaminated sediments, that could result in increased susceptibility to disease (Weeks and Warinner 1984, 1986; Weeks et al. 1986). The most common diseases generally affect the liver, although cataracts and pollution-related disorders of the skin and gills may also occur (O'Connor and Huggett 1988).

4.3 Wildlife

Birds—Very few data are available on the toxicity of PAHs in birds. In one study, Patton and Dieter (1980) fed mallards diets containing 4,000 mg PAHs/kg for a period of 7 months. No mortality or visible signs of toxicity were evident during the exposure; however, liver weight increased 25%, and blood flow to the liver increased 30% when compared to controls (Eisler 1985). In addition, PAH mixtures applied to the surface of mallard eggs have been shown to result in increased embryo mortality and increased embryo deformation (Hoffman and Gay 1981).

Mammals—In mammals, several PAHs have been shown to be potent carcinogens. In general, PAH carcinogens transform cells through genetic injury involving metabolism of the parent compound to a reactive diol epoxide (Eisler 1985). In the case of benzo(a)pyrene, one isomer of the 7,8-diol, 9,10-epoxide is an exceptionally potent carcinogen to newborn mice and is believed to be the ultimate carcinogenic metabolite of this PAH (Slaga et al. 1978). One of the most toxicologically significant processes involved in response to PAH exposure is the interaction with drug-metabolizing enzyme systems. Increased production of mixed-function oxidase enzymes in various small mammals has been induced by numerous PAH compounds (EPA 1980b). Interspecies differences in sensitivity to PAH-induced carcinogenesis are due largely to differences in levels of mixed-function oxidase activities that affect rates at which active metabolites are converted to less active products (Neff 1979).

5.0 PCBs

5.1 Benthic Organisms

There are significant interspecies differences in sensitivities to PCBs, even among species that are closely related taxonomically (Eisler 1986). Most studies of the effects of PCBs on benthic invertebrates have shown reproductive impairment and effects on survival and growth (Eisler 1986).

5.2 Fish

There are a number of effects observed in fish species due to exposure to PCBs (Eisler 1986). They include mortality (EPA 1980a), growth reduction (e.g., Mauk et al. 1978), reduced hatching success (e.g., Freeman and Idler 1975), and reduced fertilization success (e.g., Nebeker et al. 1974). Carcinogenic and biochemical perturbations have also been observed in several fish species (EPA 1980a).

The lethal toxicity of PCBs to fish varies with several factors which include the PCB formulation, the organism species and stage of development, and the test conditions employed (e.g., length of exposure, static versus flow-through tests, etc.) (Nagpal 1992). Aroclors containing 42 to 54% chlorine appear to be the most toxic formulations of PCBs in fish (Johnson and Finley, 1980; Mayer et al. 1977). In addition, injection of dioxin-like PCB congeners into fish eggs can cause early-life-stage mortality associated with blue-sac disease, which involves subcutaneous yolk sac edema (Wisk and Cooper 1990; Walker et al. 1991).

5.3 Wildlife

Birds— Chronic dietary exposure of various bird species to PCBs has been reported to result in a variety of reproductive effects, including reduced hatching success, fledging rate, and egg production; embryo mortality; developmental deformities; and altered parenting behavior (Giesy et al. 1994; Hoffman et al. 1996). In addition, there appears to be significant inter-species variability in avian sensitivity to PCBs.

The most sensitive avian species tested in the laboratory appears to be domestic chickens, based on work done by Scott et al. (1971), Britton and Huston (1972, 1973), Lillie et al. (1974, 1975), and Ax and Hansen (1975). The other avian species for which extensive laboratory testing has been published is the mallard duck (Heath et al. 1972; Custer and Heinz 1980), which appears to be less sensitive than the domestic chicken. Controlled dietary exposures to PCBs have been conducted for a few other bird species (e.g., bobwhite quail, screech owls, pheasants), though few studies have described complete exposure-response relationships, most consisting of a single dietary dose.

A substantial effort has been expended investigating potential adverse reproductive and developmental effects in wild, piscivorous bird populations exposed to PCBs (Tillitt et al. 1992; Jones et al. 1993, 1994; Giesy et al. 1994a,b). Much of this research has focused on Great Lakes populations of double-crested cormorants, because reduced reproductive success and deformities in this species were found to coincide with high exposure to organic pollutants, including PCBs. In addition to embryo mortality, PCBs have been suggested by some researchers to cause edema and beak malformations, such as crossed beaks, in double-crested cormorants (Firestone 1973; Schrankel et al. 1982; Brunström and Darnerud 1983, all as cited in Brunström 1990).

Mammals— Chronic exposure to PCBs has been shown to cause mortality or serious reproductive complications in mammals. Other effects associated with PCB toxicity

include anorexia, liver and kidney degeneration, and gastric ulcers (Wren et al. 1991). Impacts to the immune system of marine mammals have also been suggested based on biomarker research (Van Loveren et al. 2000), although the biological significance of the observed biochemical changes is unknown. Like birds, mammals appear to vary widely in their sensitivity to dietary PCBs; reproduction appears to be the most sensitive population-level endpoint for PCB toxicity (Golub et al. 1991; Rice and O'Keefe 1995; Hoffman et al. 1996).

Controlled laboratory exposures of mink to PCBs have been extensively studied (Aulerich et al. 1985; Wren et al. 1987), and this species appears to be among the most sensitive mammalian species tested (Fuller and Hobson 1986) with reproductive impacts as the most sensitive endpoint. A review of the mink toxicity literature indicates that Aroclor 1254 is the most potent Aroclor tested in mink.

In addition, several studies have been conducted with mink that were fed field-collected fish contaminated with a number of organic pollutants, including PCBs, dioxins, furans, and pesticides from Saginaw Bay (Restum et al. 1998). These studies have examined the multigenerational reproductive success of captive mink fed these field-collected fish.

6.0 DIOXINS AND FURANS

6.1 Benthic Organisms

Aquatic invertebrates are generally less sensitive to the toxicity of polychlorinated dibenzo-*p*-dioxins (PCDDs) and dibenzofurans (PCDFs) than fish. West et al. (1997) observed no effects in survival, growth, sexual, or asexual reproduction for two freshwater invertebrate species, the oligochaete (*Lumbriculus variegates*) and the midge (*Chironomus tentans*) orally exposed to TCDD. The maximum residue levels of the oligochaete (174 ng TCDD/g body wet weight) and the midge (144 ng TCDD/g body wet weight) suggested that these benthic organisms can accumulate high levels of PCDDs and PCDFs and remain relatively insensitive to the toxicity (West et al. 1997). Similarly, no effects on growth, reproduction, and food intake of snails and daphnids were observed while these organisms were immersed in solutions of 2.4-4.2 ng TCDD/L for 32 days (Yockim et al. 1978, as cited in Eisler 1986). This lack of sensitivity suggests that aquatic invertebrates may accumulate PCDDs and PCDFs from the sediment resulting in trophic transfer to the fish and wildlife that prey upon these organisms (West et al. 1997).

6.2 Fish

PCDD and PCDFs are toxic to fish. Exposure to low-levels of waterborne T_4CDD (38 pg TCDD/L) proved to be toxic to rainbow trout, resulting in decreased growth, behavior abnormalities including lethargic swimming, feeding inhibition, and lack of response to external stimuli, and mortality (Mehrle et al. 1988).

Several responses to exposure to PCDDs and PCDFs occur in fish: mortality, decreased survival, growth abnormalities, growth inhibition, immune response effects, blue-sac disease, loss of scale, and enzyme induction (Sijm and Opperhuizen 1996). Early life stages of fish are more sensitive to PCDD/PCDF exposure than adults (Eisler 1986; Sijm and Opperhuizen 1996). In a recent survey of studies, Sijm and Opperhuizen (1996) observed that lethal effects were observed at higher concentrations in experiments using adult fish than those with early life stages. Lake trout eggs and fry have been suggested to be the most sensitive to PCDD/PCDF toxicity and effects of toxicity in early life stages include reduced hatchability, the development of yolk sac edema and hemorrhages, and mortality (Peterson et al. 1993).

6.3 Wildlife

Birds—Chronic exposure to PCDDs and PCDFs has been shown to cause mortality and many sublethal effects including edema, impaired reproductive success, AHH induction, vitamin A depletion, beak deformities, and club foot in birds (Eisler 1986, Hoffman et al. 1996). Early life stages of birds have been shown to be more sensitive to PCDDs and PCDFs than adults and embryo mortality, decreased embryonic growth, and edema are perhaps the most common endpoints for birds (Hoffman et al. 1996). The effects of exposure vary by species and laboratory studies have indicated that chicken eggs may be the most sensitive to TCDD exposure in comparison to great blue heron, pheasant, and bluebird eggs (Hoffman et al. 1996).

Few studies have examined the effects of PCDDs and PCDFs on wild birds. White and Seginak (1994) investigated the reproductive effects on wood ducks in nest boxes downstream from a point source of PCDDs and PCDFs and reported that residues were higher in eggs close to the point source in comparison to eggs at a control site and overall reproductive success of the eggs close to the point source was diminished (as cited in Hoffman et al. 1996).

Mammals—PCDDs and PCDFs are toxic to mammals. The observed effects of exposure to PCDDs and PCDFs has been reported to range among laboratory mammals as primates develop chloracne-type skin lesions and rats, mice, and rabbits develop liver damage (Eisler 1986). Acute toxic responses to PCDDs reported to occur among laboratory mammals can include weight loss, hypophagia, muscular necrosis, and metabolic changes such as cachexia (Vanden Heuvel and Lucier 1993). Small mammals, such as the mink (Henny et al. 1996) and the guinea pig (Eisler 1986), are reported to be particularly sensitive to PCDDs and PCDFs. In addition, effects of exposure to TCDD have been reported to include diminished reproductive success in mammals including ovarian dysfunction, reduced fertility, prenatal mortality, and decreased litter size in rats (Peterson et al. 1993).

7.0 OTHER ORGANIC CHEMICALS

7.1 Benthic Organisms

Very few data exist on the toxicology of volatile and semi-volatile organic chemicals to benthic organisms. In general, narcosis is the toxic endpoint associated with chemicals such as chlorobenzenes, phthalates, and chlorophenols (EPA 1995; Penttinen and Kukkomen 1998; Fuschman et al. 1999). Tagatz et al. (1986) as cited in Staples et al. (1997) provides a study of potential impacts of dibutyl phthalate on benthic community structure. No impacts were observed at concentrations of 10 and 100 mg/kg in sediment, although 1,000 mg/kg dibutyl phthalate resulted in a significant reduction in benthic diversity.

7.2 Fish

Relatively fewer data exist on the toxicology of other semi-volatile organic compounds to fish. Water toxicity data for volatile organic compounds, such as chlorobenzene, are available, but tissue residue values are not. QSARs (quantitative structure-activity relationships) have been used (Roose and Brinkman 2000) to compare to concentrations of volatile organic compounds measured in fish collected from the North Sea. The toxic mechanism of chlorobenzene in fish is narcosis and the target site is in the cell membrane (Freidig and Hermens 2000).

The mode for toxic action by phenols is thought to be narcosis and/or the uncoupling of oxidative phosphorylation (Penttinen and Kukkonen 1998). Acute toxicity data are available for rainbow trout and fathead minnow (Babich and Stotzky 1985). No chronic toxicity data for phenol were available.

No data were found relating body burdens of phthalates to effects. Staples et al. (1997) provides an overview of toxicity studies conducted with fish and water exposures of various phthalates.

7.3 Wildlife

Birds—Few data are available regarding the ecotoxicology of volatile organic compounds and other compounds, such as phthalates, to birds. Hexachlorobenzene can be slightly to moderately toxic to birds. The organs affected by hexachlorobenzene exposure are the liver, kidneys, spleen, lungs, and nervous system (EXTOXNET). Phthalates have been suggested as a potential endocrine disruptor for wildlife, although no phthalate studies with birds were found.

Mammals—Data are available for assessing impacts of chemicals such as 2-methylphenol, butyl benzyl phthalate, benzidine, and hexachlorobenzene. These chemicals have been associated with effects ranging from neurotoxicity (2-methylphenol, benzidine) to liver effects, such as alterations in weight (butyl benzyl phthalate, hexachlorobenzene) and increased tumors (hexachlorobenzene) (EPA 1998b).

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ATTACHMENT B6: PORTLAND HARBOR ROUND 1 FISH TRV SELECTION

NOTE:

The fish TRV selection will be revised and submitted to EPA as a technical memorandum prior to the risk assessment.

1.0 INTRODUCTION

Toxicity reference values (TRVs) are toxicity thresholds that are compared to total exposure estimates for a given receptor to characterize ecological risk. The ecological risk assessment for Portland Harbor will include assessment of risk to fish species individuals or populations. Risk will be quantitatively characterized using the hazard quotient approach comparing either body burden or dietary doses to TRVs, depending upon the characteristics of metabolic breakdown for the particular chemical of concern (COC). This paper describes the process by which these TRVs will be identified.

In addition to this TRV approach, the risk of adverse effects to fish from direct water exposure will be assessed by comparing surface water chemical data to appropriate toxicity thresholds such as EPA's chronic ambient water quality criteria. Where appropriate thresholds are unavailable for a chemical, a literature-derived toxicity value will be developed as feasible.

The TRV derivation process involves simultaneous consideration of various factors and can't be completely summarized in a concise list of rules. Ultimately, best professional judgment plays a substantial role. However, defining the intent and method of searching for and evaluating TRVs before initiation of the TRV selection process assists in providing structure and maintaining consistency.

2.0 LITERATURE SEARCH PROCESS

Peer-reviewed publications will be targeted in a literature search including databases such as Ecotox and Environmental Residue Effects Database and review papers such as that by Jarvinen and Ankley (1999). The objective of the literature search is to find two categories of studies: studies where these endpoints were correlated with associated whole body tissue concentrations; or, for metabolizable chemicals, studies where growth, mortality or reproductive endpoints of chemical exposure through the diet were measured. Where studies that examine growth, mortality or reproduction endpoints are not available, studies that examine alternative endpoints (e.g., behavior, immune system effects) will be collected for review. All life-stages of fish will be included in the search. Chemicals targeted will be those analyzed in fish tissue and sediment collected during Round 1. Studies suitable for TRV derivation must have negative controls (control group showing no effects). The literature search will have the goal of being comprehensive, to find all relevant publications.

3.0 LITERATURE REVIEW PROCESS

All studies identified in the literature search will be obtained if feasible. Each paper will be reviewed systematically by completing a TRV Study Review Form (attached). This form documents information on the study design (e.g., chemical form, dose concentrations, test species), exposure (e.g., exposure period, frequency, vehicle), and effects (e.g., endpoint of effect, significance). There is also space to record comments regarding the study to highlight unusual characteristics that may be important in final selection of TRV studies.

The TRV Study Review forms will be signed by the original reviewer and then transferred with the paper to a QA reviewer. The QA reviewer will read through the study and associated form and make comments/edits as needed. There will be a single QA reviewer for all the fish TRV studies. The QA reviewer will be experienced in the review of exposure studies and TRV derivation. The QA reviewer will also sign the TRV Study Review form after his/her review is completed. Only studies that have been reviewed in this manner will be considered as source studies for TRV derivation. No TRVs will be based on secondary references or existing TRV compilations.

4.0 STUDY SCREENING

Once the papers have been reviewed and summarized, they will be prioritized in two steps. The first step will examine the following preferences:

- food is the preferred dose vehicle for derivation of dietary based TRVs (injection or water exposures may be considered if no dietary studies are available, but may not be necessarily accepted);
- for derivation of body burden based TRVs, exposure studies that include food dosing are preferable to those with only water exposure;
- For dietary TRVs: test chemical is in same form to which receptor would be exposed in the ISA. If multiple forms are believed to be present in significant quantity at the site, toxicity data for the most toxic chemical form will be selected;
- preferred exposure period is multigenerational > lifetime > chronic > subchronic > acute. Multigenerational>lifetime>chronic>subchronic. Multigenerational is defined as exposure through at least 2 generations; lifetime exposure is from birth to death; chronic exposure is through greater than 10 percent of the test species' average life expectancy; subchronic exposure is from 10 percent or less of the test species' average life expectancy; acute exposure is < 1 percent of the test species' average life expectancy;
- test species that are most taxonomically similar to receptor are preferred;
- chemical exposure is to a single contaminant or to a mixture of contaminants that will be assessed as a mixture for the Site (i.e., Aroclors or PAHs);
- the effect level is proven to be statistically significant

When the number of studies remaining allows, the following preferences will be considered in step 2:

- Studies with larger sample sizes are preferred
- bounded NOAELs/NOECs and LOAELs/LOECs are preferable to unbounded
- multiple dose levels are preferred to single dose levels
- studies providing ingestion rates are preferred for dietary TRVs preferred to studies which require assumptions about ingestion rates.

The result of these screening steps will be a list of prioritized studies.

4.0 SELECTION PROCESS

As part of the final review process, studies that examine all three categories of endpoint (i.e. reproduction, growth and mortality) will be reviewed and the most sensitive endpoint will be selected for use as a TRV. Both low effect and no effects levels will be used in the ecological risk assessment. One of the objectives of the ecological risk assessment is to test the risk hypotheses. These hypotheses are based on assessment endpoints that are selected to protect fish populations of various feeding guilds from reproductive, growth and mortality effects, with the exception of listed species that are assessed at the individual level. With this objective, the low effect level will be applied as a population effect threshold and the no effect level will be applied as an individual effect threshold.

Regarding adverse effects, LWG considers adverse effects those that have been shown to directly impact reproduction, growth, or survival. LWG may consider physiological effects, such as endocrine disruption, if enough evidence exists showing a causal link to reproduction, growth, or survival.

For many receptor species, no toxicity data is available. In these scenarios, surrogate species will be selected based primarily on taxonomic relationship to the receptor species of interest.

There are situations where safety or uncertainty factors may be considered when determining NOAEL/NOEC and LOAEL/LOEC values. If low-effect values have no associated no-effect value, a safety factor will be applied to estimate the no-effect value. The other scenario where safety factors will be applied is where no chronic exposure studies are available. Safety factors will be used to estimate chronic exposure toxicity from subchronic or acute exposure studies.

Ultimately, the highest no effect value and lowest effect value for the most sensitive life-stage that occurs in the ISA, derived from qualified source studies, will be selected for use in the risk assessment. A summary of the studies reviewed and the rationale for final TRV selection will be presented in the PRE.

6.0 REFERENCES

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TRV STUDY REVIEW FORM

Chemical: _____

Bird Mammal Fish

LOAEL NOAEL LOEC NOEC

Reviewed by: _____ Date: _____

QA Review by: _____ Date: _____

Paper citation: _____

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Study design

Test chemical: _____ Chemical form: _____

Test species: _____ Age: _____ Body weight: _____ Length: _____

Life stage or breeding status: _____ Lipid content: _____

Number of males/females in test group: _____ No. of replicates: _____

Number of individuals in control group: _____

Test setting (circle): Lab Field

Exposure

Target dose concentrations (include control): _____

Measured concentrations (if available): _____

Background concentrations in control: _____

Exposure period (include static or flow-through system): _____

Exposure mode: _____

Exposure medium: _____

Dose frequency (circle): Daily Weekly Other: _____

Food consumption rate: _____

Effects

Effects tested: _____

Effects observed: _____

Statistically significant effects (circle)? Yes No

Lowest exposure concentration at which significant effects were observed for each endpoint: _____

_____

Highest exposure concentration at which no significant effects were observed for each endpoint: _____

_____

Comments: _____

_____

_____

ATTACHMENT B7: A REVIEW OF AQUATIC FOOD WEB MODELS FOR POTENTIAL APPLICATION TO THE PORTLAND HARBOR SUPERFUND SITE

1.0 INTRODUCTION

Food web models can be used for many different purposes, such as to track the fate of a chemical in the environment, to estimate bioaccumulation in particular organisms, or to establish preliminary remediation goals (PRGs) in a contaminated area. This tech memo is focused on the use of food web models to evaluate pathways of exposure to aquatic organisms and to establish PRGs for the Portland Harbor Superfund Site (Site). The baseline ecological risk assessment for Portland Harbor will culminate in the identification of areas could be associated with probable or possible adverse effects to aquatic life and wildlife. Similarly, the baseline human health risk assessment (HHRA) will identify areas could be associated with probable or possible adverse effects to human health. Results of the two risk assessments will be integrated to make risk management decisions that will be protective of human and ecological receptors. To successfully develop risk-based PRGs for sediment contamination, there must be a method to link risk to sediment concentrations. A food web model needs to be identified that incorporates exposure to sediments and allows for prediction of sediment concentrations from total exposure estimates. In addition, where unacceptable risk exists, the food web model may assist in the identification of major exposure pathways to receptors. To identify potential food web models, Windward searched for and reviewed published, peer-reviewed food web models for their applicability and relevance to Portland Harbor. This paper was intended to be the basis for discussion between the Lower Willamette Group (LWG) and the U.S. Environmental Protection Agency (EPA) and EPA's partners and is not intended to be the final decision of the LWG.

All food web models carry varying degrees of uncertainty associated with their output by virtue of the fact they are defined by human assumptions about reality. Some uncertainty can be described by validating model outputs with independent observations when possible. For the Portland Harbor Remedial Investigation (RI), the selected model will be calibrated with site-specific data and model predictions will be compared to observations collected during Round 1 data collection.

2.0 LITERATURE REVIEW

Publication databases (Biosis, ASFA, and Science Citation Index) and the existing Windward literature database were searched for papers discussing modeling of bioaccumulation of chemicals through aquatic food webs. Papers with original, generic food web models were targeted. Other papers that discussed new applications of these models were sometimes obtained but not reviewed and summarized as an original model. The World Wide Web was also used as a resource for locating validation studies, and determining existence of software packages and degree of use for particular models.

Four original food web models, three mass balance models and one fugacity model, were identified: the Gobas model (Gobas 1993), the Thomann model (Thomann et al. 1992), the Morrison et al. model (Morrison et al. 1997), and the fugacity model (Campfens and Mackay 1997). Following is a summary of each model with discussion of the appropriateness for application at the Site for the purpose of determining sediment PRGs based on ecological and human health risk. A summary of model structure and validation performance is presented in Table 1.

3.0 RESULTS OF MODEL REVIEW

3.1 The Gobas Model

The Gobas (1993) food web model is a generic, 4-compartment, mechanistic chemical mass balance model. The four compartments of the food web are phytoplankton/macrophytes, zooplankton, benthic invertebrates, and fish. The phytoplankton/macrophyte model is a simple bioconcentration factor (BCF) approach dependent on the lipid content of the plant. Gobas (1993) assumes that the same approach can be used to model zooplankton because of their small size and large area/volume ratio. By using this approach to modeling phytoplankton and zooplankton bioaccumulation, Gobas (1993) assumes that uptake from diet is insignificant. The benthic invertebrate compartment is modeled as a biota sediment accumulation factor (BSAF) using equilibrium partitioning theory. The BSAF approach assumes that sediment is the only significant source of exposure to benthic invertebrates. The fish compartment incorporates chemical intake from gill respiration and diet and loss processes of metabolism, fecal elimination, growth dilution and gill elimination. These processes are modeled by first-order kinetics, which assumes bioaccumulation occurs by linear processes using rate constants. A weakness of using rate constants exists where they are used to represent terms that are actually variable. For example, first-order kinetics are used to model growth dilution in the Gobas model, in effect assuming that organisms grow at a constant rate throughout their lifetime (e.g., they grow 5 percent per year, forever). This is not an accurate representation of growth for fish. In addition to varying with time, some processes may vary between fish species and the first order kinetic terms of Gobas' model do not accommodate these differences. The actual rates of gill elimination and dietary uptake are also affected by factors other than just chemical concentration and hydrophobicity (K_{ow}), but Gobas (1993) assumes these factors are insignificant. The issues associated with the first order kinetics approach are not unique to Gobas's model and are shared by the other three models as well. The significance of some of these weaknesses, namely constant versus variable rates and interspecies differences, can be addressed by model analysis of additional scenarios (e.g., using parameters for different fish species, early life stage scenarios) and sensitivity analyses where rate constants can be varied to determine alternative outcomes.

This food web model was illustrated using Lake Ontario data for 63 organic chemicals (Gobas 1993). There was no statistically significant difference between measured and predicted concentrations in fish and benthic invertebrates. Fish taxa tested included salmonids, smelt, alewife, and sculpin. The model tended to overpredict benthic invertebrates and underpredict fish concentrations, but differences were usually less than a factor of two. The predicted concentrations in phytoplankton and zooplankton were lower than measured concentrations and within a factor of five. Gobas (1993) is not certain why this large difference exists, but the inaccuracy may be in the field data rather than the model because of sampling difficulties and small sample sizes.

Gobas (1993) models bioaccumulation by phytoplankton as equilibrium partitioning processes, controlled principally by the chemical's K_{OW} and secondarily by organic carbon concentrations. However, there is evidence that phytoplankton never reach chemical equilibrium with their environment during growth periods (Swackhamer and Skoglund 1993). This may be one explanation for the Gobas model poorly predicting phytoplankton concentrations.

The Gobas model has been widely applied and adapted to many projects and has been critically reviewed by government agencies such as the EPA. For example, the bioaccumulation algorithms of Gobas were used in the food web model for the Fox River RI/FS. Currently, the Army Corps of Engineers (ACOE) is funding development of a software program based on the Gobas model for use in dredging projects (Bridges 2002). This software will be available to download in January 2003. Frank Gobas also provides a Windows-based software program at the Simon Fraser University ToxLab website that uses an updated benthic invertebrate submodel based on Morrison et al. (1996).

3.2 The Thomann et al. Model

The Thomann et al. (1992) food web model is the pelagic model of Thomann (1989) with the addition of a sediment component. Thomann et al. (1992) state that their model was designed to provide an improved method of linking sediment to an aquatic food web over the frequently applied simple partitioning method. This model is a generic, 5-compartment, mechanistic chemical mass balance model. The five compartments are phytoplankton/detritus, zooplankton, benthic invertebrates, forage fish and piscivorous fish. The phytoplankton and benthic invertebrate compartment models are more developed and comprehensive than those of the Gobas model. The phytoplankton/detritus compartment models uptake from water and loss by excretion and growth. The benthic invertebrate compartment incorporates uptake from interstitial and overlying water and dietary sources and the loss processes of fecal elimination, gill elimination, and growth dilution. The zooplankton, forage fish, and piscivorous fish compartments incorporate uptake from water and dietary sources, with diet parameters changing as appropriate for the organism. Uptake from

water and sediment are both modeled as equilibrium partitioning processes, with the organic components of the biota and the environmental compartments assumed to be in thermodynamic equilibrium. This may not be an appropriate assumption because these organic fractions are physically separated by aqueous compartments, most notably the blood of the organism, and, because of the relatively low solubility of hydrophobic organics in blood, this represents a rate-limiting barrier that may slow or prevent the attainment of thermodynamic equilibrium. For example, Barron et al. (1989) demonstrated that di-2-ethylhexylpthalate is metabolized in the gill arches as it diffuses from water to blood, thereby preventing entry into the fish tissues. Loss processes for these compartments include metabolic breakdown, fecal elimination, growth dilution, and gill elimination. One general algorithm was developed for all three of these compartments. Like the Gobas model, all uptake and loss rates are assumed to follow first-order kinetics (i.e., to be proportional to the concentration in a single model compartment).

Model parameters appear to be generally straightforward and obtainable through field-collected data or the literature. One possible exception is the zooplankton dietary fraction of food from the water column versus sediment (Burkhard 1998). This parameter was estimated by both Burkard (1998) and Thomann et al. (1992) by determining the best fit between predicted and actual bioaccumulation factors (BAFs) and BSAFs with varying proportions of uptake from water and sediment. However, the validity of the 'actual' BAFs and BSAFs has not been properly established through regression analysis.

In a paper by Burkhard (1998), BAFs determined from the Gobas and Thomann models were compared using Lake Ontario data. Measured and predicted BAFs were compared for PCBs, chlorinated pesticides, chlorinated benzenes, chlorinated toluenes, and hexachlorobutadiene. Burkhard made a small change to both models before performing this comparison. The bioavailability correction in the Gobas model was updated using a new submodel that distinguishes dissolved and particulate organic carbon phases. Burkhard also applies the same submodel to the Thomann model because any bioavailability correction is lacking from the model. Therefore, this paper is not comparing the exact same models published by Gobas (1993) and Thomann et al. (1992). With these changes acknowledged, predicted BAFs from the Gobas and Thomann models for phytoplankton were identical, and consistently lower than measured BAFs. For zooplankton, Diporeia, forage fish, and piscivorous fish, BAFs from both models were comparably predictive for chemicals with log K_{ow} from 3.0 to 8.0, with divergence occurring in BAFs for chemicals with log K_{ow}s > 6.0 (Gobas BAFs < Thomann BAFs). BAFs predicted by Thomann dropped significantly for chemicals with log K_{ow} greater than 8.0. This difference in model performance was attributed to a difference in how gill uptake efficiency is estimated. Current experimental data do not clarify which approach is more appropriate. It is difficult to evaluate the performance

of either model in the log K_{ow} range greater than 8.0 because there were no measured BAF data for this range. Overall, both models were successful in predicting BAFs for chemicals with log K_{ow}s < 8.0. The Thomann model is more detailed for plankton and benthic invertebrate components, but predicted chemical concentrations were similar for both models (Burkhard 1998). The Thomann model is available in Lotus 123 format from the author.

Burkhard (1998) also performed sensitivity analyses on the Gobas and Thomann models, modified as described previously. Burkhard changed each parameter input by 10 percent iteratively and compared the output. Burkhard determined that the Gobas and Thomann models have similar sensitivities, the most sensitive parameters being lipid contents, K_{ow}, and the sediment-water column concentration quotient. Also, feeding preferences for benthic invertebrates in the Thomann model were relatively sensitive.

3.3 The Morrison et al. Model

The Morrison et al. (1997) food web model is a generic, 5-compartment, chemical mass balance model. The five compartments of the food web are: phytoplankton, zooplankton, filter-feeding benthic invertebrates, benthic detritivores, and fish. Bioconcentration in phytoplankton is modeled using organic carbon equilibrium partitioning. Bioaccumulation in filter-feeding benthic invertebrates is estimated differently than for benthic detritivores. Uptake processes for filter-feeders are assumed to be from respiration and suspended solids filtration. Benthic detritivores, zooplankton, and fish tissue concentrations are all estimated from the same algorithm assuming uptake is from respiration and food consumption. The loss mechanisms for all compartments of this model are comprehensive and the same as those in the Gobas model. Most model parameters are straightforward and obtainable through field-collected data or the literature. However, species-specific information on some physiological parameters, such as ventilation rates, ingestion rates, and assimilation efficiencies, may be difficult to obtain. For example, Morrison et al. (1997) provide no citation for values of PCB assimilation efficiencies in gills of zooplankton and benthic macroinvertebrates, and simply state that these are estimates without explaining their basis. These assimilation efficiencies could be critical parameters given that modeled zooplankton concentrations were sensitive to water concentrations and modeled fish concentrations were sensitive to changes in concentrations in their diet. It is possible that the estimates of these values Morrison et al. (1997) chose gave their model an optimum fit to the available data set. Morrison et al. (1999) note that the physiological rates are best-fit estimates and experimental data for these parameters are generally lacking. Similar parameters are used in all models except the Campfens and Mackay (1997) fugacity model.

Morrison et al. (1997) illustrated their model using PCB congener data from western Lake Erie. They changed some assumptions for this model application. Because metabolic transformation of PCBs is limited, this process was considered insignificant. Also, growth dilution was eliminated for zooplankton and benthic invertebrates to simplify the submodels. The predicted concentrations in benthic invertebrates (i.e., *Gammarus*, mayfly larvae, caddisfly larvae, zebra mussels, and crayfish), adult white sucker, silver bass, yellow perch, and walleye were in good agreement with measured concentrations (ratio ranging from 0.89 to 1.11). Predicted concentrations in young-of-year fish, alewife, emerald shiner, troutperch, black crappie, white perch, freshwater drum, gizzard shad, smallmouth bass, and largemouth bass were lower than measured concentrations but within a factor of two. Measured concentrations in zooplankton were not available for direct comparison, but field-measured and predicted log BAFs in phytoplankton were compared. The predicted log BAFs (5.6–8.5) were slightly higher than field-measured log BAFs from the literature (4.8–8.0) and log BAFs that would be predicted in zooplankton from simple equilibrium partitioning theory (5.6–7.4). The authors concluded that their zooplankton bioaccumulation model was reasonable, although this conclusion may be the consequence of the absence of any field data to falsify it. Another application of this model was performed by Morrison et al. (1999) using Lake Ontario PCB and dioxin and furan congener data in invertebrates and fish. Eighty-six percent of predicted concentrations were within a factor of two of measured concentrations.

Both of the Morrison papers also conducted a sensitivity analysis of the model. For zooplankton, chemical concentration in the water was the most sensitive parameter. For Gammarus, chemical concentrations in the diet and assimilation efficiency were relatively sensitive parameters. Lipid content and concentration in the diet were the most sensitive parameters for filter-feeding invertebrates. All of the parameters tested for fish were equally sensitive. The sensitivity of most parameters varied with the contaminant K_{ow}.

The Morrison et al. model has been reviewed by the EPA and applied in part or in whole to EPA projects (EPA 1999).

3.4 The Fugacity Model

The fugacity-based food web model, described by Campfens and Mackay (1997), is a thermodynamic model based on the concept of fugacity. Fugacity is the escaping tendency of a chemical from a particular phase (e.g., water, air) measured in units of pressure. Fugacity can be related to concentration by a fugacity capacity constant or Z factor. The convenience of a fugacity-based food web model is that one can estimate fugacity at any section of a food web using a single algorithm, and then determine concentration from that fugacity. This model, therefore, has an unlimited number of compartments. Campfens and Mackay build their fugacity model from the early

bioaccumulation models of Thomann, which lacked a sediment component. As a result, their model assumes the same uptake and loss processes of the previously described Thomann model, with the exception that sediment exposure can only be modeled through the diet pathway. The principle of the fugacity model is to calculate partial fugacities for each phase that contributes to bioaccumulation of the chemical in an organism and then sum them to determine the total fugacity. Concentrations are calculated from corresponding fugacities. There are some unique features to parameterization of the fugacity model. For example, a number of physical parameters are required for the model, such as Henry's Law constant, vapor pressure, and molecular mass. Also, concentrations are determined in units of mol/m^3, requiring more effort to obtain standard units of mg/kg. Despite the unusual nature of the parameters, they should be obtainable through field collected data or the literature.

The authors illustrate their model by application of PCB congener and total PCB data from Lake Ontario. Predicted concentrations in benthic invertebrates were consistently higher than measured concentrations, up to a factor of four. Fish and zooplankton concentrations were usually within a factor of three of measured concentrations. The performance of the fugacity model is the weakest of the four models reviewed. However, this model has been considered for application by the EPA (e.g., EPA 1999). Model software is available from Trent University.

Campfens and Mackay did not conduct a sensitivity analysis in their paper. Because this model was not a likely candidate for final selection, Windward did not search for sensitivity analyses.

4.0 APPLICABILITY TO PORTLAND HARBOR

The assumption of steady-state conditions is pre-defined for all the reviewed models. Portland Harbor is a dynamic, highly developed river system where contaminant inputs have been changing over time. The assumption of steady state is a weakness of all these models. However, rarely is there adequate data available to model dynamic conditions over time. Given that yearly COPC inputs to the Willamette River probably reached their maximum many years ago and sources of bioaccumulative contaminants have been present on the river for decades, it is not an unreasonable assumption that tissue bioaccumulation may be near steady state. For purposes of the RI, information regarding short-term changes in tissue bioaccumulation is not necessary. If desired, an estimate of long-term change may be extracted from statistical analyses or use of historical data in a separate application of a food web model.

The food web model that is applied to Portland Harbor will ideally be able to model bioaccumulation of any contaminant from sediment and surface water to biota, including benthic invertebrates and various trophic levels of fish. All of the models are capable of modeling any lipophilic contaminant and include compartments for

phytoplankton, zooplankton, benthic invertebrates, and fish. However, there are differences in how the compartments are modeled and some models refine the compartments further. It should be noted that in a flowing river system, phytoplankton and zooplankton may represent an insignificant part of the food web, and that biological production may be more dependent on detritus inputs and potentially epiphytic production. Therefore, some modification of these models may be necessary. The Gobas[3] model, by employing a BSAF approach, assumes that equilibrium partitioning adequately estimates bioaccumulation in benthic invertebrates. This approach assumes that sediment provides the only significant exposure source for benthic invertebrates. The fugacity model also assumes that equilibrium partitioning adequately estimates bioaccumulation by all biotic model components. The Thomann model and the Morrison et al. model estimate bioaccumulation from water and sediment sources to benthic invertebrates. Exposure to porewater, surface water, sediment, and prey are all included in the Thomann model. Surface water and diet exposure pathways to benthic detritivores are modeled in the fugacity and Morrison et al. models and sediment ingestion can be incorporated in the dietary exposure component. A unique feature of the Morrison et al. model is that filter-feeding benthic invertebrates are modeled differently than benthic detritivores. This could be a useful feature for the Portland Harbor Remedial Investigation (RI) if benthic filter feeders are determined to be an important prey item for upper trophic level organisms.

Flexibility is another feature of the ideal food web model. The exact food web structure should be adjustable to fit that of Portland Harbor, which has not yet been characterized. There are varying numbers of compartments modeled by these four models. Although the exact food web structure in Portland Harbor is currently unknown, a model that includes all the compartments that could be significant is advised. Compartments can be dropped from the food web model if they become irrelevant. The Morrison et al. model is recommended for its added feature of separate detritivorous and filter-feeding benthic invertebrate compartments. This feature may be useful if bioaccumulation from water is discovered to be significant in Portland Harbor because risks to benthic invertebrates from water and sediment contamination could be evaluated separately.

The parameters of the food web model need to be relatively easy to estimate using commonly collected site-specific data and/or general data from the literature. Although the fugacity model contains some unique parameters, they are no more difficult to estimate than parameters in the other models. However, the fugacity model does require a larger number of parameters to be estimated than any other model. All

[3] Note that on his website, Gobas indicates that the benthic invertebrate compartment of his model has been updated with the Morrison et al. submodel.

of the models use parameters that are not commonly collected in environmental monitoring. Parameters noted in the literature as difficult to collect include 'zooplankton dietary fraction of food from water column versus sediment' used in the Thomann model (Burkhard 1998), and the chemical physiological rates or rate constants used in all of the models except the fugacity model. Morrison et al. (1999) use best-fit estimates to obtain this latter parameter and Burkhard (1998) assumed zero metabolism in testing the Thomann and Gobas models because of the generally slow metabolism for PCBs and lack of data for other chemicals. Although all of the models use some parameters that may be difficult to estimate, no one model stands out as better or worse to parameterize.

Some consideration should be given to the ease with which the food web model will be explained and understood by interested parties. The Portland Harbor RI is a collaborative project involving potentially responsible parties, agencies, technical consultants, tribes, and public interest groups – a mixture of people with varying levels of technical training and experience. The fugacity model is not conceptually intuitive and may be difficult to explain to non-technical audiences. All of the mass balance models are easily described in a conceptual diagram.

Finally, the model needs to have been tested by comparison of predicted and measured concentrations. The performance of the fugacity model was poor even with the authors' own example application, with estimates frequently off by a factor of three or four. Performance on the example data sets was relatively good for the other three models. The Thomann and Gobas models were tested across chemicals of varying K_{ow}s and performed equally well, except for chemicals with very high log K_{ow} (>8.0). The Morrison et al. model was only illustrated using PCB data, but also performed well and matched measured tissue concentrations within a factor of two.

5.0 CONCLUSIONS AND RECOMMENDATION

Based on the above review, there are some clear advantages and disadvantages to some of the four models reviewed (Table 1). In validation, the fugacity model performed poorly relative to the mass balance models and also suffers from being conceptually difficult. Based on these factors, the fugacity model is not recommended for use in the Portland Harbor risk assessment. Of the three mechanistic mass balance models, all performed well; however the Morrison et al. model has been applied only to PCB and dioxin data. Its performance with regard to other chemicals is unknown. The Thomann and Gobas models have been used extensively. This review indicates that either of these models would be suitable for use in Portland Harbor. The Morrison et al. model has five compartments, with benthic invertebrates split into filter-feeding and detritivorous benthic invertebrates. This additional compartment could be advantageous if it is necessary to separate out risks to benthic invertebrates associated with water or with

hardened surfaces from those associated with sediments. Based on these factors, the Morrison et al. model appears to be the strongest model for application to Portland Harbor. This model isn't as well-known as the Gobas and Thomann models, but it has similar structure and has been critically reviewed by EPA. Also, this model is comprehensive, flexible, and designed to be easily parameterized. Finally, this model has performed well for PCB and dioxin congeners and there is no basis to expect its performance would be different for other hydrophobic contaminants, except perhaps at high K_{ow}s where the Gobas and Thomann models also perform poorly.

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ATTACHMENT B8: FISH STOMACH CONTENT SCREENING

1.0 INTRODUCTION

Understanding the diet of receptor species is critical in developing realistic risk assessments. It is not possible to characterize the potential exposure of an organism without making assumptions about what it ingests. These assumptions are usually based on descriptions of the organism's diet from the literature. Since community composition (both taxonomic diversity and relative abundance) differs across ecosystems, it is unknown how representative the literature descriptions are. Analysis of the stomach contents of individuals collected at the assessment site is useful for fine-tuning assumptions about diet composition and improving exposure characterizations.

The only known previous stomach content analysis performed on the Willamette River was by Buchanan et al. (1981) and focused solely on northern pikeminnow (*Ptychocheilus oregonensis*). Over 1,000 fish were collected in the spring of 1976 and 1977 from stations well upstream of the Initial Study Area (ISA) (two just south of Salem and one on the outskirts of Eugene). They found that the northern pikeminnow diet was variable, but the major components were fish (mostly sculpin), crayfish, and insects.

During the summer and fall of 2002, the Lower Willamette Group (LWG) collected target fish species from the ISA for the Round 1 preliminary human health and ecological risk evaluation. The primary purpose was to collect fish for tissue residue analysis. The field effort, however, provided LWG with an opportunity to retain some specimens for a reconnaissance-level analysis of stomach content of the target fish species. This study was not conducted to comprehensively examine and record the diets of the target fish species in the Lower Willamette River.

2.0 OBJECTIVES

The objective of this study was to develop a qualitative understanding of the potential diet of target fish species captured in the ISA.

3.0 METHODS

This section describes the field methods used to capture the target fish species and the laboratory methods used to remove and identify the stomach contents from each fish.

The fish used in this study were collected for the Round 1 preliminary risk evaluation, but were diverted for stomach content analysis once the tissue mass quotas for laboratory analyses were met for each species.

3.1 Field Methods

The fish used in this study were caught between October 2 and November 8, 2002 using one of the six collection methods indicated in Table 1; see the Round 1 Field Sampling Plan for further details. Once caught, fish were placed in labeled Ziploc® bags and stored on ice until they were delivered to the fish-processing laboratory later the same day.

3.2 Laboratory Methods

Upon arrival in the laboratory, fish were immediately transferred to a refrigerator until processing. All of the fish were processed within two days of capture, and most were processed within one day.

3.2.1 Stomach content removal

The fish were removed from the refrigerator and measured (total length) and weighed. The fish were dissected using a dissecting knife or fillet knife, depending on the size and species of fish. The stomach was located and removed from the fish. The stomach was then opened and the contents removed to a pre-labeled glass jar with 50% denatured ethanol as preservative. The jars were stored until they were returned to Seattle for identification.

3.2.2 Content identification

The contents of each jar were emptied onto a glass Petri dish under a dissecting scope and all contents were identified to the highest taxonomic level.

4.0 RESULTS

A total of 35 fish from seven species were collected for stomach content analysis (Table 1). Receptor species representing three of the four feeding guilds defined in the Ecological Risk Approach appendix to the Round 1 Work Plan (Windward 2003) were represented in the species collected. Peamouth (*Mylocheilus caurinus*) and sculpin (*Cottus* sp.) represent invertivorous fish, smallmouth bass (*Micropterus dolomieui*) and northern pikeminnow represent piscivorous fish, and largescale sucker (*Catostomus macrocheilus*) represents herbivorous/omnivorous fish. The only representative species absent from this analysis are juvenile chinook salmon and Pacific lamprey. Also among the fish collected were black crappie (*Pomoxis nigromaculatus*), which are piscivorous and are a target species in the human health risk assessment, and brown bullhead (*Ameiurus nebulosus*). Brown bullhead are in the same feeding guild as largescale sucker but are not a target species for either of the risk assessments. However, they are ecologically similar to yellow bullhead (*Ameiurus natalis*), a target species in the human health risk assessment.

Table 1. Stomach contents of target fish species caught in the ISA

Feeding Guild	Fish Species	Date Caught	Total Length (mm)	Weight (g)	Location	Collection Method	Stomach Content
Herbivore/ Omnivore	Largescale sucker	10/25/02	425	776.7	RM 8, Swan Isl. Lagoon	boat electrofishing	Bivalve (*Corbicula sp.*), chironomids, oligochaetes, bryozoans, gastropods, filamentous algae, sediment
		10/25/02	455	935.8	RM 8, Swan Isl. Lagoon	boat electrofishing	Bivalve (*Corbicula sp.*), chironomids, oligochaetes, bryozoans, gastropods, filamentous algae, sediment
		10/25/02	446	875.6	RM 8, Swan Isl. Lagoon	boat electrofishing	Bivalve (*Corbicula sp.*), chironomids, oligochaetes, bryozoans, gastropods, filamentous algae, sediment
		10/25/02	410	783.9	RM 6	trotline	Filamentous algae, detritus, sediment
	Brown bullhead	na	na	na	na	na	Chironomids, filamentous algae
		10/29/02	292	316.9	RM 4	trotline	Roundworm (parasite), unidentified invertebrate, filamentous algae, detritus, sediment
Invertivore	Sculpin (4)[a]	10/2/02	118, 112, 104, 107	19, 17, 13, 14	RM 8, Swan Isl. Lagoon	backpack electrofishing	Amphipods, gastropods (limpet, *Fisherola* sp.; snail, *Physa* sp.)
	Sculpin	10/15/02	166	62.4	RM 9	trotline	Amphipods, bryozoans
		10/15/02	109	13.7	RM 9	trotline	Roundworm (parasite)
		10/24/02	107	14.6	RM 3	backpack electrofishing	Dipteran (Family Sciomyzidae), gastropod (snail, *Physa* sp.)
		11/7/02	135	22.8	RM 7	crayfish trap	Bryozoan and statoblast (*Cristatalla mucedo*), unidentifiable
	Peamouth	10/29/02	190	62.6	RM 3	beach seine	Filamentous algae, terrestrial insect (wasp), sediment
		10/29/02	200	67.1	RM 4	trotline	Fish (unidentifiable), terrestrial insect (wasp)
		11/5/02	271	172.5	RM 8	trotline	Bryozoan and statoblast (*C. mucedo*)
		11/5/02	284	196.3	RM 3	na	Filamentous algae, sediment

Feeding Guild	Fish Species	Date Caught	Total Length (mm)	Weight (g)	Location	Collection Method	Stomach Content
		11/5/02	280	165.5	RM 3	na	Bryozoan and statoblast (*C. mucedo*), filamentous algae, terrestrial insect (wasp), sediment
Piscivore	Northern pikeminnow	10/24/02	224	97.5	RM 7	na	Roundworm (parasite), unidentifiable structures
		11/8/02	498	1087.1	RM 4	trotline	Fish (unidentifiable), amphipod
		NA	422	714.2	NA	na	Fish (3-spine stickleback), detritus
		11/6/02	398	582.4	RM 7	boat electrofishing	Fish (unidentifiable), crayfish
		11/7/02	460	421	RM 7	trotline	Fish (unidentifiable)
		11/7/02	255	115.1	RM 7	trotline	Crayfish
	Smallmouth bass	10/9/02	230	179.6	RM 5	boat electrofishing	Crayfish
		10/11/02	270	250	RM 6	boat electrofishing	Crayfish
		10/11/02	260	232.4	RM 6	boat electrofishing	Crayfish
		10/17/02	NA	NA	RM 8, Swan Isl. Lagoon	boat electrofishing	Water mite (Order Hydrachnida) bryozoan and statoblast (*C. mucedo*)
	Black crappie	10/15/02	249	224.8	RM 6-9	boat electrofishing	Fish (unidentifiable), isopod
		10/17/02	129	169.5	RM 6-9	boat electrofishing	Fish (shad), bryozoan and statoblast (*C. mucedo*)
		11/5/02	196	119	RM 6-9	hook and line	Amphipods
		11/5/02	196	127.2	RM 6-9	hook and line	Isopods
		11/6/02	227	156.1	RM 4	trotline	Crayfish
		11/6/02	224	215	RM 6-9	na	Unidentifiable

na – not applicable

[a] The stomach contents from four sculpin were preserved in the same jar

Of the 35 fish caught, 13 were invertivores (37%), 16 were piscivores (46%), and 6 were herbivore/omnivores (17%); 24 were collected from the upper half of the ISA (RM 6-9), and 10 of those were caught in Swan Island Lagoon (Table 1).

Overall, northern pikeminnow was the most reliably piscivorous species: four of six examined had fish in their stomachs. Two (of six) black crappie and none of the smallmouth bass examined had fish in their stomachs. Crayfish were the dominant prey of the four smallmouth bass examined, and a mix of aquatic invertebrates made up the rest of the black crappie stomach contents.

The sculpin examined were true invertivores with the exception of one infected with parasites which had only parasitic roundworms in its stomach. Stomach contents of all other sculpin were a mix of aquatic invertebrates including amphipods, gastropods, and bryozoans. Aquatic invertebrates did not, however, dominate the stomach contents of the five peamouth examined. Three of the five peamouth had ingested filamentous algae and terrestrial wasps.

Filamentous algae were found in the stomachs of all six herbivores examined. Largescale suckers were found to have ingested a variety of aquatic invertebrates usually associated with soft sediments (e.g., bivalves, chironomids, gastropods, oligochaetes). It is not surprising, therefore, that sediments were also found in the stomachs of all four sucker. The two brown bullhead examined were both found to have ingested filamentous algae and invertebrates. Sediments and detritus were also found in one bullhead.

Bryozoans were the most common item in the 35 fish stomachs examined (Table 2). They are sessile, colonial filter feeders that are superficially similar to marine corals. In the fall, bryozoans form dormant buds called statoblasts where they remain through the winter (Wood 2001). Mature bryozoans and/or their statoblasts were found in individuals from each of the three feeding guilds represented and five of the seven species examined. This is surprising given that Wood (2001) states that extensive fish predation on bryozoans has not been verified in the literature. These data alone are not adequate to determine whether fish are targeting bryozoans as a food resource or if their ingestion is more incidental. One study has suggested that fish may graze on bryozoans because they are sometimes inhabited by insect larvae (e.g. chironomids; cited in Wood [2001]).

5.0 CONCLUSIONS

It is difficult to draw many conclusions from such a small dataset. However, three findings are worth noting.

- Bryozoans were a common item ingested by fish from all feeding guilds.
- Sediments were found in the stomachs of only those individuals that also ingested filamentous algae. Only one individual that ingested algae did not have sediment in its stomach.
- The smallmouth bass appear to be ingesting crayfish.

Table 2. Distribution of stomach contents by species and number of individuals

Stomach Content	# of species (out of 7)	# of individuals (out of 35)
Filamentous algae	3	9
Bryozoan	5	9
Bivalve (*Corbicula*)	1	3
Gastropods	2	At least 5
Oligochaetes	1	3
Chironomids	2	4
Crayfish	3	6
Amphipods	3	At least 4
Isopods	1	2
Fish	3	7
Detritus	3	3
Sediment	3	8
Terrestrial insects	1	3
Water mites	1	1

6.0 References

Buchanan DV, Hooton RM, Moring JR. 1981. Northern squawfish (*Ptychocheilus oregonensis*) predation on juvenile salmonids in sections of the Willamette River basin, Oregon. Can J Fish Aquat Sci 38:360-364.

Windward. 2003. Portland Harbor round 1 work plan, appendix C: Ecological risk approach. Windward Environmental LLC, Seattle, WA.

Wood T. 2001. Bryozoans. In: Thorp J, Covich A, eds, Ecology and classification of North American freshwater invertebrates. Academic Press, San Diego, CA. pp 505-525.

ATTACHMENT B9: PORTLAND HARBOR ROUND 1 BIRD AND MAMMAL TRV SELECTION

NOTE:

The wildlife TRV selection will be revised and submitted to EPA as a technical memorandum prior to the risk assessment.

1.0 INTRODUCTION

Toxicity reference values (TRVs) are toxicity thresholds that are compared to total exposure estimates for a given receptor to characterize ecological risk. The ecological risk assessment for Portland Harbor will include assessment of risk to birds and mammals. Risk will be quantitatively characterized using the hazard quotient approach, comparing estimated total exposure to TRVs in terms of body-weight normalized daily doses. This paper describes the process by which these TRVs will be identified.

The TRV derivation process involves simultaneous consideration of various factors and can't be completely summarized in a concise list of rules. Ultimately, professional judgment plays a substantial role. However, defining the intent and method of searching for and evaluating TRVs before initiation of the TRV selection process assists in providing structure and maintaining consistency.

2.0 LITERATURE SEARCH PROCESS

Peer-reviewed publications will be targeted in a literature search including databases such as Ecotox and Toxnet and review articles such as the USFWS Biological Reports and ATSDR mammalian toxicity documents. The objective of the literature search is to find studies where growth, mortality, or reproductive endpoints of chemical exposure through the diet were measured. These general types of endpoints are commonly used in ecological risk assessment and are specifically identified as objectives for the RI in the AOC (EPA 2002). Where studies that examine growth, mortality or reproduction endpoints are not available, studies that examine alternative endpoints (e.g., behavior, immune system effects) will be collected for review. All life-stages of birds and mammals will be included in the search. Chemicals targeted will be those analyzed in fish tissue and sediment collected during Round 1. Studies suitable for TRV derivation must have negative controls. The literature search will have the goal of being comprehensive, to find all relevant publications.

3.0 LITERATURE REVIEW PROCESS

All studies identified in the literature search will be obtained if feasible. Each paper will be reviewed systematically by completing a TRV Study Review Form (attached). This form documents information on the study design (e.g., chemical form, dose concentrations, test species), exposure (e.g., exposure period, frequency, vehicle), and effects (e.g., endpoint of effect, significance). There is also space to include comments regarding the study to highlight unusual characteristics that may be important in final selection of TRV studies.

The TRV Study Review forms will be signed by the original reviewer and then transferred with the paper to a QA reviewer. The QA reviewer will read through the study and associated form and make comments/edits as needed. There will be a maximum of 2 QA reviewers for the bird and mammal TRV studies. QA reviewers will

be experienced in the review of exposure studies and TRV derivation. The QA reviewer will also sign the TRV Study Review form after his/her review is completed. Only studies that have been reviewed in this manner will be considered as source studies for TRV derivation. No TRVs will be based on secondary references or existing TRV compilations.

4.0 STUDY SCREENING

Once the papers have been reviewed and summarized, they will be prioritized in two steps. The first step will examine the following preferences:

- Food is the preferred dose vehicle (IP injection and oral gavage may be considered if no dietary studies are available, but may not be necessarily accepted);
- Wild test species are generally preferred over domestic test species. For example, chickens can be extremely sensitive to chemicals and are bred to maximize reproductive production. Therefore, this species would be least appropriate to represent a wild species.
- For dietary TRVs, the test chemical is in same form to which receptor would be exposed in the ISA. If multiple forms are believed to be present in significant quantity at the site, toxicity data for the most toxic chemical form will be selected.
- Preferred exposure period is multigenerational>lifetime>chronic>subchronic. Multigenerational is defined as exposure through at least 2 generations; lifetime exposure is from birth to death; chronic exposure is through greater than 10 percent of the test species' average life expectancy; subchronic exposure is 10 percent or less of the test species' average life expectancy.
- Test species that are most taxonomically similar to receptor and have similar physiology are preferred.
- Chemical exposure is to a single contaminant or to a mixture of contaminants for which clear effects of the chemical of interest can be identified and distinguished quantitatively from those of other chemicals;
- The effect level is proven to be statistically significant

When the number of studies remaining allows, the following preferences will be considered in step 2:

- Studies with larger sample sizes are preferred
- Bounded NOAELs and LOAELs, where the study observed an effect at one dose/concentration and no effect at another (in addition to control) for the endpoint of interest, are preferable to unbounded
- Multiple dose levels are preferred to single dose levels

- Studies where the dosed food was a prey item are preferred to those where lab chow is offered.
- Studies providing ingestion rates are preferred to studies which require assumptions about ingestion rates.

The result of these screening steps will be a list of prioritized studies.

4.0 SELECTION PROCESS

As part of the final review process, studies that examine all three categories of endpoint (i.e. reproduction, growth and mortality) will be reviewed and the most sensitive endpoint will be selected for use as a TRV. Both LOAELs and NOAELs will be used in the ecological risk assessment. One of the objectives of the ecological risk assessment is to test the risk hypotheses. These hypotheses are based on assessment endpoints that are selected to protect wildlife populations of various feeding guilds from reproductive, growth and mortality effects, with the exception of listed species which are assessed at the individual level. With this objective, the LOAEL will be applied as a population effect threshold and the NOAEL will be applied as an individual effect threshold.

Regarding adverse effects, LWG considers adverse effect those that have been shown to directly impact reproduction, growth, or survival. LWG may consider physiological effects, such as endocrine disruption, if evidence is strong enough to show a causal link to reproduction, growth, or survival at the appropriate level of protection (i.e. population or individual).

For many receptor species, no toxicity data is available. In these scenarios, surrogate species will be selected based primarily on taxonomic relationship to the receptor species of interest. Where it is appropriate, relative body size will also be taken into account as a basis for surrogate selection. Body weight can be used as a measure of metabolic rate, which is one measure of physiological similarity. EPA (1993) discusses the inverse relationship between body size and metabolism that generally occurs in birds and mammals. For example, in selection of a surrogate, if the test species available from toxicity studies are the rat and raccoon and the receptor is a shrew, the rat would be selected as the most appropriate surrogate, because it is closer to the target receptor in metabolic rate. The rat is in the order Rodentia and the raccoon is in the order Carnivora—neither is an insectivore. However, the rat is a much smaller mammal than a raccoon with a correspondingly faster metabolic rate than the raccoon, and more closely resembles the metabolic rate of the shrew, also a much smaller mammal than a raccoon.

There are situations where safety or uncertainty factors may be considered when determining NOAEL and LOAEL values. If LOAEL values have no associated NOAEL value, a safety factor will be applied to estimate the NOAEL. The other scenario where safety factors will be applied is where no chronic exposure studies are available. Safety

factors will be used to estimate chronic exposure toxicity from subchronic exposure studies.

The calculations of NOAEL and LOAEL values will be performed using all the available relevant data from the study (i.e., ingestion rates, body weight). Where information is lacking from the study, values will be estimated using other literature sources for the test species. These will be selected by matching the characteristics of the test species (i.e., size, age, type of diet) as closely as possible. Ultimately, the highest NOAELs and lowest LOAELs derived from qualified source studies will be selected for use in the risk assessment. In cases where the highest NOAEL is higher than the lowest LOAEL, the studies will be reviewed in the context of the other available toxicity studies, preferably the most valid studies identified in the screening process. The other existing dose-response data will be considered as a "reality check" to determine if an alternative, more representative and qualified study should be selected for the NOAEL or LOAEL. A summary of the studies reviewed and the rationale for study rejection and final TRV selection will be presented in the Round 1 Preliminary Risk Evaluation.

5.0 REFERENCES

EPA. 1993. Wildlife exposure factors handbook. Volume I. EPA/600/R-93/187a. Office of Research and Development, US Environmental Protection Agency, Washington, DC.

EPA. 2001. Administrative order on consent for remedial investigation/feasibility study for Portland Harbor Superfund Site. US Environmental Protection Agency Region 10, Portland, OR.

Chemical: _____

Bird Mammal Fish

LOAEL NOAEL LOEC NOEC

TRV STUDY REVIEW FORM

Reviewed by: _____ Date: _____

QA Review by: _____ Date: _____

Paper citation:_____

****

Study design

Test chemical: _____ Chemical form: _____

Test species: _____ Age: _____ Body weight: _____ Length _____

Life stage or breeding status: _____

Number of males/females in test group: _____ No. of replicates: _____

Number of individuals in control group: _____

Test setting (circle): Lab Field

Exposure

Target dose concentrations (include control): _____

Measured concentrations (if available): _____

Background concentrations in control: _____

Exposure period (include static or flow-through system): _____

Exposure mode: _____

Exposure medium: _____

Dose frequency (circle): Daily Weekly Other: _____

Food consumption rate: _____

Effects

Effects tested:_____

Effects observed:_____

Statistically significant effects (circle)? Yes No

Lowest exposure concentration at which significant effects were observed for each endpoint:_____

_____

Highest exposure concentration at which no significant effects were observed for each endpoint:_____

_____

Comments:_____

_____

Appendix C

LWG
LOWER WILLAMETTE GROUP

PORTLAND HARBOR RI/FS PROGRAMMATIC WORK PLAN

APPENDIX C: HUMAN HEALTH RISK ASSESSMENT APPROACH

REVISED DRAFT FINAL
November 13, 2003

Prepared for:
The Lower Willamette Group

Prepared by:
Kennedy/Jenks Consultants

TABLE OF CONTENTS

1.0 INTRODUCTION 1
1.1 HHRA Objectives 1
1.2 HHRA Approach 2

2.0 DATA COLLECTION AND EVALUATION 4
2.1 Data from Previous Investigations 4
2.2 Remedial Investigation 4
2.3 Identification of Chemicals of Potential Concern 5
2.3.1 Sediments 5
2.3.2 Surface Water 7
2.3.3 Fish and Shellfish Tissue 8

3.0 EXPOSURE ASSESSMENT 9
3.1 Identification of Potential Human Receptors 9
3.1.1 Human Use Areas 10
3.2 Identification of Exposure Pathways 11
3.2.1 Definition and Significance of Exposure Pathways 13
3.2.2 Conceptual Site Model 14
3.3 Exposure Pathways for identified receptors 14
3.3.1 Current and Future Dockside Worker 14
3.3.2 Current and Future Transients 15
3.3.3 Current and Future Recreational Beach User 16
3.3.4 Current and Future Fishers 16
3.3.5 Potentially Overlapping Exposure Scenarios 22
3.4 Process to Estimate Exposure Point Concentrations 22
3.4.1 Surface Water Exposure Point Concentrations 22
3.4.2 Sediment Exposure Point Concentrations 23
3.4.3 Tissue Exposure Point Concentrations 24
3.4.4 Incorporation of Non-detects in EPCs 24
3.4.5 Chemical-Specific Assumptions 25
3.5 Process to Calculate Intakes 27
3.5.1 Receptor-Specific Assumptions 28

4.0 TOXICITY ASSESSMENT 31
4.1 Sources of Toxicity Values 31
4.2 Chemicals of Potential Concern With Noncarcinogenic Effects 32
4.3 Chemicals of Potential Concern With Carcinogenic Effects 32
4.3.1 Qualitative Characterization of Hazard 33
4.3.2 Quantitative Assessment of Dose Response 33
4.4 Dioxins and Furans 34
4.5 Polychlorinated Biphenyls 34
4.6 Dermal Toxicity Assessment 35

5.0 RISK CHARACTERIZATION 37

5.1 Noncancer Hazard Estimates 37
5.2 Cancer Risk Estimates 37
5.3 Evaluation of Overlapping Scenarios 38

6.0 UNCERTAINTY ANALYSIS 39

7.0 REFERENCES 40

LIST OF FIGURES

Figures 1a, 1b, and 1c. Human Use Area Designations for the Site.
Figure 2. Preliminary Conceptual Site Model for Human Exposures.

LIST OF TABLES

Table 1. Selection of Exposure Pathways.
Table 2. Home Ranges for Resident Fish Species in the Lower Willamette River that may be consumed by Human Receptors.
Table 3. Summary of Tissue Data for Tissue Target Analytes from Resident Fish in the Lower Willamette River.
Table 4. Selected Target Fish Species for the Human Health Risk Assessment.
Table 5. Initial Values for Daily Intake Calculations – Dockside Worker Sediment Exposures.
Table 6. Initial Values for Daily Intake Calculations – Transient Sediment Exposures.
Table 7. Initial Values for Daily Intake Calculations – Transient Surface Water Exposures.
Table 8. Initial Values for Daily Intake Calculations – Adult Recreational Beach User Sediment Exposures.
Table 9. Initial Values for Daily Intake Calculations – Adult Recreational Beach User Surface Water Exposures.
Table 10. Initial Values for Daily Intake Calculations – Child Recreational Beach User Sediment Exposures.
Table 11. Initial Values for Daily Intake Calculations – Child Recreational Beach User Surface Water Exposures.
Table 12. Initial Values for Daily Intake Calculations – Adult Recreational Fisher Sediment Exposures.
Table 13. Initial Values for Daily Intake Calculations – Adult Native American Consumption Fisher Sediment Exposures.
Table 14. Initial Values for Daily Intake Calculations – Adult Non-tribal Consumption Fisher Sediment Exposures.
Table 15. Daily Intake Equation for Fish and Shellfish Consumption – Adult Recreational Fisher Biota Exposures.
Table 16. Daily Intake Equation for Fish and Shellfish Consumption – Child Recreational Fisher Biota Exposures.

Table 17. Daily Intake Equation for Fish and Shellfish Consumption – Adult Native American Consumption Fisher Biota Exposures.
Table 18. Daily Intake Equation for Fish and Shellfish Consumption – Child Native American Consumption Fisher Biota Exposures.
Table 19. Daily Intake Equation for Fish and Shellfish Consumption – Adult Non-tribal Consumption Fisher Biota Exposures.
Table 20. Daily Intake Equation for Fish and Shellfish Consumption – Child Non-tribal Consumption Fisher Biota Exposures.
Table 21. Chemical-Specific Dermal Absorption Factors.
Table 22. Toxic Equivalency Factors for Dioxins, Furans and PCB Congeners.

APPENDICES

Attachment A: Conversation Logs

1.0 INTRODUCTION

This Human Health Risk Assessment (HHRA) approach describes the information and processes that will be undertaken by the Lower Willamette Group (LWG) as they prepare the baseline HHRA for the Portland Harbor Superfund Site (Site) in Portland, Oregon. This document incorporates the results of numerous discussions among interested parties (EPA, DEQ, ODHS, and Native American Tribes) on appropriate risk assessment techniques for the Site to the greatest extent possible at this time. Because these discussions are ongoing, it is acknowledged that additional updates and revisions will be made to this document in the form of addenda, as outstanding issues are resolved. The HHRA approach described herein is based on U.S. EPA (1986, , 1989, 1991, 2001a, 2001b) and Region 10 EPA (2000a) guidance. The approach is also consistent with Oregon Department of Environmental Quality (DEQ) guidance for HHRA (DEQ 2000a).

The remedial investigation/feasibility study (RI/FS) for the Site is designed to be an iterative process that addresses the relationships among the factors that may affect chemical distribution, risk estimates, and remedy selection. Currently, four rounds of field investigations are planned as part of the overall RI/FS, with data collected during Rounds 1 and 2 to support the baseline HHRA. Round 1 was conducted in 2002 and focused primarily on chemical concentrations in fish and shellfish tissue and in beach sediments. Rounds 2A and 2B will be conducted prior to the Baseline Risk Assessment to provide additional needed for the HHRA.

The procedures and assumptions outlined in this HHRA approach are based on the data currently anticipated to be available following the Round 2 investigation. These procedures and assumptions will be used to estimate potential risks to human health in the Baseline Risk Assessment.

In the Statement of Work, EPA implemented an initial study area (ISA) concept for sampling and analysis in the Portland Harbor. The ISA concept focuses the investigation and characterization efforts on the in-water portion of the 5.7-mile stretch of the Willamette River from the southern tip of Sauvie Island at River Mile (RM) 3.5 to the southern end of Swan Island at RM 9.2. Recognizing that the ISA concept does not define the Site boundaries, the HHRA approach described here will be applicable if the Site boundaries change.

1.1 HHRA OBJECTIVES

The general objective of an HHRA is to characterize the potential risks to human health that may be posed by chemicals present in or entering into environmental media (i.e., water, air, or soil) or bioaccumulating in the food chain. The results of the baseline HHRA help to establish acceptable exposure levels for use in showing

that risks to human receptors are acceptable or in developing protective remedial action objectives.

The overall objective of the baseline HHRA for the Portland Harbor Superfund Site will be to determine whether exposure to chemicals in sediment, surface water, or biota within the Site results in unacceptable risks to human health, thereby warranting consideration of further investigation or possible response action. To achieve the overall objective, the following are specific objectives of the baseline HHRA:

- Identify and select chemicals of potential concern (COPCs) for human health
- Identify potential exposure pathways to human receptors who may contact COPCs within the Site
- Characterize potentially exposed populations and estimate the extent of their exposure to COPCs within the Site
- Quantitatively characterize the noncarcinogenic and carcinogenic risks to the human receptors resulting from potential exposure to COPCs within the Site and identify chemicals of concern (COCs) that will be considered in the risk management phase of the RI/FS.

1.2 HHRA APPROACH

The approach and methods that will be used to perform the baseline HHRA will be based on EPA (1989 and subsequent) guidance. In accordance with EPA guidance (1989), the HHRA will incorporate health-protective assumptions in estimating the potential health risk associated with COPCs at the Site. If possible, site-specific data will be substituted for default assumptions in order to more accurately estimate potential human health risks associated with the Site.

Due to the iterative nature of the RI/FS process for the Portland Harbor Superfund Site, site-specific data will be generated in each round of investigation and characterization efforts, so the actual data that will be available at the time of the Baseline Risk Assessment are not known at this time. This HHRA Approach is based on the data that are currently anticipated to be available, which include historic data and data collected during the remedial investigation. Historic data classified as Category 1 (see Section 4 of the Programmatic Work Plan) will be evaluated to identify data that could be used in the baseline HHRA. Fish and shellfish tissue and beach sediment data collected in the Round 1 investigation together with historic data selected for use in the HHRA will be reviewed to determine the adequacy and completeness of the data available for these media and assess data gaps, if any. Surface water data and other data identified during the data gap review will be collected in Round 2 to support the data needs of the HHRA. For purposes of this HHRA Approach, it is assumed that fish and shellfish tissue data collected during the

remedial investigation will be sufficient to evaluate human health risks and that modeling tissue concentrations will not be needed. If it is determined that tissue data are not sufficient, the approach to derive tissue concentrations, such as the use of biota sediment accumulation factors and bioconcentration factors, will be developed in the future through discussion with EPA and its partners.

Prior to the baseline HHRA, the LWG will meet with EPA and its partners to develop a list of interim deliverables that will provide detailed information to support the HHRA. These interim deliverables will include information recommended by EPA guidance (2001a), as well as other information that might be identified by the LWG and EPA and its partners during the discussion. It is currently anticipated that this meeting will occur approximately eight months prior to the baseline HHRA; however, this schedule is dependent on the progress of the remedial investigation and availability of data.

The draft baseline HHRA will be prepared following Round 2 using available data at that time. The baseline HHRA will identify chemicals in sediments, surface water, and fish and shellfish tissue that result in unacceptable risks to human health. For chemicals resulting in unacceptable risks, risk-based concentrations will be established following the baseline HHRA that would be protective of human receptors at the Site.

In accordance with guidance from EPA (1989), which is consistent with DEQ guidance (2000a), the HHRA will incorporate the four steps of the baseline risk assessment process: data collection and evaluation, exposure assessment, toxicity assessment, and risk characterization, which will include an uncertainty assessment.

2.0 DATA COLLECTION AND EVALUATION

Data collection and evaluation will include the gathering and analysis of data from the Site relevant to human exposures and to identify those chemicals present in the Site that will be the focus of the baseline HHRA. Initial data needs for the baseline HHRA were identified through the data quality objective (DQO) process described in Section 7 of the RI Work Plan. As new data are gathered, they will be incorporated into the DQO process to evaluate additional data needs.

2.1 DATA FROM PREVIOUS INVESTIGATIONS

Data from previous investigations at the Site will be used in the baseline HHRA, if appropriate. Previous investigations included the following categories: physical parameters, sediments, surface water, groundwater, ecological, and cultural and human resources. Results of previous investigations are discussed further in Section 4 of the Programmatic Work Plan. Historic data classified as Category 1 will be evaluated to identify data that could be used in the baseline HHRA. The results of this evaluation and a description of how any historic data would be used in baseline HHRA will be submitted to EPA as an interim deliverable after the categorization of historic data is final.

Only data of confirmed quality that meet the DQOs for historic data will be considered for quantitative evaluation. The historic data DQOs are described in the Data Quality Objectives for Historical Data technical memorandum submitted to EPA on 21 December 2001 (Striplin Environmental Associates 2001).

2.2 REMEDIAL INVESTIGATION

Sediment, surface water, and tissue samples will be collected and analyzed during the RI, which will include several rounds of data collection. Beach sediment and fish/crayfish tissue samples were collected during Round 1 and surface water samples will be collected during Round 2 to support the baseline HHRA. After receiving Round 1 data, Round 1 data and historical data of adequate quality will be evaluated, including comparison to HHRA DQOs, to determine if additional site-specific data are needed. The results of this evaluation will be reported to EPA and its partners in summer 2003. If additional data needs are identified, a sampling plan will be developed for approval and implementation in late summer/fall of 2003. Data collected during the remedial investigation will be quantitatively evaluated in the baseline HHRA.

2.3 IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN

COPCs will be quantitatively evaluated in the baseline HHRA. COPCs for human health will be selected according to EPA guidance (1989).

EPA guidance recommends considering criteria to limit the number of chemicals that are included in a quantitative risk assessment while also ensuring that all chemicals that may contribute significantly to the overall risk are addressed. According to EPA guidance, the screening procedure is used to focus quantitative risk assessment efforts on chemicals that could be of concern under health-protective exposure assumptions. The process that will be used to select the COPCs for the Site in sediments, tissue, and surface water for quantitative evaluation in the baseline HHRA is described in the following subsections.

2.3.1 Sediments

Sediments will be evaluated in the baseline HHRA for potential risks to human health through direct contact. As a result, the selection of COPCs in beach sediment is based only on potential for direct human contact and not on potential for bioaccumulation. Bioaccumulative chemical exposures will be addressed directly using COPC concentrations in fish and crayfish, as described in Section 2.3.3. The selection of COPCs in sediment will only evaluate sediment data where direct contact with human receptors could occur (only reasonably accessible beach sediments, such as those with access from contiguous upland areas or by boat). Historic beach sediment data selected for use in the HHRA (see Section 2.1) and beach sediment data of acceptable quality gathered during the RI will be used to identify the COPCs in sediment for quantitative evaluation in the baseline HHRA. The decision process that will be used to select COPCs in sediment for the baseline HHRA is described below.

2.3.1.1 Comparison with Risk-Based Concentrations

Chemicals detected in beach sediments will be compared to risk-based screening concentrations. As a health-protective initial approach, EPA Region 9 preliminary remediation goals (PRGs) for soil will be used as the basis for screening values for beach sediments (EPA 2002a). For carcinogenic chemicals, the Region 9 PRGs will be used as the screening value. For noncarcinogenic chemicals, the Region 9 PRGs will be divided by 10 to account for potential cumulative effects from multiple chemicals, and this modified PRG will be used as the screening value, as required by EPA Region 10. For chemicals that exhibit both carcinogenic and noncarcinogenic effects, the more conservative screening value will be used for selecting COPCs.

Region 9 PRGs have been developed for both residential and industrial exposure scenarios for soil. Because uses of Portland Harbor include both recreational and industrial activities, COPCs will be selected using both residential and industrial Region 9 PRGs. In areas where exposures could occur during recreational, transient, or fishing activities, COPCs in beach sediment will be selected using residential soil

PRGs. In areas where occupational exposures could occur, COPCs will be selected using industrial soil PRGs.

Residential soil Region 9 PRGs are based on exposure assumptions of 350 days per year. For cancer endpoints, the residential Region 9 PRGs are calculated using an age-adjusted soil ingestion factor that takes into account the difference in daily soil ingestion rates, body weight, and exposure duration for children from 1 to 6 years old and others from 7 to 31 years old (total exposure over 30 years). For noncancer endpoints, the residential Region 9 PRGs are calculated using exposure factors for children from 1 to 6 years old and chronic toxicity criteria. Industrial soil Region 9 PRGs are based on exposure assumptions of 250 days per year for 25 years. Both residential and industrial Region 9 PRGs are based on a target cancer risk of 1×10^{-6} for carcinogenic chemicals or a hazard quotient of 1 for noncarcinogenic chemicals. Dividing Region 9 PRGs for noncarcinogenic chemicals by 10 is equivalent to using a hazard quotient of 0.1. Because the potential exposure to sediments that may occur at the Site is anticipated to be less than the exposure that was assumed to occur with soil in developing the Region 9 PRGs, the PRGs represent conservative screening values for protection of human health.

For chemicals that are detected in sediment, the detected concentrations will be compared to soil PRGs. The maximum detected concentration of each chemical from all samples collected in recreational, transient, or fishing beach areas will be compared to the residential soil PRGs. If the maximum detected concentration of a chemical is greater than the residential soil PRG, that chemical will be selected as a COPC for sediment in recreational, transient or fisher exposures. The maximum detected concentration of each chemical from all samples collected in industrial beach areas will be compared to the industrial soil PRG. If the maximum detected concentration of a chemical is greater than the industrial soil PRG, that chemical will be selected as a COPC for sediment in occupational exposures. Chemicals selected as COPCs for sediment will be quantitatively evaluated in the baseline HHRA. Chemicals with maximum detected concentrations less than the PRGs will not be selected as COPCs for quantitative evaluation in the baseline HHRA. However, these chemicals may be considered in the nature and extent investigative efforts and in the evaluation of remediation goals for bioaccumulative chemicals. For chemicals that do not have Region 9 PRGs, Region 9 PRGs for surrogate chemicals with similar chemical structures will be used (e.g., naphthalene for 1- and 2-methylnaphthalene and pyrene for phenanthrene). Chemicals that do not have Region 9 PRGs or surrogate chemicals with Region 9 PRGs will be evaluated qualitatively in the baseline HHRA.

For chemicals that are not detected in sediment, the maximum detection limits will be compared to the PRGs. If the maximum detection limit is greater than the PRG, the chemical will be retained for further evaluation within the Uncertainty Assessment of the baseline HHRA. If a chemical is not detected, and the maximum detection limit

is less than the PRG, the chemical will not be evaluated further in the baseline HHRA.

2.3.1.2 Frequency of Detection

Frequency of detection is not an applicable criterion for sediment data collected during Round 1 to support the baseline HHRA. The sampling design for beach sediments consisted of one composite sample from each beach, and risk will be evaluated at individual beaches. Therefore, if a chemical is identified as a COPC in beach sediments based on only one detection, it will be evaluated at the beach where it was detected. If future sampling of sediment for use in the HHRA generates data that could support the use of frequency of detection as a screening criterion, this criterion will be discussed with EPA and its partners at that time to determine whether it is appropriate to use.

2.3.2 Surface Water

Direct contact with surface water will be evaluated in the baseline HHRA for potential risks to human health. As a result, the selection of COPCs in surface water is based only on potential for direct human contact and not on potential for bioaccumulation. Historic surface water data selected for use in the HHRA (see Section 2.1) and surface water data gathered during the RI will be used to identify the COPCs in surface water for quantitative evaluation in the baseline HHRA. The decision process that will be used to select COPCs in surface water for the baseline HHRA is described below.

2.3.2.1 Comparison with Risk-Based Concentrations

Chemicals detected in surface water will be compared to risk-based screening values. As a health-protective initial approach, EPA Region 9 PRGs for tap water will be used as the screening values for surface water (EPA 2002a). For carcinogenic chemicals, the Region 9 PRGs will be used as the screening value. For noncarcinogenic chemicals, the Region 9 PRG will be divided by 10 to account for potential cumulative effects from multiple chemicals, and this modified PRG will be used as the screening value, as required by EPA Region 10.

Tap water Region 9 PRGs are based on domestic use of water, including ingestion, and on a target cancer risk of 1×10^{-6} for carcinogenic chemicals or a hazard quotient of 1 for noncarcinogenic chemicals. Dividing Region 9 PRGs for noncarcinogenic chemicals by 10 is equivalent to using a hazard quotient of 0.1. Because surface water at the Site is not used as a domestic water source, the Region 9 PRGs represent conservative screening values.

For chemicals that are detected in surface water, the detected concentrations will be compared to tap water PRGs. If the maximum detected concentration of a chemical in surface water is greater than the PRG, that chemical will be selected as a COPC for surface water and will be quantitatively evaluated further in the baseline HHRA.

Chemicals that are detected only at concentrations less than the PRGs will not be selected as COPCs for quantitative evaluation. For chemicals that do not have Region 9 PRGs, Region 9 PRGs of surrogate chemicals with similar chemical structures will be used (e.g., naphthalene for 1- or 2-methylnaphthalene and pyrene for phenanthrene). Chemicals that do not have Region 9 PRGs or surrogate chemicals with Region 9 PRGs will be evaluated qualitatively in the baseline HHRA.

For chemicals that are not detected in surface water, the maximum detection limits will be compared to the PRGs for tap water. If the maximum detection limit is greater than the PRG, the chemical will be retained for further evaluation within the Uncertainty Assessment of the baseline HHRA. If the maximum detection limit is less than the PRG, the chemical will not be evaluated further in the baseline HHRA.

2.3.2.2 Frequency of Detection

Frequency of detection is not an applicable criterion for surface water data based on the anticipated sampling design for surface water to support the baseline HHRA. If future sampling of surface water for human health generates data that could support the use of frequency of detection as a screening criterion, this criterion will be discussed with EPA and its partners at that time to determine whether it is appropriate to use.

2.3.3 Fish and Shellfish Tissue

Fish and shellfish tissue will be evaluated in the baseline HHRA for potential risks to human health through ingestion. Historic tissue data selected for use in the HHRA (see Section 2.1) and fish and shellfish data gathered during the RI to support the HHRA will be used to identify the COPCs in tissue for quantitative evaluation in the baseline HHRA. Because EPA Region 10 does not accept any criteria for screening tissue, all chemicals detected in fish and shellfish tissue that will support the HHRA will be selected as COPCs.

3.0 EXPOSURE ASSESSMENT

The objectives of the exposure assessment will be to identify potential exposure pathways to individuals who may come in contact with COPCs at the Site, to characterize potentially exposed populations, and to estimate the extent of exposure.

The exposure assessment in the HHRA will follow EPA guidance and incorporate the reasonable maximum exposure (RME) methods recommended by EPA. As stated in EPA guidance (EPA 1989), the RME is a conservative exposure level that is still within the range of possible exposures. The exposure assessment will also use central tendency (CT) values, which are less conservative exposure values that are more representative of average exposures. According to EPA (1989), an exposure assessment includes four primary tasks:

- Identify potentially exposed human populations that may come in contact with the COPC. This requires knowledge of (and/or making reasonable assumptions regarding) both current and future populations.
- Identify relevant exposure pathways for human populations by which potentially exposed populations may contact environmental media containing chemicals.
- Estimate exposure point concentrations (EPCs) at the points of potential human contact for all identified COPCs. EPCs for chemicals will be derived directly from analytical data.
- Estimate daily intakes for exposure routes and potentially exposed populations. The daily intakes will be derived using the EPCs and assumptions regarding such variables as exposure duration, consumption rates, skin absorption factors, and other various parameters that describe human activities.

The exposure assumptions and methods for each task included in the exposure assessment are discussed below.

3.1 IDENTIFICATION OF POTENTIAL HUMAN RECEPTORS

Potentially exposed populations were identified based on consideration of current and future uses of the Site and EPA (1989) guidance. The potential human receptors identified below represent those receptors that are anticipated to be present within the Site under current and reasonably foreseeable future conditions. The evaluation to be done for the selected receptors should be protective of other potential receptors that will not be evaluated quantitatively in the HHRA. The receptors for current and future uses of the Site include the following:

- Dockside worker
- Transient
- Recreational beach user
- Recreational consumption fisher
- Native American consumption fisher
- Non-tribal consumption fisher

The receptors were identified based on human activities that are known to occur at the Site, as described in Section 4.4 of the RI Work Plan. Within the consumption fisher receptors, pregnant and nursing women are a subgroup of potential concern due to potential exposures to fetuses and nursing infants and will be discussed further with EPA and its partners. It is assumed that the recreational beach user, which includes exposure to surface water during swimming activities, will be protective of divers in Portland Harbor. This assumption will be reassessed when additional information regarding divers in Portland Harbor becomes available, and, if needed, a diver receptor may be included in the HHRA.

Potential risks will be quantified for each of the receptors; however, certain individuals may participate in activities resulting in potential exposures under more than one category (e.g., recreational beach users may also be recreational fishers). Potentially overlapping exposures are discussed in Section 3.3.5 of this appendix.

The HHRA will focus on potential exposures occurring within the Site in quantifying potential risks to human receptors. However, certain receptors may also be exposed to media at upland sites adjacent to the Site. The HHRA will acknowledge that additional upland exposures may occur and these potential risks will be addressed by DEQ through upland activities.

3.1.1 Human Use Areas

Portland Harbor encompasses approximately six miles of the lower Willamette River. Because of its size, specific human activities are localized to different areas of Portland Harbor. To evaluate potential exposures, areas used by different human receptors were identified. These areas are classified as human use areas. Human use areas within the ISA are shown in Figures 1a, 1b, and 1c. Additional use areas outside of the ISA may be identified during the RI/FS. The use areas were identified using the following sources:

- Aerial photos of the Site
- City of Portland zoning maps
- City of Portland Willamette River Atlas
- A limited site survey

- Discussions with EPA and its partners
- Input from local fishers and others familiar with Portland Harbor
- Observations during preliminary Round 1 field activities
- The site video

Dockside worker use areas were developed, relying on the data sources described above, by identifying active industrial/commercial sites containing beach areas where direct contact with sediments and surface water could occur.

Transient use areas were developed, similarly relying on data sources described above, by identifying sites that are not utilized as active industrial/commercial sites, are not secured, and contain beach areas where direct contact with sediments and surface water could occur.

Recreational beach areas were similarly developed by identifying sites known to be used for boating, water skiing, swimming, and other near shore water or beach activities, that are not in the Industrial Sanctuary, and that contain beach areas where direct contact with sediments or surface water could occur.

Fishing activities via boat could occur throughout the Site, but bank fishing would be limited to beaches with unrestricted access. Use areas were not identified for fisher receptors in Figures 1a, 1b, and 1c; however bank fishing could occur at recreational and transient beaches, as these beaches have unrestricted access. Therefore, recreational and transient beaches shown in Figures 1a, 1b, and 1c will be evaluated as fisher use areas.

3.2 IDENTIFICATION OF EXPOSURE PATHWAYS

Exposure pathways are defined as the physical ways in which chemicals may enter the human body (e.g., ingestion, inhalation, dermal absorption). A complete exposure pathway consists of the following four elements:

- A source of chemical release
- A retention or transport medium (or media in cases involving media transfer)
- An exposure point (a point of potential human contact with the contaminated medium)
- An exposure route (e.g., ingestion, dermal contact) at the exposure point.

If any of the above elements is missing, the pathway is considered incomplete and exposure does not occur.

As discussed in Section 4 of the RI/FS Work Plan, the currently known affected media within the Site are sediments and surface water. Current and historical industrial activities and processes within, upstream and downstream of the ISA may have led to either point or nonpoint chemical releases to the Site. In addition to these releases, discharges to the river from outfalls and groundwater may be potential chemical sources to the Site. Finally, releases that occur upstream and downstream of the Site and atmospheric deposition may be potential sources to the Site. Potential sources are discussed in greater detail in Section 3 of the RI/FS Work Plan. In addition, chemicals in sediment may be accumulated by bottom-dwelling organisms. Fish and shellfish species feeding on these organisms and living within the Site may accumulate chemicals in their tissues through dietary exposures and direct exposure to sediment and surface water. The potential exposure pathways to human receptors at the Site include:

- Ingestion of sediment and surface water
- Dermal contact with sediment and surface water
- Ingestion of fish and shellfish.

Direct contact with groundwater may be a complete exposure pathway for human receptors at some beaches designated as human use areas, specifically at locations where groundwater comes to the surface (i.e., seeps) on the beach above the water line. A field reconnaissance survey was conducted during low water to identify potential groundwater seep locations above the water line. Results of the seep survey are documented in a technical memorandum prepared by Groundwater Solutions (2003). Identified seep locations will be reviewed to determine if any are located within potential human use beaches. If a groundwater seep is identified within a potential human use beach, the upland groundwater data will be reviewed to determine whether chemicals might be present at the point of discharge of the seep on the beach at concentrations that could result in risks to human health. Locations where groundwater data are not available but where site uses indicate a potential for chemicals to be present at the point of discharge of the seep on the beach will be referred to DEQ for sampling under the upland source control program. Locations where chemicals are present in groundwater in the vicinity of seeps at potential human use areas will be evaluated further to assess the potential for exposure and risk.

The following section provides a more detailed discussion of potential exposures at the Site under current and reasonably foreseeable future conditions, and presents the rationale for including or eliminating pathways from quantitative evaluation. The identified receptors, exposure routes, and exposure pathways, and the rationale for selection or exclusion are also summarized in Table 1.

3.2.1 Definition and Significance of Exposure Pathways

Exposure pathways are designated in one of the following four ways:

- ***Potentially Complete and Significant:*** There is a source or release from a source, an exposure point where contact can occur, and an exposure route by which contact can occur, and the pathway is considered a potentially important contributor to the overall risk. Pathways considered complete and significant will be quantitatively evaluated in the HHRA.
- ***Potentially Complete and Significance Unknown:*** There is a source or release from a source, an exposure point where contact can occur, and an exposure route by which contact can occur. However, the contribution of the pathway to the overall risk cannot be determined with existing data, either because the extent of contamination of the exposure media is unknown or the extent of exposure of the receptor is unknown. Pathways considered complete and significance unknown will be quantitatively evaluated in the HHRA.
- ***Potentially Complete and Insignificant:*** There is a source or release from a source, an exposure point where contact can occur, and an exposure route by which contact can occur; however, the pathway is considered negligible to the overall risk. Pathways are considered insignificant when they meet one of the following criteria:
    - Exposure is anticipated to occur infrequently and at low levels, resulting in minimal intake, or
    - Concentrations of COPCs in exposure medium are low, resulting in minimal intake.

  Pathways considered complete and insignificant will not be evaluated further in the HHRA.
- ***Potentially complete pathway, but not relevant for this receptor, pathway evaluated under a different receptor category:*** These pathways may be complete for individuals in this receptor category due to overlapping exposure scenarios (e.g., some dockside workers may also be recreational fishers), but are not evaluated for the identified receptor category because the pathways are not considered relevant for that receptor. These pathways are evaluated under different receptor categories where the pathways are considered potentially complete and significant. Overlapping exposures that may occur for the different receptor categories are discussed further in Section 3.3.5 of this appendix.

3.2.2 Conceptual Site Model

The conceptual site model (CSM) for human exposures based on the current understanding of the Site is presented in Figure 2. The CSM graphically depicts possible sources of COPCs based on current information, possible COPC-affected media, mechanisms of COPC transfer between media, and the processes through which human receptors may be exposed to chemicals. Only those pathways that are theoretically complete and may result in significant exposure or for which significance is unknown will be evaluated quantitatively in the HHRA.

3.3 EXPOSURE PATHWAYS FOR IDENTIFIED RECEPTORS

The following sections provide a detailed discussion of potential exposures at the Site for each identified receptor under current and reasonably foreseeable future conditions and present the rationale for including or eliminating pathways from quantitative evaluation. This information is also summarized in Table 1 and Figure 2.

3.3.1 Current and Future Dockside Worker

Industrial use of the Site and adjacent areas has been extensive and is anticipated to continue in the future. Industrial and commercial workers at facilities near the river are generally not exposed to beach sediments and surface water unless they are conducting specific activities within natural river beach areas, such as unloading ships or barges from the beach itself or conducting occasional maintenance activities along the water's edge. The actual activities that occur within natural river beach areas are site-specific and generally occur only very infrequently. Through these activities, industrial and commercial workers may have some direct contact with surface water and beach sediments.

3.3.1.1 Incidental Ingestion of and Dermal Contact with Surface Water

Direct contact with surface water may occur during occupational activities within river beach areas. However, dermal contact or ingestion of surface water that may occur during occupational activities would be unintentional and infrequent. As a result, the exposure to surface water that may occur during occupational activities is considered to be minimal. Therefore, these pathways are considered complete and insignificant, as they are negligible to the overall risk. These pathways will not be quantitatively evaluated in the baseline HHRA for the dockside worker.

3.3.1.2 Incidental Ingestion of and Dermal Contact with Beach Sediments

Although exposure is anticipated to be infrequent to non-existent, workers conducting activities within natural river beach areas may contact beach sediments within riverfront industrial and commercial sites at the Site. Incidental ingestion of beach sediments can occur through normal hand-to-mouth behavior. Chemicals in sediments also may be absorbed through exposed skin. Therefore, these pathways are

considered complete and significant for dockside workers and will be quantitatively evaluated in the baseline HHRA.

3.3.1.3 Consumption of Fish and Shellfish

Dockside workers do not consume fish or shellfish through occupational activities. Therefore, this pathway is not evaluated under this exposure scenario. While dockside workers may consume fish and shellfish as consumption fishers in Portland Harbor, this consumption will be addressed under the appropriate fisher scenario. Potential risk from overlapping scenarios will be presented in the baseline HHRA (see Section 3.3.5).

3.3.2 Current and Future Transients

During past site tours, tents and makeshift dwellings were observed as evidence that individuals were occupying some riverbank areas. Transients are expected to continue to utilize this area in the future. This receptor only includes adult transients, as children have not been observed as transients within the Site. These transients may have direct contact with surface water and beach sediments within natural river beach areas. Transients may also be consuming fish and shellfish; however, no information is available regarding this potential exposure pathway.

3.3.2.1 Ingestion of and Dermal Contact with Surface Water

Transients may have direct contact with surface water within river beach areas. Dermal contact or incidental ingestion of surface water may occur during swimming, bathing or other activities such as washing of clothing or equipment. Transients may also use river water as a drinking water source. Because the existing data for surface water are limited and data on the frequency and duration of transient contact with and ingestion of surface water are not available, these pathways are considered complete and significance unknown. Additional data will be collected to reduce the uncertainty in the level of exposure of transients to surface water through dermal contact and ingestion. These pathways will be quantitatively evaluated in the baseline HHRA.

3.3.2.2 Incidental Ingestion of and Dermal Contact with Beach Sediments

Transients may contact beach sediments within riverfront beach areas at the Site that are not active industrial sites and are not otherwise restricted from access. Incidental ingestion of beach sediments can occur through normal hand-to-mouth behavior. Chemicals in sediments also may be absorbed through exposed skin. Therefore, these pathways are considered complete and significant and will be quantitatively evaluated in the baseline HHRA.

3.3.2.3 Consumption of Fish and Shellfish

Transients may consume fish and shellfish caught at the Site. However, the amount of fish and shellfish from the Site consumed by transients cannot be easily determined. Due to inherent difficulties in collecting data that would be required to quantitatively evaluate this pathway, this pathway will not be evaluated under this

exposure scenario. Fish and shellfish consumption will be evaluated for other receptors and will include long-term, high-end exposures. It is anticipated that the high-end consumption rates for these receptors will be adequately conservative to be protective of the potential consumption pathway for transients. Potential risk from overlapping scenarios will be presented in the baseline HHRA (see Section 3.3.5).

3.3.3 Current and Future Recreational Beach User

The lower Willamette River is used by both adults and children for boating, water skiing, swimming, and other water activities. Figures 1a, 1b, and 1c present the primary areas currently used for recreational beach activities at the Site. Recreational beach use may occur sporadically at other areas in the Site. However, ongoing, long-term, repetitive beach use will be the focus of the baseline HHRA, as it is anticipated to result in the greatest potential risk. Beach uses are anticipated to continue in the future. Recreational beach users may have direct contact with surface water and beach sediments within river beach areas.

3.3.3.1 Incidental Ingestion of and Dermal Contact with Surface Water

Direct contact with surface water may occur during recreational activities in the river. Incidental ingestion of surface water and dermal contact with surface water would occur to the greatest extent while swimming in the river. These pathways are considered complete and significance unknown because sufficient chemical data for river water are not currently available. Surface water data will be collected during Round 2 field sampling activities. These pathways will be quantitatively evaluated in the baseline HHRA.

3.3.3.2 Incidental Ingestion of and Dermal Contact with Beach Sediments

Recreational beach users may contact beach sediments within recreational beach areas at the Site. Incidental ingestion of beach sediments can occur through normal hand-to-mouth behavior. Chemicals in sediments also may be absorbed through exposed skin. Therefore, these pathways are considered complete and significant and will be quantitatively evaluated in the baseline HHRA.

3.3.3.3 Consumption of Fish and Shellfish

Recreational beach users do not consume fish or shellfish through beach use activities. Therefore, this pathway is not evaluated under this exposure scenario. While recreational beach users may consume fish and shellfish as recreational or consumption fishers in Portland Harbor, this consumption will be addressed under the appropriate fisher scenario. Potential risk from overlapping scenarios will be presented in the baseline HHRA (see Section 3.3.5).

3.3.4 Current and Future Fishers

Three different angler receptors have been identified for evaluation in the baseline HHRA. The fisher categories are differentiated by the frequency of fishing and by the

amount of fish and shellfish and types of species that are consumed. The three fisher receptors, recreational fishers, Native American consumption fishers, and non-tribal consumption fishers, that will be evaluated in the baseline HHRA are described below.

Fishers may distribute fish and shellfish they catch from the Site to family and friends, resulting in fish and shellfish consumption by non-fishers as well. Fish and shellfish consumption is considered an "off-bank" exposure, as the exposure does not necessarily occur within the Site. Because the fisher receptor scenario addresses both fish and shellfish consumption that occurs "off-bank" and potential contact with sediments and surface water at the bank within the Site, the fisher receptors are anticipated to be protective of all fish consumption receptors.

- ***Recreational Fisher:*** A year-round recreational fishery exists within the Site. Current information suggests that spring Chinook, steelhead, Coho, shad, crappie, bass, and white sturgeon are the fish species preferred by local recreational fishers (DEQ 2000b, Hartman 2002, and Steele 2002). Recreational fishing is anticipated to continue in the future. This scenario will evaluate potential exposures for adult and child recreational fishers who consume fish and for adult recreational fishers who may contact surface water and sediments while fishing. Although not specifically addressed in the baseline HHRA, this scenario will be protective of "off-bank" exposures for individuals who consume fish that are caught from the Site and who consume similar fish species at similar fish ingestion rates as the recreational fishers.

- ***Native American Consumption Fisher:*** Certain Native American Tribes have treaty-fishing rights to fish in the Willamette River within the Site. Four of the Native American Tribes were included in a fish consumption survey that was conducted on the reservations of the participating Tribes and completed in 1994 (CRITFC 1994). The results of the survey suggest that Native American tribal members have higher fish ingestion rates than the general public and are recommended for evaluation of Native American subsistence fishing populations (EPA 1997a). Fish species, especially salmon and Pacific lamprey, are an important food source as well as an integral part of the Native Americans' cultural, economic, and spiritual welfare. Native American fishing is anticipated to continue in the future. This scenario will evaluate potential exposures for adult and child Native American fishers who consume fish and for adult Native American fishers who may contact surface water and sediments during fishing

activities. Although not specifically addressed in the baseline HHRA, this scenario will be protective of "off-bank" exposures for individuals who consume fish that are caught from the Site and who consume similar fish species at similar fish ingestion rates as the Native American fishers.

- ***Non-tribal Consumption Fisher:*** It is likely that other fish consumption patterns exist on the Willamette that are not fully reflected by estimates for the recreational and Native American fisher scenarios. The investigation by the Oregonian and the limited surveys of other portions of the Willamette River indicate that the groups most likely to be catching and eating fish from the lower Willamette are immigrants from Eastern Europe and Asia, African-Americans, and Hispanics (ATSDR 2002). These preliminary surveys also indicate that the most consumed species are carp, bullhead catfish, and smallmouth bass (ATSDR 2002), but non-tribal fishers may consume other species as well. Non-tribal fishing is anticipated to continue in the future. This scenario will evaluate potential exposures for adult and child non-tribal fishers who consume fish and for adult non-tribal fishers who may contact surface water and sediments during fishing activities. Although not specifically addressed in the baseline HHRA, this scenario will be protective of "off-bank" exposures for individuals who consume fish that are caught from the Site and who consume similar fish species at similar fish ingestion rates as the non-tribal fishers.

3.3.4.1 Incidental Ingestion of and Dermal Contact with Surface Water

Direct contact with surface water may occur during fishing activities in the river, but is anticipated to be minimal. As a result, dermal contact with and ingestion of surface water during fishing activities is assumed to be negligible; therefore, these pathways are considered complete and insignificant and will not be quantitatively evaluated in the HHRA.

3.3.4.2 Incidental Ingestion of and Dermal Contact with Beach Sediments

Fishers may contact beach sediment within areas of the Site where bank fishing occurs, and the extent of direct contact with sediments will be evaluated further. Ingestion of and dermal contact with beach sediments may occur in bank-fishing locations, but the significance of this contact is unknown. This pathway is considered complete and significance unknown because sediment data from bank fishing areas are not currently available. These pathways will be quantitatively evaluated in the baseline HHRA.

3.3.4.3 Consumption of Fish and Shellfish

Certain chemicals may accumulate in fish and shellfish tissue. Potential current and future receptors that consume fish or shellfish caught within the Site may be exposed to COPCs that accumulate in the fish or shellfish tissue. Therefore, this pathway is considered complete and significant for fishers who consume fish and shellfish caught within the Site.

For all of the fisher receptors, only those fish species that may be considered resident within the Site and thus exposed mainly to site-related COPCs will be considered for potential exposure via consumption. The following discusses the rationale for selecting the fish species that will be the focus of investigation efforts.

Anadromous Fish

Anadromous species, such as salmon, spend a small fraction of their lifespan within Portland Harbor and some of that time is within the latter part of their adult life during which they have substantially reduced feeding. Previous reports documenting the tissue contaminants of anadromous fish in the Columbia River Basin (EPA 2002b, Tetra Tech 1996) indicate that these fish species generally represent exposures over hundreds of miles of freshwater river and their time at sea. Other studies conducted in Puget Sound have attributed only 1% of salmon body burden to freshwater exposures (O'Neill et al. 1998). As a result, the body burden of anadromous species results from exposure to sources throughout their lifespan over hundreds of miles of river habitat and extended time at sea. Due to the inability to discriminate between potential exposures to COPCs at the Site and other sources of contamination, anadromous species were not selected as target species for the baseline HHRA.

A reconnaissance survey was conducted during the Round 1 investigation to observe the adult lamprey harvest and identify those lamprey species that are harvested. The results of the reconnaissance survey were summarized in a technical memorandum (Kennedy/Jenks Consultants 2003a). Results of the survey indicated that only one species, the anadromous Pacific lamprey, was collected by the Tribes during their annual harvest. The resident lamprey species, the western brook lamprey, was not harvested by the Native American Tribes, and in fact, members of the Native American Tribes at the harvest were not familiar with this species. Additional interviews with members of the Native American Tribes will be conducted to verify the results of the reconnaissance survey. Based on available information regarding the lamprey harvest, lamprey was not selected as a target species for the baseline HHRA due to the anadromous habit of the lamprey species harvested.

Sturgeon

White sturgeons are the largest freshwater fish in North America and range from the Aleutian Islands to Monterey Bay (Scott and Crossman 1973). In the lower Columbia River, sturgeon can migrate freely between Bonneville Dam and the Pacific Ocean and associated river systems. White sturgeons found in the lower Willamette are considered part of the lower Columbia River population (Rien 2001). Sturgeons do

not spawn within the Site, but may spawn upstream of Portland Harbor below Willamette Falls.

White sturgeons are semi-anadromous. As a migratory species, a sturgeon may spend significant portions of their lives outside the lower Willamette River (Devore and Grimes 1993). Studies have demonstrated that adults are capable of making extensive migrations outside their natal river basins, and genetic evidence suggests that the Columbia Basin provided founders for the Fraser River (British Columbia) system following the last ice age (Scott and Crossman 1973).

White sturgeons in the Lower Willamette are highly valued as sport fish and are consumed by humans. However, due to their extensive home range, it would not be possible to accurately correlate COPCs in tissue with potential exposure within the Site, which is an integral input to the human health DQOs (Section 7 of the RI Work Plan). Due to the inability to evaluate potential exposure to COPCs at the Site, sturgeon was not selected as a target fish species for the baseline HHRA.

Resident Fish and Shellfish

Resident fish and shellfish species are anticipated to spend the majority of their lives within the lower Willamette River and therefore may be exposed to COPCs within the Site. In a study of the lower Willamette, Farr and Ward (1993) identified 27 resident fish species. Due to the potentially large number of resident fish species present in the Site, target species were identified for the baseline HHRA. The use of target species will allow for more intensive studies within the Site.

In order to focus on those resident fish and shellfish species anticipated to result in the greatest potential risks to human health, the following criteria were used to select the target species that were collected and analyzed in the Round 1 investigation:

- **Common Human Consumption**. According to EPA guidance (2000b), the most important criterion for selecting target fish species is that the species is commonly caught and consumed in the study area. Resident fish that are consumed regularly and in significant quantities are anticipated to result in greater risks to human health. Therefore, the baseline HHRA will focus on those species that are preferentially consumed by humans. Fish species consumed by humans were identified through review of previous studies in the area of the Site (Adolfson 1996, ATSDR 2002) and through personal communications with local fishers (Attachment A).
- **Limited Home Range**. As stated in the DQOs for human health (Section 7 of the RI Work Plan), the baseline HHRA will address risks associated with exposure to COPCs in the Site. Resident fish with limited home ranges that are caught within the Site are most likely to feed within the Site and may receive the greatest

exposure to site-related COPCs. In addition, resident fish with limited home ranges that are caught within the Site will be most representative of exposures to fish occurring within the Site. Fish with large home ranges may be exposed to COPCs outside the Site or may not receive significant exposure within the Site. Therefore, the baseline HHRA will focus on those species with limited home ranges, when possible (Table 2).

- **Potential for Bioaccumulation**. Certain fish species may accumulate greater concentrations of chemicals than other fish species due to their feeding habits and other factors. Factors that may enhance bioaccumulation in particular species as well as tissue data from previous studies in the lower Willamette (Table 3) were considered in the selection of target fish species.
- **Predators and Bottom-feeders**. EPA (2000b) recommends collecting bottom-feeding and predator fish species. Using different ecological groups of fish allows for monitoring of a wide variety of habitats, feeding strategies, and physiological factors that may impact the bioaccumulation potential. The baseline HHRA will focus on both predator and bottom-feeder species.
- **Relatively Abundant Species**. As stated in EPA guidance (2000b), it is practical to sample target species that are abundant and easy to capture. Due to the number of individual fish that will be targeted during investigation efforts, the practicality of capturing a sufficient quantity of fish for evaluation in the baseline HHRA was considered in the selection of target species.

The above criteria were combined to select the target species for the baseline HHRA. The selected target fish species that will be used to evaluate potential risks to human health due to fish consumption are presented in Table 4. In addition to the target fish species listed in Table 4, crayfish will be evaluated for potential risks to human health due to shellfish consumption.

Although tissue data will only be collected for the target fish species, tissue data for target species may be used to evaluate potential risks associated with consumption of other resident fish species. Resident fish species with similar habitats and feeding strategies as the target fish species are expected to have similar tissue concentrations as the target fish species. Therefore, the risk estimates in the HHRA would be applicable to people who consume resident fish species other than the target fish species.

3.3.5 Potentially Overlapping Exposure Scenarios

Exposure can potentially occur under more than one scenario for an individual. These overlapping scenarios include a dockside worker who is also a recreational fisher and recreational beach user, a transient who is also a non-tribal consumption fisher, a Native American consumption fisher who is also a recreational beach user, and others. The potentially overlapping scenarios are indicated in Figure 2. It is possible that one or more of the exposure scenarios potentially affecting an individual will pose a much lower level of risk than the other scenario(s), such that combining the effects of the scenarios will not influence risk management decisions for the Site. Risk from potentially overlapping scenarios will be presented in the baseline HHRA.

3.4 PROCESS TO ESTIMATE EXPOSURE POINT CONCENTRATIONS

Exposure point concentrations (EPCs) will be calculated for media and pathways that will be evaluated quantitatively. EPCs will be based on available monitoring data. The average value of replicate samples will be used in EPC calculations.

According to EPA guidance (1989), the 95th percent upper confidence limit (95% UCL) on the average media concentration is recommended to evaluate the RME. Due to the use of subsets of the dataset to generate EPCs for the various scenarios (e.g., intake will be calculated at individual beaches, requiring calculation of an EPC for each beach), a large enough dataset may not be available to calculate the 95% UCL for any of the media tested. Should there be enough data collected in the future to allow calculation of the 95% UCL for any of the media, appropriate statistical methods will be identified through discussions with EPA and its partners to calculate the 95% UCL.

In the absence of sufficient data to calculate the 95% UCL, the maximum detected concentration will be used for the RME, and the average concentration will be used for the CT if multiple samples are included in the dataset. In the absence of multiple samples for a dataset, the single result will be used for both the RME and the CT.

3.4.1 Surface Water Exposure Point Concentrations

Surface water data collected during Round 2 will be used to estimate the EPCs for surface water. Historic data of confirmed quality that meet the DQOs for historic data will also be used to estimate EPCs for surface water. Within the Site, surface water samples will be collected from the main river channel and within quiescent areas where swimming may occur to evaluate potential exposures to surface water in the baseline HHRA. The process to estimate EPCs for surface water will depend on the sampling design, which has not yet been developed. As a result, the process to estimate surface water EPCs will be developed following the implementation of the surface water sampling, in cooperation with EPA and its partners, and will be documented as an interim deliverable prior to the baseline HHRA.

3.4.2 Sediment Exposure Point Concentrations

Sediment data collected during Round 1 and any subsequent investigations will be used to estimate the EPCs for sediment. Historic data of confirmed quality that meet the DQOs for historic data will also be used to estimate EPCs for sediment. Within the Site, EPCs will be estimated for exposure areas based on the types of populations potentially exposed. Since potentially complete exposure pathways for sediment involve direct contact with beach sediments, only beach sediment data will be used in estimating EPCs for direct exposure pathways. Because exposure is not homogeneous within each of the exposure areas, it is anticipated that all available sediment data within an exposure area will be used to estimate the EPCs. The process to estimate EPCs for each receptor is described below.

3.4.2.1 Dockside Workers

Areas where dockside workers could potentially be exposed to beach sediments are shown in Figures 1a, 1b, and 1c. Sediment data from these areas will be used to estimate the EPCs for dockside workers. For dockside workers, the exposure area is considered to be the industrial site where the worker is employed. Therefore, EPCs will be estimated for each individual industrial site within the dockside worker use areas for beach sediment samples collected within the property boundaries. If the beach area extends across multiple facilities, the EPCs will be estimated for the beach area and those EPCs will be used to evaluate the dockside workers at each of the facilities.

3.4.2.2 Transients

Areas where transients could potentially be exposed to beach sediments are shown in Figures 1a, 1b, and 1c. Although transients are anticipated to move throughout the Site, some may spend a majority of their time at only one of the identified areas. Therefore, EPCs for transients will be estimated for each beach area within the transient use areas. Additional information and review of Round 1 data may indicate that it is appropriate to combine data from more than one beach to develop EPCs for transients. If so, a separate evaluation using the combined EPCs will also be presented in the baseline HHRA.

3.4.2.3 Recreational Beach Users

Areas where recreational beach users could potentially be exposed to beach sediments are shown in Figures 1a, 1b, and 1c. Sediment data from these areas will be used to estimate the EPCs for recreational beach users. For recreational beach users, the exposure area is considered to be one river beach area, which represents a conservative assumption for the HHRA. Therefore, EPCs will be estimated for individual beaches within the recreational beach use areas. Additional information and review of Round 1 data may indicate that it is appropriate to combine data from more than one beach to develop EPCs for recreational beach users. If so, a separate exposure evaluation using the combined EPCs will also be presented in the baseline HHRA.

3.4.2.4 Fishers

Bank fishing may occur at beaches with unrestricted access throughout the Site. As discussed in Section 3.1.1, beaches with unrestricted access have been identified as recreational or transient beaches. Therefore, sediment data from the recreational and transient beaches will be used to estimate the EPCs for fishers. For fishers, the exposure area is considered to be one river beach area, which represents a conservative assumption for the HHRA. Therefore, EPCs will be estimated for each individual beach area within the fisher use areas. Additional information and review of Round 1 data may indicate that it is appropriate to combine data from more than one beach to develop EPCs for recreational fishers. If so, a separate evaluation using the combined EPCs will also be presented.

3.4.3 Tissue Exposure Point Concentrations

Data from uncooked fish and shellfish samples collected during Round 1 and any subsequent investigations will be used to estimate the EPCs for tissue. Historic tissue data selected for use in the HHRA (see Section 2.1) will also be used to estimate EPCs for tissue. EPCs will be estimated only for individual fish and shellfish species that are consumed by fishers in the area. EPCs for fish will be calculated for both fillets and whole bodies.

EPCs for tissue will be estimated both for individual sampling locations and for the entire Site. EPCs will be estimated by location for crayfish, by river mile for bass (due to their small home range), and by fishing zone (defined as RM 3-6 and RM 6-9, representing the upper and lower ends of the ISA) for carp, crappie, and bullhead, since these fish have larger home ranges than bass. Site-wide EPCs will also be estimated for each species.

3.4.4 Incorporation of Non-detects in EPCs

In estimating EPCs for surface water and sediment, one-half the detection limit will be used as a proxy concentration for non-detects where it is reasonably likely that a COPC is present. If a COPC is not detected in any sample for a given medium, then it will be assumed that the COPC is not present in that medium. If a chemical is not detected in a given medium and the detection limit is above the risk-based screening level (or, if a risk-based screening level is not available, the analytical concentration goal for protection of human health), potential risks associated with the inability to detect the COPC will be discussed qualitatively in the baseline HHRA.

For non-detects in tissue samples, EPCs will be estimated according to the rules from the CRITFC study (EPA 2002b), which are as follows:

1. If a chemical is not detected in any sample for a given species and sample type (i.e., fillet or whole body), it will be assumed to not be present and will not be evaluated.

2. If a chemical is detected at least once in samples for a given species and sample type, a concentration equal to one-half the detection limit will be assumed for values reported as not detected when estimating the EPC.

Due to the smaller home range of bass, EPCs will be based on detections by river mile for bass. If a chemical is detected in a bass in a given river mile, then one-half the detection limit will be used for non-detects in bass for that chemical in that river mile. If that chemical is not detected in bass in other river miles, that chemical will be assumed to not be present in those river miles. EPCs will be calculated for bass throughout the Site based on chemicals detected within each river mile only. One-half the detection limit will not be used for non-detects if the chemical was not detected in any bass collected in a specific river mile.

For carp, crappie, and bullhead, EPCs for fishing zones will be based on detections for each zone, but EPCs for the Site will be based on detections throughout the Site. If a chemical is detected in carp, crappie or bullhead in one fishing zone (RM 3-6 or RM 6-9) but not the other, then one-half the detection limit will be used for non-detects in calculating the EPC for that fishing zone, but an EPC will not be calculated for the fishing zone in which the chemical was not detected. For EPCs calculated for the ISA, one-half the detection limit will be used for non-detects of chemicals that are detected in either fishing zone for a particular species and sample type, due to the potential for these fish to visit at least part of both zones.

Dioxins/furans and PCB congeners will be treated like individual chemicals and will be addressed using the rules above.

3.4.5 Chemical-Specific Assumptions

In general, the EPC used in calculating the daily intakes will be based on the detected concentration of the COPC in the medium under evaluation using the approach presented above. However, for certain chemicals, the EPC used in the daily intake will be derived from the detected concentration and chemical-specific assumptions, as described below.

3.4.5.1 Arsenic

Arsenic in tissue will initially be analyzed only as total arsenic. Toxicity data are only available for inorganic arsenic. The percent of inorganic arsenic relative to total arsenic in tissue has been reported in two previous studies in the lower Columbia River and Willamette River (Tetra Tech 1996, EVS 2000). In those studies, the percent inorganic arsenic relative to total arsenic ranged from 0.1% to 26.6%. In the lower Columbia River, the average percent inorganic arsenic was 9.1% in resident fish. In the Willamette River, the average percent inorganic arsenic was 5.3%.

Recognizing the limitations of existing analytical methods for the chemical speciation of arsenic including, but not limited to, a lack of data on the efficiencies of recovery

of arsenic species during analysis, the possible inter-conversion of arsenical species during extraction and analyses and the lack of native standard reference materials for use in determining accuracy, precision and reproducibility, the Columbia River Basin Fish Contaminant Survey (EPA 2002b) determined that a "value of 10% is expected to result in a health protective estimate of the potential health effects from arsenic in fish", based on the following reasoning:

1. The wide range found in percent inorganic arsenic among the freshwater samples of a given species in the Lower Columbia River and Willamette River studies,

2. The limited data base on concentrations of inorganic arsenic in freshwater fish,

3. The uncertainties in the toxicity and concentrations of DMA [dimethylarsenic] in fish, and

4. The uncertainties in the analytical techniques used for the chemical speciation of arsenic.

Therefore, as an initial estimate, the EPC for inorganic arsenic in the baseline HHRA will be estimated as 10% of the total arsenic detected in tissue. If the initial assumption of 10% indicates an unacceptable risk from inorganic arsenic, a value of 5% will be used in the calculation for comparison. If assuming an inorganic arsenic fraction of 5% does not result in unacceptable risk, speciation and analysis for inorganic arsenic may be done, in which case, the actual inorganic arsenic concentrations will be used to estimate the EPC.

3.4.5.2 Polychlorinated Biphenyls

Polychlorinated biphenyls (PCBs) in tissue will be analyzed as Aroclors in fillet and whole body samples and as individual PCB congeners in whole body samples only. The total PCB concentration will be estimated both by summing the individually detected Aroclors and by summing the individual PCB congeners, where the congener data are available. Both total PCB concentrations will be used in the risk assessment. Noncarcinogenic risks will be estimated using the total PCB concentrations. Carcinogenic risks will be evaluated for the total PCB and dioxin-like congener concentrations. Because total PCB concentrations include dioxin-like congeners, the concentration of dioxin-like congeners will be subtracted from the total PCB concentration to avoid "double counting". The adjusted total PCB concentration for carcinogenic risk evaluation will be equal to the total PCB concentration minus the concentration of dioxin-like PCB congeners.

The total PCB concentrations for Aroclors and congeners will be used as the EPCs for noncancer endpoints. The adjusted total PCB concentrations for Aroclors and congeners will be used as the EPCs for cancer endpoints. Cancer endpoint EPCs will also be estimated for dioxin-like PCB congeners using the 2,3,7,8-tetrachlorodibenzo-

p-dioxin (2,3,7,8-TCDD) toxic equivalent concentrations, which will be calculated by summing the dioxin-like congeners, as described in Section 4.5.

Analysis of both Aroclors and the 209 PCB congeners are being conducted on a subset of samples (whole body only) because the congener analysis may provide a more accurate measure of PCBs in environmental samples than does the Aroclor analysis. Although PCBs originally entered the environment as technical Aroclor mixtures, weathering processes may have led to changes in the congener distributions in environmental media such that they no longer closely match the technical Aroclor mixtures used as standards in the laboratory analysis, leading to inaccuracies in quantitation. In samples where both Aroclor data and data for individual congeners are available, total PCBs will be estimated for both Aroclors and congeners, and the two methods for estimating total PCBs will be compared to evaluate the uncertainty of using Aroclors to predict total PCBs. The approach that will be used to assess the toxicity of PCB congeners is discussed further in Section 4.5.

PCBs in sediments and surface water will be analyzed initially as Aroclors. Results of the Aroclor analysis will be used to identify those areas where congener analysis may be needed. If PCBs are analyzed as congeners in sediments and surface water, the EPCs for evaluation of ingestion and dermal contact will be calculated in the same manner as tissue.

3.5 PROCESS TO CALCULATE INTAKES

EPA (1989) defines exposure as "the contact with a chemical or physical agent" and defines the magnitude of exposure as "the amount of an agent available at human exchange boundaries (i.e., the lungs, gut, and skin) during a specified time period." Exposure assessments are designed to determine the degree of contact a person has with a chemical. Thus, estimating human exposure to a chemical requires information regarding the concentration of the chemical in the environmental media (air, soil, water, tissue) with which a person will come into contact and the extent of contact the person will have with the media.

Chemical-specific intake or dose will be quantified in the HHRA by estimating the chronic daily intake (CDI) for noncarcinogens or the lifetime average daily intake (LADI) for carcinogens. CDI and LADI, expressed in terms of the mass of substance taken into the body per unit body weight per unit time (mg/kg/day), will be calculated using equations based on exposure parameters that represent the duration of exposure, frequency of exposure, and other factors that affect overall chemical dose. According to EPA guidance (1989), exposure assessment will be based on the reasonable maximum exposure (RME) expected to occur under both current and future land use conditions. An exposure assessment using central tendency (CT) values, which are more representative of average exposures, will also be conducted. Rationale and/or references for each of the RME and CT values for exposure pathways that will be

quantitatively assessed are provided in the exposure factor tables for each receptor (Tables 5 through 20).

Intakes will be quantified using standard exposure equations (EPA 1989). These equations take the general form:

$$\text{CDI or LADI} = \frac{\text{EPC} * \text{IR} * \text{EF} * \text{ED}}{\text{BW} * \text{AT}}$$

Where:

EPC = Exposure point concentration
IR = Intake rate
EF = Exposure frequency
ED = Exposure duration
BW = Body weight
AT = Averaging time

3.5.1 Receptor-Specific Assumptions

Receptor-specific assumptions will be used to select exposure parameters to calculate the pathway-specific chemical intakes. Currently, site-specific values are not available for all receptors and pathways. Therefore, default values will be used where site-specific values are not available. Where default values are not available, best professional judgment based on knowledge of human uses of the Site will be used.

Exposure parameters that will be used in the HHRA to calculate the CDIs and LADIs are discussed below and presented in Tables 5 to 20. These values represent potential exposures throughout the Site and may not accurately represent potential exposures within a specific human use area. If appropriate, beach-specific values may be developed in cooperation with EPA and its partners to evaluate exposures within a given use area. Values that have not yet been determined are shown as TBD (to be determined) in the tables.

3.5.1.1 Dockside Worker

Industrial land use will be assumed only for portions of the Site that are zoned for industrial use and with river front areas where significant exposure to sediment may occur. River front areas where sediment exposure could occur are natural river beach or bank areas. These areas are not within active industrial areas of the sites. Industrial activities are assumed to continue in the future.

Exposure assumptions for the dockside worker are based on occupational exposure values from EPA and best professional judgment regarding Site uses. Operations at Portland Harbor industrial sites do not occur frequently in areas of the site where direct contact of sediment could occur. In fact, it is unlikely that workers are in direct

contact with sediments and surface water through typical industrial activities on a daily basis. Table 5 summarizes RME and CT exposure values for the dockside worker and the reference or rationale for each value.

3.5.1.2 Transients

Transient land use is assumed only for portions of the Site with riverfront access that are not also active industrial sites. Transient activities are assumed to continue in the future.

Transients may be exposed to beach sediments and surface water while utilizing river beaches. Transients may use river water as a source of drinking water and may wash clothing and equipment in the river. Exposure values for surface water are based on dermal contact and ingestion that may occur during activities involving direct contact with the river and use as a drinking water source. Tables 6 and 7 summarize RME and CT exposure values for sediment and surface water, respectively, for the transient scenario, and the reference or rationale for each value.

3.5.1.3 Recreational Beach User

Recreational beach use is assumed only for portions of the Site where recreational exposures are reasonably likely to occur. Due to the exposures assumed for this receptor, beach use will be evaluated in those areas with potential for significant, long-term, ongoing beach activities. Recreational beach users may have direct contact with beach sediments within river beach areas and with surface water while swimming or during other water activities. Recreational beach activities are assumed to continue in the future.

The temperature of river water would limit swimming activities during much of the year. Therefore, exposure to surface water is only evaluated for the summer months when swimming might occur. Exposure assumptions for the recreational beach user are based on residential exposure values from EPA and best professional judgment. The recreational beach user includes both adult and child receptors. Tables 8 and 9 summarize RME and CT exposure values for sediment and surface water, respectively, for adult recreational beach users. Tables 10 and 11 summarize child recreational beach user RME and CT values. A reference or rationale is included for each value.

3.5.1.4 Fishers

Exposure assessments for the fisher scenarios will quantitatively evaluate potential exposure to COPCs through direct contact with sediment and through consumption of fish and shellfish. Direct contact with beach sediments only occurs in river bank areas when fishing activities occur; therefore, the exposure frequency and duration values for sediments will reflect the episodic nature of fishing activities. However, for fish and shellfish consumption, it will be assumed that exposure is continuous as fishers may catch fish at the Site and then freeze them for later use. The fisher scenarios assume that children do not frequently participate in bank fishing activities,

so sediment exposure will not be evaluated for child fishers. Fish and shellfish consumption will be evaluated for both adult and child receptors.

Beach sediment exposure would only occur for fishers during bank fishing within the Site. As a result, the exposure values to evaluate beach sediment for the fishing receptors are based only on bank fishing scenarios. Fishing that occurs from docks, piers, or by boat is not included in the evaluation of beach sediment. In addition, fishing that occurs outside of the Site is not included in the evaluation. Exposure assumptions for sediment contact for fishers are presented in Tables 12 through 14.

The HHRA will use a range of fish ingestion rates for each fisher category based on both individual species and mixed diet with and without fractional intakes to evaluate risks from fish consumption. The fish consumption rates included in the HHRA will be from technically defensible studies or EPA guidance that are appropriate for Portland Harbor. The actual rates will be determined through discussions with EPA and its partners and documented through approval of the Fish Ingestion Technical Memorandum (submitted as draft in Kennedy/Jenks Consultants 2003b) no later than 1 February 2004. Once approved, the fish ingestion rates will become part of the Work Plan and will be used in the HHRA unless additional information becomes available prior to the HHRA. In the case that additional information does become available, it will be discussed with EPA and its partners as to if and how it will be used in the HHRA.

The parameters and intake equations that will be used to evaluate fish and shellfish ingestion are presented in Tables 15 through 20.

4.0 TOXICITY ASSESSMENT

The toxicity assessment will weigh available evidence regarding the potential for particular COPCs to cause adverse health effects and to provide, where possible, a quantitative estimate of the relationship between the extent of exposure to a chemical and the increased likelihood of adverse effects. Toxicity assessment will be accomplished in two steps: hazard identification and dose-response assessment.

Hazard identification is defined as the process of determining whether human exposure to a substance is associated with an increase in the incidence of an adverse health effect. This also involves characterizing the nature and strength of the evidence of causation (NAS 1983).

Dose-response assessment is the process of characterizing the relationship between the dose of a substance and the likelihood of an adverse effect on the exposed population (Preuss and Ehrlich 1987). Although there are some data on human exposures, the bulk of available information about human dose-response relationships is based on data collected from animal studies. The highest degree of uncertainty identified with most health risk assessments is associated with the extrapolation of results obtained from animals tested at high doses to the low doses encountered by humans in the environment.

4.1 SOURCES OF TOXICITY VALUES

Toxicity values that describe the relationship between exposure to a chemical and the associated increased likelihood of adverse effects will be compiled. The following hierarchy of sources of toxicity values currently recommended for use at Superfund sites will be used in the baseline HHRA to evaluate the potential (relative) hazard of the COPCs identified at the Site:

- Integrated Risk Information System (IRIS) database (EPA 2003) is the preferred source of information because it contains the most recent toxicity values extensively reviewed by EPA.
- Health Effects Assessment Summary Table (HEAST) (EPA 1997b) will be consulted if a toxicity value is not available on IRIS. EPA compiled these values for use in risk assessments; however HEAST values are not as rigorously reviewed as those presented in IRIS.
- EPA's National Center for Environmental Assessment (NCEA) values are recommended for use when values are not available in IRIS or HEAST. The EPA Region 9 PRG Table provides a source of NCEA values (EPA 2002a). Other EPA documents or databases will be used when appropriate.

- Agency for Toxic Substances and Disease Registry (ATSDR) Toxicological Profiles and Minimal Risk Levels offer toxicity value information. These values would only be used in the absence of information from the above sources.

If an alternative hierarchy of toxicity values is recommended for use at the time of the baseline HHRA, that alternative hierarchy will be used to select toxicity values.

In those instances when toxicity values are not available for a COPC from the sources above, alternative toxicity values may be derived if the COPC is thought to contribute to risk. This evaluation will be performed on a chemical-specific basis. One possible methodology for selecting alternative toxicity values is the use of reference doses and slope factors of structurally similar compounds as surrogates. For example, the reference dose for naphthalene is generally used for methylnaphthalenes in the absence of other human health toxicity values and for some of the combinations of polycyclic aromatic hydrocarbons (PAHs). If an alternative toxicity value is considered, the derived toxicity values will be submitted to EPA for evaluation prior to the baseline HHRA. If an alternative toxicity value is not available, the potential risks associated with the COPC will be discussed qualitatively in the baseline HHRA.

4.2 CHEMICALS OF POTENTIAL CONCERN WITH NONCARCINOGENIC EFFECTS

A chemical that exhibits adverse effects other than cancer or mutation-based developmental effects is believed to have a threshold (i.e., a dose below which no adverse effect is expected to occur). For chemicals with noncarcinogenic effects, EPA has established reference doses (RfDs) for oral exposures based on animal data and epidemiological studies. A chronic RfD is defined as a daily dose to which humans, including sensitive subpopulations, may be exposed throughout their lifetimes without adverse health effects. The chronic RfD will be used in the baseline HHRA as the toxicity endpoint for COPCs with noncarcinogenic effects.

4.3 CHEMICALS OF POTENTIAL CONCERN WITH CARCINOGENIC EFFECTS

A chemical that exhibits carcinogenicity is generally considered by EPA to have no threshold because EPA believes there is no level of exposure to such a chemical that does not pose a finite probability, no matter how slight, of generating a carcinogenic response (EPA 1989). Therefore, in the absence of chemical-specific information related to the mechanism of carcinogenesis, an effect threshold cannot be estimated. For carcinogenic effects, the evaluation of a chemical involves two components: 1) a qualitative determination of the likelihood of it being a human carcinogen and 2) a quantitative assessment of the relationship between exposure dose and response.

4.3.1 Qualitative Characterization of Hazard

Under current EPA risk assessment guidelines (EPA 1986), candidate chemicals are classified into one of the following groups using a weight-of-evidence approach, based on animal and epidemiological studies (EPA 1989):

- Group A: human carcinogen (sufficient evidence of carcinogenicity in humans)
- Group B: probable human carcinogen
    - B1: limited evidence of carcinogenicity in humans
    - B2: sufficient evidence of carcinogenicity in animals with inadequate evidence in humans
- Group C: possible human carcinogen (limited evidence of carcinogenicity in animals, no evidence in humans; absence of human data)
- Group D: not classifiable as to human carcinogenicity (inadequate or no evidence)
- Group E: evidence of noncarcinogenicity for humans (no evidence of carcinogenicity in adequate studies)

Under the more recent draft EPA risk assessment guidelines (EPA 1999), standardized descriptors are applied to candidate chemicals for each route of exposure using a weight-of-evidence approach, based on animal and epidemiological studies:

- "Carcinogenic to humans"
- "Likely to be carcinogenic to humans"
- "Suggestive evidence of carcinogenicity, but not sufficient to assess human carcinogenic potential"
- "Data are inadequate for an assessment of human carcinogenic potential"
- "Not likely to be carcinogenic to humans"

The baseline HHRA will provide a weight-of-evidence evaluation of carcinogenic COPCs. Where available, the baseline HHRA will present the weight-of-evidence classification of COPCs using both the current and draft EPA guidelines.

4.3.2 Quantitative Assessment of Dose Response

Slope factors (SFs) are used to quantify the response potency of a potential carcinogen. The SF is an upper-bound estimate of the probability of a response over a

lifetime. SFs are derived from either human epidemiological or animal studies by applying a mathematical model to the data set to extrapolate from the high doses in studies to the lower exposure levels expected for human contact in the environment (EPA 1989). The SF will be used in the baseline HHRA as the toxicity endpoint of carcinogenic COPCs.

4.4 DIOXINS AND FURANS

Currently, EPA has no recommended SFs for polychlorinated dioxin and furan congeners other than 2,3,7,8-TCDD. EPA recommends use of toxic equivalency factors (TEFs) to evaluate carcinogenic effects of the other dioxin and furan congeners (Table 22). Concentrations of congeners are multiplied by their TEFs to estimate the toxicity of these congeners relative to 2,3,7,8-TCDD; the resulting concentrations may be summed into a total 2,3,7,8-TCDD toxic equivalent concentration. Currently, EPA is in the process of revising the recommended TEFs based on the alternative World Health Organization (WHO) TEFs. The WHO TEFs are shown in Table 22. The most current, defensible, TEFs available during the risk assessment process will be used in the baseline HHRA to estimate cancer risks associated with dioxins and furans.

Dioxin and furan congeners that are not detected will be evaluated using the same process described in Section 3.4.4 for estimating EPCs. If, by following the rules for non-detects, a congener is assumed to not be present, it will not be included in summing the total 2,3,7,8-TCDD toxic equivalent concentration. Otherwise, one-half the detection limit will be used for the non-detected congener in summing the total 2,3,7,8-TCDD toxic equivalent concentration.

4.5 POLYCHLORINATED BIPHENYLS

According to EPA recommendations for the human health effects of PCBs (EPA 1996, 2000c), coplanar PCB congeners that exhibit dioxin-like toxicity have been assigned dioxin TEFs. These congeners will be treated like dioxin and furan congeners and will be summed into a total 2,3,7,8-TCDD toxic equivalent concentration.

Coplanar PCB congeners that are not detected in the analysis will be evaluated using the process described in Section 3.4.4 for estimating EPCs. If, by following the rules for non-detects, a congener is assumed to not be present, it will not be included in summing the total 2,3,7,8-TCDD toxic equivalent concentration. Otherwise, one-half the detection limit will be used for the non-detected congener in summing the total 2,3,7,8-TCDD toxic equivalent concentration.

Dioxin-like PCB congeners only represent a fraction of total PCBs. Therefore, carcinogenic effects will also be assessed for adjusted total PCBs, which will not include the dioxin-like PCB congeners, as described in Section 3.4.5.2. SFs for total PCBs have been developed based on Aroclor toxicity using a tiered approach. Because several of the exposure pathways being evaluated in the baseline HHRA are classified under the tier of High Risk and Persistence, the most conservative upper-bound slope factor of 2.0 per milligram per kilogram per day will initially be used as the toxicity endpoint (EPA 2003). As discussed in Section 3.4.4, adjusted total PCBs will be calculated for both Aroclors and individual congeners, where data are available.

Estimated adverse noncancer health effects are generally assessed using RfDs available for PCB mixtures. RfDs are currently available in IRIS for Aroclor 1016 and Aroclor 1254. Because environmental mixtures of PCBs found in Site sediments and biota are likely to more closely resemble the more highly chlorinated Aroclor 1254 mixture as opposed to the Aroclor 1016 mixture, the Aroclor 1254 RfD will be used to evaluate noncancer effects of total PCBs. Noncancer health effects will be evaluated for total PCBs calculated both for Aroclors and individual congeners, where data are available.

4.6 DERMAL TOXICITY ASSESSMENT

Most toxicity values are based on oral, not dermal, exposures. For oral exposures, toxicity values are often expressed as the amount of substance administered, whereas dermal exposures are expressed as absorbed dose. EPA has developed a simplified method for oral-to-dermal extrapolations (EPA 2001b). These extrapolations involve an adjustment to the oral toxicity value based on the gastrointestinal (GI) absorption factor of the specific chemical in the same administration vehicle (e.g., corn oil, food) as used in the critical toxicity study to derive an estimated dermal dose.

As recommended by EPA guidance (EPA 2001b), an adjustment to the oral toxicity factor to account for the estimated absorbed dose will be applied in the baseline HHRA when the following conditions are met:

- The toxicity value derived from the critical study is based on an administered dose (e.g., through diet or by gavage)
- A scientifically defensible database demonstrates the GI absorption of the chemical is less than 50% in a medium similar to the one used in the critical study.

If both of these conditions are met, the oral toxicity factor will be adjusted to reflect the absorbed dose in the baseline HHRA. For carcinogenic effects, the oral slope factor will be divided by the GI absorption factor to estimate the dermal slope factor.

For noncarcinogenic effects, the oral reference dose will be multiplied by the GI absorption factor to estimate the dermal reference dose.

If both conditions for adjustment are not met, the oral toxicity value will be used as a surrogate for the dermal toxicity value in the baseline HHRA.

5.0 RISK CHARACTERIZATION

Risk characterization integrates the information from the exposure assessment and toxicity assessment, using a combination of qualitative and quantitative information. With this information, risk characterization estimates the potential health risk based on the dose of a chemical that a person may receive under certain site-specific exposure conditions and the toxicity of that chemical. To characterize potential noncarcinogenic effects, comparisons will be made between projected intakes of substances and toxicity values. To characterize potential carcinogenic effects, projected intakes and chemical-specific, dose-response data will be used to estimate the probability that an individual will develop cancer over a lifetime of exposure.

This section describes how estimates for noncancer and cancer health risks will be estimated in the baseline HHRA.

5.1 NONCANCER HAZARD ESTIMATES

The potential for adverse effects resulting from exposure to chemicals with noncarcinogenic effects is generally addressed by comparing the COPC-specific chronic daily intake (CDI) or absorbed dose to its RfD. This comparison will be made by calculating the ratio of the estimated CDI (or absorbed dose) to the corresponding RfD to yield a hazard quotient (HQ):

$$HQ = \frac{CDI}{RfD}$$

HQs for individual chemicals are summed to yield hazard indices (HIs) that provide a conservative estimate of total hazard.

HQs will be presented separately for each receptor population that is carried through the risk evaluation process. Each receptor scenario (e.g., recreational beach users and fishers) is evaluated separately. The receptor-specific HQs then will be summed across chemical and exposure pathways. Separate HIs for different types of adverse health effects will be calculated only if the overall HIs exceed 1. Separate HIs will not be calculated if most of the HI value is attributable to a single chemical.

Estimated hazard indices will be compared to a hazard index of 1, below which remedial action at a Superfund site is generally not warranted.

5.2 CANCER RISK ESTIMATES

Potential cancer risks will be assessed by multiplying the estimated lifetime average daily intake (LADI) or absorbed dose of a carcinogen by its SF. This calculated risk is

expressed as the probability of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen and is an estimated upper bound, incremental probability of excess individual lifetime cancer risk.

$$Risk = LADI * SF$$

Initially, potential cancer risks will be estimated separately for exposure to each chemical for each exposure pathway. The separate potential cancer risk estimates will be summed across chemicals and across all exposure pathways to obtain the total-potential-excess lifetime cancer risk for the potentially exposed population.

Estimated total cancer risks will be compared to a 10^{-4} to 10^{-6} risk range, which is the "target range" within which the EPA strives to manage risk as a part of the Superfund program. Estimated cancer risks will be compared to the DEQ acceptable risk levels of 1×10^{-6} for individual carcinogens and 1×10^{-5} for total cancer risks.

5.3 EVALUATION OF OVERLAPPING SCENARIOS

As discussed in Section 3, certain individuals may be exposed to COPCs at the Site through different receptor categories, such as a recreational beach user who is also a recreational fisher. The baseline HHRA will evaluate the significance of potential overlapping exposures to the total risk for an individual in a given receptor group who might have overlapping exposures. This approach, and its potential impact on risk estimates, will be discussed further in the uncertainty assessment.

6.0 UNCERTAINTY ANALYSIS

The HHRA will include a detailed discussion of uncertainties associated with each step of the risk assessment. The discussion will focus on issues likely to have the greatest effects on the results of the risk analyses. In this discussion, conclusions about hazard and dose response are evaluated in the context of the uncertainties associated with each aspect of the assessment. This section will focus on issues of variability and uncertainty associated with each of the parameters used in the risk estimates.

Variability arises from true heterogeneity in characteristics such as dose-response differences within a population, or differences in contaminant levels in the environment. The values of some variables used in an assessment change with time and space, or across the population whose exposure is being estimated. The uncertainty section will address the resulting variability in doses received by members of the target populations. Use of RME and CT scenarios provide an estimate of high-end and average exposures that may reasonably occur. The difference between the RME and CT risk estimates provides an initial evaluation of the degree of variability in exposure between individuals.

Uncertainty, on the other hand, represents lack of knowledge about factors such as adverse effects or chemical concentrations. Uncertainty may be reduced with additional study. A substantial amount of uncertainty is often inherent in environmental sampling as well as in the scientific models used in risk assessment.

The uncertainty analysis will include a discussion of variability and uncertainty in each of the parameters used in the risk estimates. Each risk estimate generated in the Risk Characterization Section will be presented with its associated variability and uncertainty. For example, the discussion will address those chemicals not detected but with detection limits above risk-based screening levels and a discussion of those COPCs for which no toxicity data are available.

In addition, the uncertainty analysis may include a probability assessment using Monte Carlo simulation, which provides a means to better characterize the variability and uncertainty in the risk estimates. If conducted, the methods for the probability assessment will be developed through discussion with EPA and its partners and will be consistent with EPA guidance (EPA 2001c).

If the uncertainty assessment indicates that the baseline HHRA includes a high-degree of uncertainty, the need for additional data collection will be considered. If additional data are collected to address the uncertainty, the baseline HHRA will be refined to incorporate those data.

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Attachment A

Conversation Logs

Conversation Log **Kennedy/Jenks Consultants**

Contact Name:	Mr. Bud Hartman
Affiliation:	President of Pan Fish Association, Portland, OR
Referred by:	John Crellin, ATSDR
Telephone Number:	503-253-5631

Date of Conversation:	19 March 2002
Conducted by:	Bill Williams, PhD (Kennedy/Jenks Consultants)

Summary of Verbal Discussion:

At the suggestion of John Crellin (ATSDR), a "coffee and cheesecake" meeting was held with Bud Hartman on Tuesday, 19 March 2002, to learn about recreational fishing practices and fishing areas associated with the Portland Harbor area. He is a wealth of information about fish species in the area, local habitats preferred by each species, spatial movement of "resident" species, best times for catching specific fish species, general fishing habits of specialized populations that fish the Willamette River (Asians, Eastern Europeans, etc) and other valuable information that may be used in the Human Health Risk Assessment (HHRA). Bud and some of his fishing associates helped catch fish for the Oregonian fish tissue study and he has a reasonably good understanding of the issues associated with fish sampling and collection for scientific studies.

Some of the discussions are summarized in the bullets below:

- Local area residents tend to fish in the entire River area, moving up and down the River as appropriate. This designation includes, but is not limited to, the current designated ISA.

- The most predominant (resident) pan fish caught for food by local anglers are bass and crappie. The numbers of these fish caught far outnumber the other species caught for food. However, local anglers also fish for walleye, sturgeon, pike minnow,

- Numerous areas within the current ISA are especially favored by many local fishers, depending on the species, season, and perceived habitats for some fish species (many species tend to have favorite areas where they feed and congregate) and most local fishers know of these areas. Some favorite areas for pan fish include the piers, pilings, and other areas where predator fish tend to forage. Some resident anglers have been known to use the areas in terminals and other areas where the water is slow moving or still.

Conversation Log

Summary of Verbal Discussion - *cont'd:*

- Several local populations (Asian and Euro Americans) fish for and consume just about any fish in the River. Some of these populations probably use the River as much or more than the local anglers.
- Local Native Americans have several specialized uses of the River, especially the collection of lamprey near the base of the Willamette Falls at Oregon City. Bud suggested that this is a well-known fact among local fishers.
- Some fishers tend to consume more of the fish they catch than others (especially the Asian and European Americans). Generally, however, it is common practice among the local anglers to eat only the fillets from any fish.
- Angling for Salmon is generally dependent on several factors dictated by ODF&W and the US FWS staff. Salmon fishing in the River tends to be at numerous areas, but is often concentrated upstream of the ISA near the Falls and downstream near the confluence with the Columbia River. These areas are often covered with dozens of anglers (boats) tied within a very small area.

Action Items:

- Continue to communicate with Bud and consider him as a resource to support the fish collection for tissue analysis.
- Collate information he provided for use in the HHRA.

Conversation Log

Contact Name:	Mr. Ralph Steele
Affiliation:	Owner of Lure-em Tackle Shop, Portland, OR
Referred by:	John Crellin, ATSDR
Telephone Number:	503-762-1273

Date of Conversation:	8 April 2002
Conducted by:	Bill Williams, PhD (Kennedy/Jenks Consultants)

Summary of Verbal Discussion:

At the suggestion of John Crellin (ATSDR), a telephone conversation was held with Mr. Steele on 8 April 2002 to learn about his understanding of the recreational fishing practices and fishing areas associated with the Portland Harbor area. He is very well versed in the fishing practices in the Willamette River, and the fishing that occurs in the general area of the ISA. Mr. Steele is very knowledgeable about the fishing practices in the region and is particularly versed in the species of fish and the areas preferred by local fishers. His interactions with local fishers has resulted in some interesting and useful understanding of the relative movement of "resident" species, and the best times for catching specific fish species. He also appears to be generally familiar with the fishing practices of local populations of Asian Americans and Eastern European Americans. Mr. Steele appears to have a reasonably good understanding of the issues associated with potential for contamination to fish in the area and expressed his concern that there remains a significant potential for upstream impacts on the contaminant levels of fish caught in the area.

Many of the comments made by Mr. Steele are similar to those gleaned from earlier discussions with Mr. Bud Harman (March 19,2002).

Some of the discussions are summarized in the bullets below:

- Local area residents tend to fish in the entire River area, moving up and down the River as appropriate. This designation includes, but is not limited to, areas located within the current designated ISA.

- Bass and crappie are the most predominant (resident) fish caught by local anglers. The numbers of these fish caught far outnumber the other species caught both for release and for food. However, local anglers also catch fish for walleye, sturgeon, and pike minnow. Fishing for salmon is one of the largest recreational fishing efforts by"local" fishers.

- Several local populations (Asian and Euro Americans) fish for and consume just about any fish in the River. Some of these populations probably use the River as much or more than the local anglers.

- Mr. Steele indicated that it is well known that local Native Americans have several

Conversation Log

Summary of Verbal Discussion - *cont'd:*

specialized uses of the River, especially the collection of lamprey near the base of the Willamette Falls at Oregon City.

- Some of the preferred fishing areas in the River include areas near piers, pilings, and other deep water areas.
- Some fishers tend to consume more of the fish they catch than others (especially the Asian and European Americans, who tend to eat almost the entire fish). Generally, however, it is common practice among the local recreational anglers to eat only the fillets from any fish.
- Salmon fishing in the River occurs at numerous areas, but is often concentrated upstream of the ISA near the Falls and downstream near the confluence with the Columbia River. These areas are often covered with dozens of anglers (boats) tied within a very small area.
- Collection of crawfish occurs in the River, but the exact areas of concentrated collection of crawfish are not known to Mr. Steele.

Action Items:

- Continue to communicate with Mr. Steele and consider him as a resource to support the fish collection for tissue analysis.
- Collate information he provided for possible use in the HHRA.

Table 1
Selection of Exposure Pathways

Scenario Timeframe	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Surface Water	Dockside Worker Use Areas	Dockside Workers	Adult	Ingestion	None	Ingestion of water would be unintentional and infrequent
					Dermal	None	Contact with water would be unintentional and infrequent
		Transient Use Areas	Transients	Adult	Ingestion	Quant.	Transients may ingest water, but further evaluation of significance required
					Dermal	Quant.	Transients may contact water, but further evaluation of significance required
		Recreational Beach Use Areas	Recreational Beach User	Adult	Ingestion	Quant.	Beach users may inadvertantly ingest water while swimming, but further evaluation of significance required
					Dermal	Quant.	Beach users may use river for swimming, but further evaluation of significance required
		Fishing Use Areas	Recreational Fisher	Adult	Ingestion	None	Ingestion of water while fishing anticipated to be negligible
					Dermal	None	Contact with water while fishing anticipated to be negligible
		Fishing Use Areas	Native American Fisher	Adult	Ingestion	None	Ingestion of water while fishing anticipated to be negligible
					Dermal	None	Contact with water while fishing anticipated to be negligible
		Fishing Use Areas	Non-tribal Fisher	Adult	Ingestion	None	Ingestion of water while fishing anticipated to be negligible
					Dermal	None	Contact with water while fishing anticipated to be negligible
	Sediment	Dockside Worker Use Areas	Dockside Workers	Adult	Ingestion	Quant.	Workers may contact sediment while conducting activities in river beaches
					Dermal	Quant.	Workers may contact sediment while conducting activities in river beaches
		Transient Use Areas	Transients	Adult	Ingestion	Quant.	Transients may contact sediment while residing on river banks
					Dermal	Quant.	Transients may contact sediment while residing on river banks
		Recreational Beach Use Areas	Recreational Beach User	Adult	Ingestion	Quant.	Recreational beach users may contact sediment in beach areas
					Dermal	Quant.	Recreational beach users may contact sediment in beach areas
				Child	Ingestion	Quant.	Recreational beach users may contact sediment in beach areas
					Dermal	Quant.	Recreational beach users may contact sediment in beach areas
		Fishing Use Areas	Recreational Fisher	Adult	Ingestion	Quant.	Fishers may contact sediment, but further evaluation of significance required
					Dermal	Quant.	Fishers may contact sediment, but further evaluation of significance required
		Fishing Use Areas	Native American Fisher	Adult	Ingestion	Quant.	Fishers may contact sediment, but further evaluation of significance required
					Dermal	Quant.	Fishers may contact sediment, but further evaluation of significance required
		Fishing Use Areas	Non-tribal Fisher	Adult	Ingestion	Quant.	Fishers may contact sediment, but further evaluation of significance required
					Dermal	Quant.	Fishers may contact sediment, but further evaluation of significance required
	Tissue	Resident Fish and Shellfish in ISA	Recreational Fisher	Adult	Ingestion	Quant.	Chemicals in sediment and water may accumulate in fish and shellfish tissue
				Child	Ingestion	Quant.	Chemicals in sediment and water may accumulate in fish and shellfish tissue
			Native American Fisher	Adult	Ingestion	Quant.	Chemicals in sediment and water may accumulate in fish and shellfish tissue
				Child	Ingestion	Quant.	Chemicals in sediment and water may accumulate in fish and shellfish tissue
			Non-tribal Fisher	Adult	Ingestion	Quant.	Chemicals in sediment and water may accumulate in fish and shellfish tissue
				Child	Ingestion	Quant.	Chemicals in sediment and water may accumulate in fish and shellfish tissue

Table 2
Home Ranges of Resident Fish Species in the Lower Willamette River that may be consumed by Human Receptors

Species	Estimated Home Range (miles)
Largescale Sucker	0.5-10 (LaVigne 2002)
White Crappie	<0.1-31 (Ward, et al. 1991)
Black Crappie	5.4 (Scott and Crossman 1973), 2-7 (Ward, et al. 1991)
Smallmouth Bass	0.5-5 (some up to 30) (Scott and Crossman 1973). In the LWR average 0.87 mi., range <0.1-6.7 mi. (North et al. 2002)
Largemouth Bass	less than 5 (Scott and Crossman 1973)
Bluegill	28 meters (0.02 miles) (Species Information Library)
Nothern Pikeminnow	0.5-6 (Isaak and Bjornn). In the LWR average 0.87mi., range <0.1-13.4 mi. (North et al. 2002). Note: in this study, fish may have traveled much farther because several fish were not recaptured.
Common Carp	Spawning migrations (may be long distance) (Panek 1987)
Yellow Bullhead	Local spawning and forage migrations (Scott and Crossman 1973)
Brown Bullhead	<0.1 to 16 (Scott and Crossman 1973)
Channel Catfish	<0.1-99 (Scott and Crossman 1973)
Walleye	3-5 (some up to 100) (Scott and Crossman 1973). In the LWR average 3.9 mi., range <0.1-9.7 mi. (North et al. 2002)
Yellow Perch	<0.1-62 (Indiana Department of Natural Resources 2000)

Table 3
Summary of Tissue Data for Tissue Target Analytes from Resident Fish in the Lower Willamette River

Species	Arsenic	Chromium	Copper	Lead	Mercury	Zinc	2,3,7,8-TCDD	Aroclor 1254	Aroclor 1260	Aldrin	a-Chlordane	aHCH	Dieldrin	g-Chlordane	gHCH	Heptachlor	Heptachlor Epoxide	DDE	DDD	DDT
	ppm	ppm	ppm	ppm	ppm	ppm	ppt	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
Wet Weight																				
Black Crappie					0.013-0.52						0.47-0.88		0.95-2.7	0.24-0.37	0.09-0.18			14-130	3-11	1.8-15
Chiselmouth					0.04-0.13															
Common Carp					0.054-0.49						2.5-8.2		3.2-4.6	4.2				25-85	7.2-37	3.3-16
Largemouth Bass					0.16-0.5															
Largescale Sucker		0.2-0.55	0.053-0.5		0.013-36	3.6-7.4														
Northern Pikeminnow					0.8															
Peamouth					0.05-0.17															
Smallmouth Bass					0.11-0.54					2	0.5-3.8	2	1.34-3.6	0.25-2	0.19-2	2	2	15-450	2.2-32	2.5-79
Sucker					0.05-0.35															
White Crappie					0.23															
Dry Weight																				
Common Carp		0.04	0.13-0.78	0.03	0.11-0.2	8.7-14.6	7	160-360	25-1403			4	10-352		2			12-268	2-144	5-216
Largemouth Bass							0.74													
Largescale Sucker							2.25													
Northern Pikeminnow	0.03		0.24-0.57	0.03	0.21-0.34	7.3-16.4	0.8-1.89	200	96-209		10	4						52-130	20	10
Peamouth	0.06-0.07		0.5-0.59	0.05-0.08	0.04-0.05	17.5-17.6		10-100	100		10		10					30	10	10
Bass			0.23		0.1	5.8														
Sucker			0.27		0.05	5.64						7.17			18.6			37.1		

2,3,7,8-TCDD: 2,3,7,8-Tetrachlorodibenzo-p-dioxin
aHCH: alpha-Hexachlorocyclohexane
gHCH: gamma-Hexachlorocyclohexane (Lindane)

Tissue data compiled from the following studies of the lower Willamette (not necessarily within the ISA):
DEQ 1994.
DEQ 2000.
EPA 1992.
Hart Crowser, Inc. 1988.
Oregonian 2000.
PTI 1992.
Bonn 1998.

Table 4
Selected Target Fish Species for the Human Health Risk Assessment

Family/Species of Resident Fish	Common Name	Selected Target Species	Rationale for Inclusion or Exclusion
Salmonidae			
Prosopium williamsoni	Mountain Whitefish		Not common in the LWR (Hughes and Gammon 1987, TetraTech 1995, Farr and Ward 1993) and no indication of significant human consumption (ATSDR 2002, Adolfson 1996, Hartman 2002, Steele 2002).
Catostomidae			
Catostomus macrocheilus	Largescale Sucker		May be consumed (ATSDR 2002), but not a preferentially consumed species (Hartman 2002, Steele 2002). Sucker is a bottom-feeder similar to carp, which is a target species. Previous studies indicate similar bioaccumulation potential as carp (Table 3)
Catostomus platyrhynchus	Mountain Sucker[2]		No indication of significant human consumption (ATSDR 2002, Adolfson 1996, Hartman 2002, Steele 2002).
Centrarchidae			
Pomoxis annularis	White Crappie[1]		Home range of white crappie may be larger than ISA (Table 2) and limited bioaccumulation data are available (Table 3). Similar to black crappie, which is a target species.
Pomoxis nigromaculatus	Black Crappie[1]	X	One of most consumed fish species by recreational/non-tribal fishers (ATSDR 2002, Hartman 2002 Steele 2002) Potential for bioaccumulation from previous studies (See Table 3) Limited home range (Table 2) Recommended predator target species (EPA 2000c) Abundant species (ATSDR 2002)
Micropterus dolomieui	Smallmouth Bass[1]	X	One of most consumed fish species by recreational/non-tribal fishers (ATSDR 2002, Hartman 2002 Steele 2002) Potential for bioaccumulation from previous studies (See Table 3) Limited home range, in general (Table 2) Recommended predator target species (EPA 2000c) Abundant species (ATSDR 2002)
Micropterus salmoides	Largemouth Bass[1]		May be consumed (Adolfson 1996), but is not considered a commonly consumed fish in the LWR (ATSDR 2002) and limited bioaccumulation data available (Table 3). Similar to smallmouth bass, which is a target species.
Lepomis macrochirus	Bluegill[1]		May be consumed (Adolfson 1996), but is not considered a commonly consumed fish in the LWR (ATSDR 2002, Hartman 2002, Steele 2002) and is not as prevalent as bass (Farr and Ward 1993), which is a target species.
Lepomis gibbosus	Pumpkinseed[1]		No indication of significant human consumption (ATSDR 2002, Adolfson 1996, Hartman 2002, Steele 2002).
Lepomis gulosus	Warmouth[1]		No indication of significant human consumption (ATSDR 2002, Adolfson 1996, Hartman 2002, Steele 2002).
Cyprinidae			
Ptychocheilus oregonensis	Northern Pikeminnow[2]		May be consumed (ATSDR 2002), but not consumed as much as other species (Hartman 2002, Steele 2002). Due to the bounty on the pikeminnow, it is anticipated that many fish that are caught would be redeemed for a bounty rather than consumed. Also, home ra
Mylocheilus caurinus	Peamouth		No indication of significant human consumption (ATSDR 2002, Adolfson 1996, Hartman 2002, Steele 2002).
Acrocheilus alutaceus	Chiselmouth[2]		No indication of significant human consumption (ATSDR 2002, Adolfson 1996, Hartman 2002, Steele 2002).
Cyprinus carpio	Common Carp[1]	X	Preferentially consumed by certain non-tribal populations (Oregonian 2000, ATSDR 2002) Potential for bioaccumulation from previous studies (See Table 3) Potentially wide home range during spawning (Table 2) Recommended bottom-feeder target species (EPA 20
Carassius auratus	Goldfish[1]		No indication of significant human consumption (ATSDR 2002, Adolfson 1996, Hartman 2002, Steele 2002).
Richardsonius balteatus	Redside Shiner		No indication of significant human consumption (ATSDR 2002, Adolfson 1996, Hartman 2002, Steele 2002).
Rhinichthys cataractae	Longnose Dace[2]		No indication of significant human consumption (ATSDR 2002, Adolfson 1996, Hartman 2002, Steele 2002).
Fundulidae			
Fundulus diaphanus	Banded Killifish[1]		No indication of significant human consumption (ATSDR 2002, Adolfson 1996, Hartman 2002, Steele 2002).
Gasterosteidae			
Gasterosteus aculeatus	Threespine Stickleback[2]		No indication of significant human consumption (ATSDR 2002, Adolfson 1996, Hartman 2002, Steele 2002).
Ictaluridae			
Ictalurus nebulosus	Brown Bullhead[1]	X	Consumed by non-tribal fishers (ATSDR 2002) No available bioaccumulation data Limited home range (Table 3) Bottom-feeder species in target species genus *Ictalurus* (EPA 2000c) Abundant species (ATSDR 2002)
Ictalurus natalis	Yellow Bullhead[1]		Less abundant than but similar to brown bullhead, which is a target species.
Ictalurus punctatus	Channel Catfish[1]		Recommended bottom-feeder species (EPA 2000c), but difficult to capture in LWR (North et al 2002, Beak 2000). Similar to brown bullhead, which is a target species.

Table 4
Selected Target Fish Species for the Human Health Risk Assessment

Family/Species of Resident Fish	Common Name	Selected Target Species	Rationale for Inclusion or Exclusion
Percidae			
Stizostedion vitreum	Walleye		May be consumed (ATSDR 2002), but not consumed as much as other species (Hartman 2002, Steele 2002). Walleye is a predator, similar to crappie and bass, which are target species. Crappie and bass are more abundant species in the LWR (Beak 2000, Hartman 2002)
Perca flavescens	Yallow Perch[1]		May be consumed (Adolfson 1996), but is not considered a commonly consumed fish in the LWR (ATSDR 2002, Hartman 2002, Steele 2002). Home range of yellow perch may be larger than ISA (Table 2) and no bioaccumulation data are available (Table 3).
Percopsidae			
Percopsis transmontana	Sand Roller[2]		No indication of significant human consumption (ATSDR 2002, Adolfson 1996, Hartman 2002, Steele 2002).
Cottidae			
Cottus asper	Prickly Sculpin		No indication of significant human consumption (ATSDR 2002, Adolfson 1996, Hartman 2002, Steele 2002).
Cottus perplexus	Reticulate Sculpin[2]		No indication of significant human consumption (ATSDR 2002, Adolfson 1996, Hartman 2002, Steele 2002).

(1) Introduced (exotic) species
(2) Species characteristic of the West Cascades/Willamette River basin Ichthyogeographic Region (Hughes and Gammon 1987).

Fish species from ODFW- Farr and Ward (1993); North et al. (2002).

Table 5
Initial Values for Daily Intake Calculations – Dockside Worker Sediment Exposures

Scenario Timeframe: Current/Future
Medium: Sediment
Receptor Population: Dockside Worker
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	EPC	Exposure point concentration, sediment	mg/kg	TBD	–	TBD	–	Daily Intake (mg/kg-day) =
	BW	Body weight	kg	70	Recommended value for adults (EPA 1989)	70	Recommended value for adults (EPA 1989)	EPC x SIR x EF x ED x CF x 1/BW x 1/AT
	EF	Exposure frequency	days/yr	50	Best professional judgment. Equivalent to 1 day per week with direct sediment contact during 250 days/year at facility, which is recommended for occupational exposure (EPA 1991)	44	Best professional judgment. Equivalent to 1 day per week with direct sediment contact during 219 days/year at facility, which is recommended for occupational exposure (EPA 1991)	
	ED	Exposure duration	years	25	Recommended value for occupational exposures (EPA 1991)	9	Recommended value for occupational exposures (EPA 1991)	
	SIR	Sediment ingestion rate	mg/day	200	Recommended value for occupational exposures (EPA 2000a)	50	Recommended value for occupational exposures (EPA 2000a)	
	ATc	Averaging time, cancer	days	25550	Recommended value (EPA 1989)	25550	Recommended value (EPA 1989)	
	ATnc	Averaging time, noncancer	days	9,125	Recommended value (EPA 1989)	3,285	Recommended value (EPA 1989)	
	CF	Conversion Factor	kg/mg	1.E-06	–	1.E-06	–	
Dermal	EPC	Exposure point concentration, sediment	mg/kg	TBD	–	TBD	–	Daily Intake (mg/kg-day) =
	BW	Body weight	kg	70	Recommended value for adults (EPA 1989)	70	Recommended value for adults (EPA 1989)	EPC x SA x AF x ABS x EF x ED x CF x 1/BW x 1/AT
	EF	Exposure frequency	days/yr	50	Best professional judgment. Equivalent to 1 day per week with direct sediment contact during 250 days/year at facility, which is recommended for occupational exposure (EPA 1991)	44	Best professional judgment. Equivalent to 1 day per week with direct sediment contact during 219 days/year at facility, which is recommended for occupational exposure (EPA 1991)	
	ED	Exposure duration	years	25	Recommended value for occupational exposures (EPA 1991)	9	Recommended value for occupational exposures (EPA 1991)	
	SA	Skin surface area	cm2	3,300	Recommended value for adult industrial scenario (EPA 2001b)	3,300	Recommended value for adult industrial scenario (EPA 2001b)	
	AF	Adherence factor	mg/cm2	0.2	Recommended value for adult industrial scenario (EPA 2001b)	0.02	Recommended value for adult industrial scenario (EPA 2001b)	
	ABS	Absorption factor	–	See Table 21	–	See Table 21	–	
	ATc	Averaging time, cancer	days	25550	Recommended value (EPA 1989)	25550	Recommended value (EPA 1989)	
	ATnc	Averaging time, noncancer	days	9,125	Recommended value (EPA 1989)	3,285	Recommended value (EPA 1989)	
	CF	Conversion Factor	kg/mg	1.E-06	–	1.E-06	–	

Table 6
Initial Values for Daily Intake Calculations – Transient Sediment Exposures

Scenario Timeframe: Current/Future
Medium: Sediment
Receptor Population: Transients
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	EPC	Exposure point concentration, sediment	mg/kg	TBD	–	TBD	–	Daily Intake (mg/kg-day) =
	BW	Body weight	kg	70	Recommended value for adults (EPA 1989)	70	Recommended value for adults (EPA 1989)	EPC x SIR x EF x ED x CF x 1/BW x 1/AT
	EF	Exposure frequency	days/yr	365	Best professional judgment. Equivalent to every day during the entire year.	183	Best professional judgment. Equivalent to every day for half the year.	
	ED	Exposure duration	years	2	Best professional judgment	1	Best professional judgment	
	SIR	Sediment ingestion rate	mg/day	200	Required by EPA Region 10	50	Recommended value for residential adult exposures (EPA 2000a)	
	ATc	Averaging time, cancer	days	25550	Recommended value (EPA 1989)	25550	Recommended value (EPA 1989)	
	ATnc	Averaging time, noncancer	days	730	Recommended value (EPA 1989)	365	Recommended value (EPA 1989)	
	CF	Conversion Factor	kg/mg	1.E-06	–	1.E-06	–	
Dermal	EPC	Exposure point concentration, sediment	mg/kg	TBD	–	TBD	–	Daily Intake (mg/kg-day) =
	BW	Body weight	kg	70	Recommended value for adults (EPA 1989)	70	Recommended value for adults (EPA 1989)	EPC x SA x AF x ABS x EF x ED x
	EF	Exposure frequency	days/yr	365	Best professional judgment. Equivalent to every day during the entire year.	183	Best professional judgment. Equivalent to every day for half the year.	CF x 1/BW x 1/AT
	ED	Exposure duration	years	2	Best professional judgment	1	Best professional judgment	
	SA	Skin surface area	cm2	5,700	Recommended value for residential adults (EPA 2001b)	5,700	Recommended value for residential adults (EPA 2001b)	
	AF	Adherence factor	mg/cm2	0.3	Value for residential adults as gardeners (EPA 2001b)	0.07	Value for residential adults as gardeners (same as recommended RME for residentia adults) (EPA 2001b)	
	ABS	Absorption factor	–	See Table 21	–	See Table 21	–	
	ATc	Averaging time, cancer	days	25550	Recommended value (EPA 1989)	25550	Recommended value (EPA 1989)	
	ATnc	Averaging time, noncancer	days	730	Recommended value (EPA 1989)	365	Recommended value (EPA 1989)	
	CF	Conversion Factor	kg/mg	1.E-06	–	1.E-06	–	

Table 7
Initial Values for Daily Intake Calculations – Transient Surface Water Exposures

Scenario Timeframe: Current/Future
Medium: Surface Water
Receptor Population: Transients
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	EPC	Exposure point concentration, surface water	mg/L	TBD	–	TBD	–	Daily Intake (CDI) (mg/kg-day) =
	BW	Body weight	kg	70	Recommended value for adults (EPA 1989)	70	Recommended value for adults (EPA 1989)	EPC x WIR x EF x ED x 1/BW x 1/AT
	EF	Exposure frequency	days/yr	365	Best professional judgment. Equivalent to every day during the entire year.	183	Best professional judgment. Equivalent to every day for half the year.	
	ED	Exposure duration	years	2	Best professional judgment	1	Best professional judgment	
	WIR	Water ingestion rate	L/day	2	Recommended value for residential ingestion of drinking water (EPA 1989)	1.4	Recommended value for residential ingestion of drinking water (EPA 1989)	
	ATc	Averaging time, cancer	days	25,550	Recommended value (EPA 1989)	25,550	Recommended value (EPA 1989)	
	ATnc	Averaging time, noncancer	days	730	Recommended value (EPA 1989)	365	Recommended value (EPA 1989)	
Dermal	EPC	Exposure point concentration, surface water	mg/L	TBD	–	TBD	–	Daily Intake (mg/kg-day) =
	BW	Body weight	kg	70	Recommended value for adults (EPA 1989)	70	Recommended value for adults (EPA 1989)	EPC x SA x DA x EvD x EF x ED
	EvD	Event duration	hr/event	0.25	Best professional judgment for bathing in river. Equivalent to 15 minutes per bathing event (same as the CT value for residential showering/bathing (EPA 2001b))	0.16	Best professional judgment for bathing in river. Equivalent to 9 minutes per bathing event.	CF x 1/BW x 1/AT
	EF	Exposure frequency	events/yr	104	Best professional judgment (assumes 2 days per week during entire year)	52	Best professional judgment (assumes 2 days per week during half the year)	
	ED	Exposure duration	years	2	Best professional judgment	1	Best professional judgment	
	SA	Skin surface area	cm2	18,000	Recommended for adults while showering/bathing (EPA 2001b)	18,000	Recommended for adults while showering/bathing (EPA 2001b)	
	DA	Absorbed dose per event	mg/cm2-event	TBD	Chemical-specific	TBD	Chemical-specific	
	ATc	Averaging time, cancer	days	25,550	Recommended value (EPA 1989)	25,550	Recommended value (EPA 1989)	
	ATnc	Averaging time, noncancer	days	730	Recommended value (EPA 1989)	365	Recommended value (EPA 1989)	
	CF	Conversion Factor	L/cm3	1.E-03	–	1.E-03	–	

Table 8
Initial Values for Daily Intake Calculations – Adult Recreational Beach User Sediment Exposures

Scenario Timeframe: Current/Future
Medium: Sediment
Receptor Population: Recreational Beach User
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	EPC	Exposure point concentration, sediment	mg/kg	TBD	–	TBD	–	Daily Intake (mg/kg-day) =
	BW	Body weight	kg	70	Recommended value for adults (EPA 1989)	70	Recommended value for adults (EPA 1989)	EPC x SIR x EF x ED x CF x 1/BW x 1/AT
	EF	Exposure frequency	days/yr	94	Best professional judgment. 5 days per week during summer (13 weeks), 1 day per week during spring/fall (26 weeks), 1 day per month during winter (3 months)	38	Best professional judgment. 2 days per week during summer (13 weeks), 2 days per month during spring/fall (6 months)	
	ED	Exposure duration	years	30	Recommended value for residential occupancy (EPA 1997)	9	Recommended value for residential occupancy (EPA 1997)	
	SIR	Sediment ingestion rate	mg/day	100	Recommended value for residential adult exposures (EPA 2000a)	50	Recommended value for residential adult exposures (EPA 2000a)	
	ATc	Averaging time, cancer	days	25550	Recommended value (EPA 1989)	25550	Recommended value (EPA 1989)	
	ATnc	Averaging time, noncancer	days	10,950	Recommended value (EPA 1989)	3,285	Recommended value (EPA 1989)	
	CF	Conversion Factor	kg/mg	1.E-06	–	1.E-06	–	
Dermal	EPC	Exposure point concentration, sediment	mg/kg	TBD	–	TBD	–	Daily Intake (mg/kg-day) =
	BW	Body weight	kg	70	Recommended value for adults (EPA 1989)	70	Recommended value for adults (EPA 1989)	EPC x SA x AF x ABS x EF x ED x CF x 1/BW x 1/AT
	EF	Exposure frequency	days/yr	94	Best professional judgment. 5 days per week during summer (13 weeks), 1 day per week during spring/fall (26 weeks), 1 day per month during winter (3 months)	38	Best professional judgment. 2 days per week during summer (13 weeks), 2 days per month during spring/fall (6 months)	
	ED	Exposure duration	years	30	Recommended value for residential occupancy (EPA 1997)	9	Recommended value for residential occupancy (EPA 1997)	
	SA	Skin surface area	cm2	5,700	Recommended value for residential adults (EPA 2001b)	5,700	Recommended value for residential adults (EPA 2001b)	
	AF	Adherence factor	mg/cm2	0.3	Value for residential adults as gardeners (EPA 2001b)	0.07	Value for residential adults as gardeners (same as recommended RME for residential adults) (EPA 2001b)	
	ABS	Absorption factor	–	See Table 21	–	See Table 21	–	
	ATc	Averaging time, cancer	days	25550	Recommended value (EPA 1989)	25550	Recommended value (EPA 1989)	
	ATnc	Averaging time, noncancer	days	10,950	Recommended value (EPA 1989)	3,285	Recommended value (EPA 1989)	
	CF	Conversion Factor	kg/mg	1.E-06	–	1.E-06	–	

Table 9
Initial Values for Daily Intake Calculations – Adult Recreational Beach User Surface Water Exposures

Scenario Timeframe: Current/Future
Medium: Surface Water
Receptor Population: Recreational Beach User
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	EPC	Exposure point concentration, surface water	mg/L	TBD	–	TBD	–	Daily Intake (CDI) (mg/kg-day) =
	BW	Body weight	kg	70	Recommended value for adults (EPA 1989)	70	Recommended value for adults (EPA 1989)	EPC x WIR x EF x ED x 1/BW x 1/AT
	EvD	Event duration	hrs/event	1	Best professional judgment	0.5	Best professional judgment	
	EF	Exposure frequency	events/yr	26	Best professional judgment. 2 days per week during summer (13 weeks)	13	Best professional judgment. 1 day per week during summer (13 weeks)	
	ED	Exposure duration	years	30	Recommended value for residential occupancy (EPA 1997)	9	Recommended value for residential occupancy (EPA 1997)	
	WIR	Water ingestion rate	mL/hour	50	Recommended value for ingestion while swimming (EPA 1989)	50	Recommended value for ingestion while swimming (EPA 1989)	
	ATc	Averaging time, cancer	days	25550	Recommended value (EPA 1989)	25550	Recommended value (EPA 1989)	
	ATnc	Averaging time, noncancer	days	10,950	Recommended value (EPA 1989)	3,285	Recommended value (EPA 1989)	
Dermal	EPC	Exposure point concentration, surface water	mg/L	TBD	–	TBD	–	Daily Intake (mg/kg-day) =
	BW	Body weight	kg	70	Recommended value for adults (EPA 1989)	70	Recommended value for adults (EPA 1989)	EPC x SA x DA x EvD x EF x ED
	EvD	Event duration	hr/event	1	Best professional judgment	0.5	Best professional judgment	CF x 1/BW x 1/AT
	EF	Exposure frequency	events/yr	26	Best professional judgment. 2 days per week during summer (13 weeks)	13	Best professional judgment. 1 day per week during summer (13 weeks)	
	ED	Exposure duration	years	30	Recommended value for residential occupancy (EPA 1997)	9	Recommended value for residential occupancy (EPA 1997)	
	SA	Skin surface area	cm2	18,000	Recommended for adults while swimming (EPA 2001b)	18,000	Recommended for adults while swimming (EPA 2001b)	
	DA	Absorbed dose per event	mg/cm2-event	TBD	Chemical-specific	TBD	Chemical-specific	
	ATc	Averaging time, cancer	days	25550	Recommended value (EPA 1989)	25550	Recommended value (EPA 1989)	
	ATnc	Averaging time, noncancer	days	10,950	Recommended value (EPA 1989)	3,285	Recommended value (EPA 1989)	
	CF	Conversion Factor	L/cm3	1.E-03	–	1.E-03	–	

Table 10
Initial Values for Daily Intake Calculations – Child Recreational Beach User Sediment Exposures

Scenario Timeframe: Current/Future
Medium: Sediment
Receptor Population: Recreational Beach User
Receptor Age: Child

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	EPC	Exposure point concentration, sediment	mg/kg	TBD	–	TBD	–	Daily Intake (mg/kg-day) =
	BW	Body weight	kg	15	Recommended value for children (EPA 1991)	15	Recommended value for children (EPA 1991)	EPC x SIR x EF x ED x CF x 1/BW x 1/AT
	EF	Exposure frequency	days/yr	94	Best professional judgment. 5 days per week during summer (13 weeks), 1 day per week during spring/fall (26 weeks), 1 day per month during winter (3 months)	38	Best professional judgment. 2 days per week during summer (13 weeks), 2 days per month during spring/fall (6 months)	
	ED	Exposure duration	years	6	Recommended value for children (EPA 1991)	6	Recommended value for children (EPA 1991)	
	SIR	Sediment ingestion rate	mg/day	200	Recommended value for residential child exposures (EPA 2000a)	100	Recommended value for residential child exposures (EPA 2000a)	
	ATc	Averaging time, cancer	days	25550	Recommended value (EPA 1989)	25550	Recommended value (EPA 1989)	
	ATnc	Averaging time, noncancer	days	2,190	Recommended value (EPA 1989)	2,190	Recommended value (EPA 1989)	
	CF	Conversion Factor	kg/mg	1.E-06	–	1.E-06	–	
Dermal	EPC	Exposure point concentration, sediment	mg/kg	TBD	–	TBD	–	Daily Intake (mg/kg-day) =
	BW	Body weight	kg	15	Recommended value for children (EPA 1991)	15	Recommended value for children (EPA 1991)	EPC x SA x AF x ABS x EF x ED x
	EF	Exposure frequency	days/yr	94	Best professional judgment. 5 days per week during summer (13 weeks), 1 day per week during spring/fall (26 weeks), 1 day per month during winter (3 months)	38	Best professional judgment. 2 days per week during summer (13 weeks), 2 days per month during spring/fall (6 months)	CF x 1/BW x 1/AT
	ED	Exposure duration	years	6	Recommended value for children (EPA 1991)	6	Recommended value for children (EPA 1991)	
	SA	Skin surface area	cm2	2,800	Recommended value for residential children (EPA 2001b)	2,800	Recommended value for residential children (EPA 2001b)	
	AF	Adherence factor	mg/cm2	3.3	Value for children playing in wet soil (EPA 2001b)	0.2	Value for children playing in wet soil (same as recommended RME for residential children) (EPA 2001b)	
	ABS	Absorption factor	–	See Table 21	–	See Table 21	–	
	ATc	Averaging time, cancer	days	25550	Recommended value (EPA 1989)	25550	Recommended value (EPA 1989)	
	ATnc	Averaging time, noncancer	days	2,190	Recommended value (EPA 1989)	2,190	Recommended value (EPA 1989)	
	CF	Conversion Factor	kg/mg	1.E-06	–	1.E-06	–	

Table 11
Initial Values for Daily Intake Calculations – Child Recreational Beach User Surface Water Exposures

Scenario Timeframe: Current/Future
Medium: Surface Water
Receptor Population: Recreational Beach User
Receptor Age: Child

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	EPC	Exposure point concentration, surface water	mg/L	TBD	–	TBD	–	Daily Intake (CDI) (mg/kg-day) =
	BW	Body weight	kg	15	Recommended value for children (EPA 1991)	15	Recommended value for children (EPA 1991)	EPC x WIR x EF x ED x 1/BW x 1/AT
	EvD	Event duration	hrs/event	1	Best professional judgment	0.5	Best professional judgment	
	EF	Exposure frequency	events/yr	65	Best professional judgment. 5 days per week during summer (13 weeks)	26	Best professional judgment. 2 days per week during summer (13 weeks)	
	ED	Exposure duration	years	6	Recommended value for children (EPA 1991)	6	Recommended value for children (EPA 1991)	
	WIR	Water ingestion rate	mL/hour	50	Recommended value for ingestion while swimming (EPA 1989)	50	Recommended value for ingestion while swimming (EPA 1989)	
	ATc	Averaging time, cancer	days	25550	Recommended value (EPA 1989)	25550	Recommended value (EPA 1989)	
	ATnc	Averaging time, noncancer	days	2,190	Recommended value (EPA 1989)	2,190	Recommended value (EPA 1989)	
Dermal	EPC	Exposure point concentration, surface water	mg/L	TBD	–	TBD	–	Daily Intake (mg/kg-day) =
	BW	Body weight	kg	15	Recommended value for children (EPA 1991)	15	Recommended value for children (EPA 1991)	EPC x SA x DA x EvD x EF x ED
	EvD	Event duration	hr/event	1	Best professional judgment	0.5	Best professional judgment	CF x 1/BW x 1/AT
	EF	Exposure frequency	events/yr	65	Best professional judgment. 5 days per week during summer (13 weeks)	26	Best professional judgment. 2 days per week during summer (13 weeks)	
	ED	Exposure duration	years	6	Recommended value for children (EPA 1991)	6	Recommended value for children (EPA 1991)	
	SA	Skin surface area	cm2	6,600	Recommended for children while swimming (EPA 2001b)	6,600	Recommended for children while swimming (EPA 2001b)	
	DA	Absorbed dose per event	mg/cm2-event	TBD	Chemical-specific	TBD	Chemical-specific	
	ATc	Averaging time, cancer	days	25550	Recommended value (EPA 1989)	25550	Recommended value (EPA 1989)	
	ATnc	Averaging time, noncancer	days	2,190	Recommended value (EPA 1989)	2,190	Recommended value (EPA 1989)	
	CF	Conversion Factor	L/cm3	1.E-03	–	1.E-03	–	

Table 12
Initial Values for Daily Intake Calculations – Adult Recreational Fisher Sediment Exposures

Scenario Timeframe: Current/Future
Medium: Sediment
Receptor Population: Recreational Fisher
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	EPC	Exposure point concentration, sediment	mg/kg	TBD	–	TBD	–	Daily Intake (mg/kg-day) =
	BW	Body weight	kg	70	Recommended value for adults (EPA 1989)	70	Recommended value for adults (EPA 1989)	EPC x SIR x EF x ED x CF x
	EF	Exposure frequency	days/yr	156	Required by EPA Region 10	52	Required by EPA Region 10	1/BW x 1/AT
	ED	Exposure duration	years	30	Recommended value for residential occupancy (EPA 1997)	9	Recommended value for residential occupancy (EPA 1997)	
	SIR	Sediment ingestion rate	mg/day	100	Recommended value for residential adult exposures (EPA 2000a)	50	Recommended value for residential adult exposures (EPA 2000a)	
	ATc	Averaging time, cancer	days	25,550	Recommended value (EPA 1989)	25,550	Recommended value (EPA 1989)	
	ATnc	Averaging time, noncancer	days	10,950	Recommended value (EPA 1989)	3,285	Recommended value (EPA 1989)	
	CF	Conversion Factor	kg/mg	1.E-06	–	1.E-06	–	
Dermal	EPC	Exposure point concentration, sediment	mg/kg	TBD	–	TBD	–	Daily Intake (mg/kg-day) =
	BW	Body weight	kg	70	Recommended value for adults (EPA 1989)	70	Recommended value for adults (EPA 1989)	EPC x SA x AF x ABS x EF x
	EF	Exposure frequency	days/yr	156	Required by EPA Region 10	52	Required by EPA Region 10	ED x CF x 1/BW x 1/AT
	ED	Exposure duration	years	30	Recommended value for residential occupancy (EPA 1997)	9	Recommended value for residential occupancy (EPA 1997)	
	SA	Skin surface area	cm2	5,700	Recommended value for residential adults (EPA 2001b)	5,700	Recommended value for residential adults (EPA 2001b)	
	AF	Adherence factor	mg/cm2	0.3	Value for residential adults as gardeners (EPA 2001b)	0.07	Value for residential adults as gardeners (same as recommended RME for residential adults) (EPA 2001b)	
	ABS	Absorption factor, chemical-specific	–	See Table 21	–	See Table 21	–	
	ATc	Averaging time, cancer	days	25,550	Recommended value (EPA 1989)	25,550	Recommended value (EPA 1989)	
	ATnc	Averaging time, noncancer	days	10,950	Recommended value (EPA 1989)	3,285	Recommended value (EPA 1989)	
	CF	Conversion Factor	kg/mg	1.E-06	–	1.E-06	–	

Table 13
Initial Values for Daily Intake Calculations – Adult Native American Consumption Fisher Sediment Exposures

Scenario Timeframe: Current/Future
Medium: Sediment
Receptor Population: Native American Fisher
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	EPC	Exposure point concentration, sediment	mg/kg	TBD	–	TBD	–	Daily Intake (mg/kg-day) =
	BW	Body weight	kg	70	Recommended value for adults (EPA 1989)	70	Recommended value for adults (EPA 1989)	EPC x SIR x EF x ED x CF x 1/BW x 1/AT
	EF	Exposure frequency	days/yr	260	Required by EPA Region 10	104	Required by EPA Region 10	
	ED	Exposure duration	years	70	Conventional lifetime (EPA 1989)	30	95th percentile for time at one residence (same as recommended RME for residential adults) (EPA 1997)	
	SIR	Sediment ingestion rate	mg/day	100	Recommended value for residential adult exposures (EPA 2000a)	50	Recommended value for residential adult exposures (EPA 2000a)	
	ATc	Averaging time, cancer	days	25,550	Recommended value (EPA 1989)	25,550	Recommended value (EPA 1989)	
	ATnc	Averaging time, noncancer	days	25,550	Recommended value (EPA 1989)	10,950	Recommended value (EPA 1989)	
	CF	Conversion Factor	kg/mg	1.E-06	–	1.E-06	–	
Dermal	EPC	Exposure point concentration, sediment	mg/kg	TBD	–	TBD	–	Daily Intake (mg/kg-day) =
	BW	Body weight	kg	70	Recommended value for adults (EPA 1989)	70	Recommended value for adults (EPA 1989)	EPC x SA x AF x ABS x EF x ED x CF x 1/BW x 1/AT
	EF	Exposure frequency	days/yr	260	Required by EPA Region 10	104	Required by EPA Region 10	
	ED	Exposure duration	years	70	Conventional lifetime (EPA 1989)	30	95th percentile for time at one residence (same as recommended RME for residential adults) (EPA 1997)	
	SA	Skin surface area	cm2	5,700	Recommended value for residential adults (EPA 2001b)	5,700	Recommended value for residential adults (EPA 2001b)	
	AF	Adherence factor	mg/cm2	0.3	Value for residential adults as gardeners (EPA 2001b)	0.07	Value for residential adults as gardeners (same as recommended RME for residential adults) (EPA 2001b)	
	ABS	Absorption factor, chemical-specific	–	See Table 21	–	See Table 21	–	
	ATc	Averaging time, cancer	days	25,550	Recommended value (EPA 1989)	25,550	Recommended value (EPA 1989)	
	ATnc	Averaging time, noncancer	days	25,550	Recommended value (EPA 1989)	10,950	Recommended value (EPA 1989)	
	CF	Conversion Factor	kg/mg	1.E-06	–	1.E-06	–	

Table 14
Initial Values for Daily Intake Calculations – Adult Non-tribal Consumption Fisher Sediment Exposures

Scenario Timeframe: Current/Future
Medium: Sediment
Receptor Population: Non-tribal Fisher
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	EPC	Exposure point concentration, sedir	mg/kg	TBD	–	TBD	–	Daily Intake (mg/kg-day) =
	BW	Body weight	kg	70	Recommended value for adults (EPA 1989)	70	Recommended value for adults (EPA 1989)	EPC x SIR x EF x ED x CF x 1/BW x 1/AT
	EF	Exposure frequency	days/yr	104	Best professional judgment. 2 days per week for entire year	26	Best professional judgment. 1 day every other week for entire year	
	ED	Exposure duration	years	30	Recommended value for residential occupancy (EPA 1997)	9	Recommended value for residential occupancy (EPA 1997)	
	SIR	Sediment ingestion rate	mg/day	100	Recommended value for residential adult exposures (EPA 2000a)	50	Recommended value for residential adult exposures (EPA 2000a)	
	ATc	Averaging time, cancer	days	25,550	Recommended value (EPA 1989)	25,550	Recommended value (EPA 1989)	
	ATnc	Averaging time, noncancer	days	10,950	Recommended value (EPA 1989)	3,285	Recommended value (EPA 1989)	
	CF	Conversion Factor	kg/mg	1.E-06	–	1.E-06	–	
Dermal	EPC	Exposure point concentration, sedir	mg/kg	TBD	–	TBD	–	Daily Intake (mg/kg-day) =
	BW	Body weight	kg	70	Recommended value for adults (EPA 1989)	70	Recommended value for adults (EPA 1989)	EPC x SA x AF x ABS x EF x ED x CF x
	EF	Exposure frequency	days/yr	104	2 days per week for entire year	26	1 day every other week for entire year	1/BW x 1/AT
	ED	Exposure duration	years	30	Recommended value for residential occupancy (EPA 1997)	9	Recommended value for residential occupancy (EPA 1997)	
	SA	Skin surface area	cm2	5,700	Recommended value for residential adults (EPA 2001b)	5,700	Recommended value for residential adults (EPA 2001b)	
	AF	Adherence factor	mg/cm2	0.3	Value for residential adults as gardeners (EPA 2001b)	0.07	Value for residential adults as gardeners (same as recommended RME for residential adults) (EPA 2001b)	
	ABS	Absorption factor, chemical-specific	–	See Table 21	–	See Table 21	–	
	ATc	Averaging time, cancer	days	25,550	Recommended value (EPA 1989)	25,550	Recommended value (EPA 1989)	
	ATnc	Averaging time, noncancer	days	10,950	Recommended value (EPA 1989)	3,285	Recommended value (EPA 1989)	
	CF	Conversion Factor	kg/mg	1.E-06	–	1.E-06	–	

Table 15
Daily Intake Equation for Fish and Shellfish Consumption – Adult Recreational Fisher Biota Exposures

Scenario Timeframe: Current/Future
Medium: Biota
Receptor Population: Recreational Fisher
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	Intake Equation/ Model Name
Ingestion	EPCf	Exposure point concentration, fish tissue	mg/kg	Daily Intake (mg/kg-day) =
	EPCs	Exposure point concentration, shellfish tissue	mg/kg	[(EPCf x FIR) + (EPCs x SIR)] x EF x ED x CF x 1/BW x 1/AT
	BW	Body weight	kg	
	EF	Exposure frequency	days/yr	
	ED	Exposure duration	years	
	FIR	Fish ingestion rate	g/day	
	SIR	Shellfish ingestion rate	g/day	
	ATc	Averaging time, cancer	days	
	ATnc	Averaging time, noncancer	days	
	CF	Conversion Factor	kg/g	

Table 16
Daily Intake Equation for Fish and Shellfish Consumption – Child Recreational Fisher Biota Exposures

Scenario Timeframe: Current/Future
Medium: Biota
Receptor Population: Recreational Fisher
Receptor Age: Child

Exposure Route	Parameter Code	Parameter Definition	Units	Intake Equation/ Model Name
Ingestion	EPCf	Exposure point concentration, fish tissue	mg/kg	Daily Intake (mg/kg-day) =
	EPCs	Exposure point concentration, shellfish tissue	mg/kg	[(EPCf x FIR) + (EPCs x SIR)] x EF x ED x CF x 1/BW x 1/AT
	BW	Body weight	kg	
	EF	Exposure frequency	days/yr	
	ED	Exposure duration	years	
	FIR	Fish ingestion rate	g/day	
	SIR	Shellfish ingestion rate	g/day	
	ATc	Averaging time, cancer	days	
	ATnc	Averaging time, noncancer	days	
	CF	Conversion Factor	kg/g	

Table 17
Daily Intake Equation for Fish and Shellfish Consumption – Adult Native American Consumption Fisher Biota Exposures

Scenario Timeframe: Current/Future
Medium: Biota
Receptor Population: Native American Consumption
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	Intake Equation/ Model Name
Ingestion	EPC	Exposure point concentration, tissue	mg/kg	Daily Intake (mg/kg-day) =
	BW	Body weight	kg	EPC x FIR x EF x ED x CF x 1/BW x 1/AT
	EF	Exposure frequency	days/yr	
	ED	Exposure duration	years	
	FIR	Fish ingestion rate	g/day	
	ATc	Averaging time, cancer	days	
	ATnc	Averaging time, noncancer	days	
	CF	Conversion Factor	kg/g	

Table 18

Daily Intake Equation for Fish and Shellfish Consumption – Child Native American Consumption Fisher Biota Exposures

Scenario Timeframe: Current/Future
Medium: Biota
Receptor Population: Native American Consumption
Receptor Age: Child

Exposure Route	Parameter Code	Parameter Definition	Units	Intake Equation/ Model Name
Ingestion	EPC	Exposure point concentration, tissue	mg/kg	Daily Intake (mg/kg-day) =
	BW	Body weight	kg	EPC x FIR x EF x ED x CF x 1/BW x 1/AT
	EF	Exposure frequency	days/yr	
	ED	Exposure duration	years	
	FIR	Fish ingestion rate	g/day	
	ATc	Averaging time, cancer	days	
	ATnc	Averaging time, noncancer	days	
	CF	Conversion Factor	kg/g	

Table 19
Daily Intake Equation for Fish and Shellfish Consumption – Adult Non-tribal Consumption Fisher Biota Exposures

Scenario Timeframe: Current/Future
Medium: Biota
Receptor Population: Non-tribal Consumption
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	Intake Equation/ Model Name
Ingestion	EPCf	Exposure point concentration, fish tissue	mg/kg	Daily Intake (mg/kg-day) =
	EPCs	Exposure point concentration, shellfish tissue	mg/kg	[(EPCf x FIR) + (EPCs x SIR)] x EF x ED x CF x 1/BW x 1/AT
	BW	Body weight	kg	
	EF	Exposure frequency	days/yr	
	ED	Exposure duration	years	
	FIR	Fish ingestion rate	g/day	
	SIR	Shellfish ingestion rate	g/day	
	ATc	Averaging time, cancer	days	
	ATnc	Averaging time, noncancer	days	
	CF	Conversion Factor	kg/g	

Table 20

Daily Intake Equation for Fish and Shellfish Consumption – Child Non-tribal Consumption Fisher Biota Exposures

Scenario Timeframe: Current/Future
Medium: Biota
Receptor Population: Non-tribal Consumption
Receptor Age: Child

Exposure Route	Parameter Code	Parameter Definition	Units	Intake Equation/ Model Name
Ingestion	EPCf	Exposure point concentration, fish tissue	mg/kg	Daily Intake (mg/kg-day) =
	EPCs	Exposure point concentration, shellfish tissue	mg/kg	[(EPCf x FIR) + (EPCs x SIR)] x EF x ED x CF x 1/BW x 1/AT
	BW	Body weight	kg	
	EF	Exposure frequency	days/yr	
	ED	Exposure duration	years	
	FIR	Fish ingestion rate	g/day	
	SIR	Shellfish ingestion rate	g/day	
	ATc	Averaging time, cancer	days	
	ATnc	Averaging time, noncancer	days	
	CF	Conversion Factor	kg/g	

Table 21
Chemical-Specific Dermal Absorption Factors

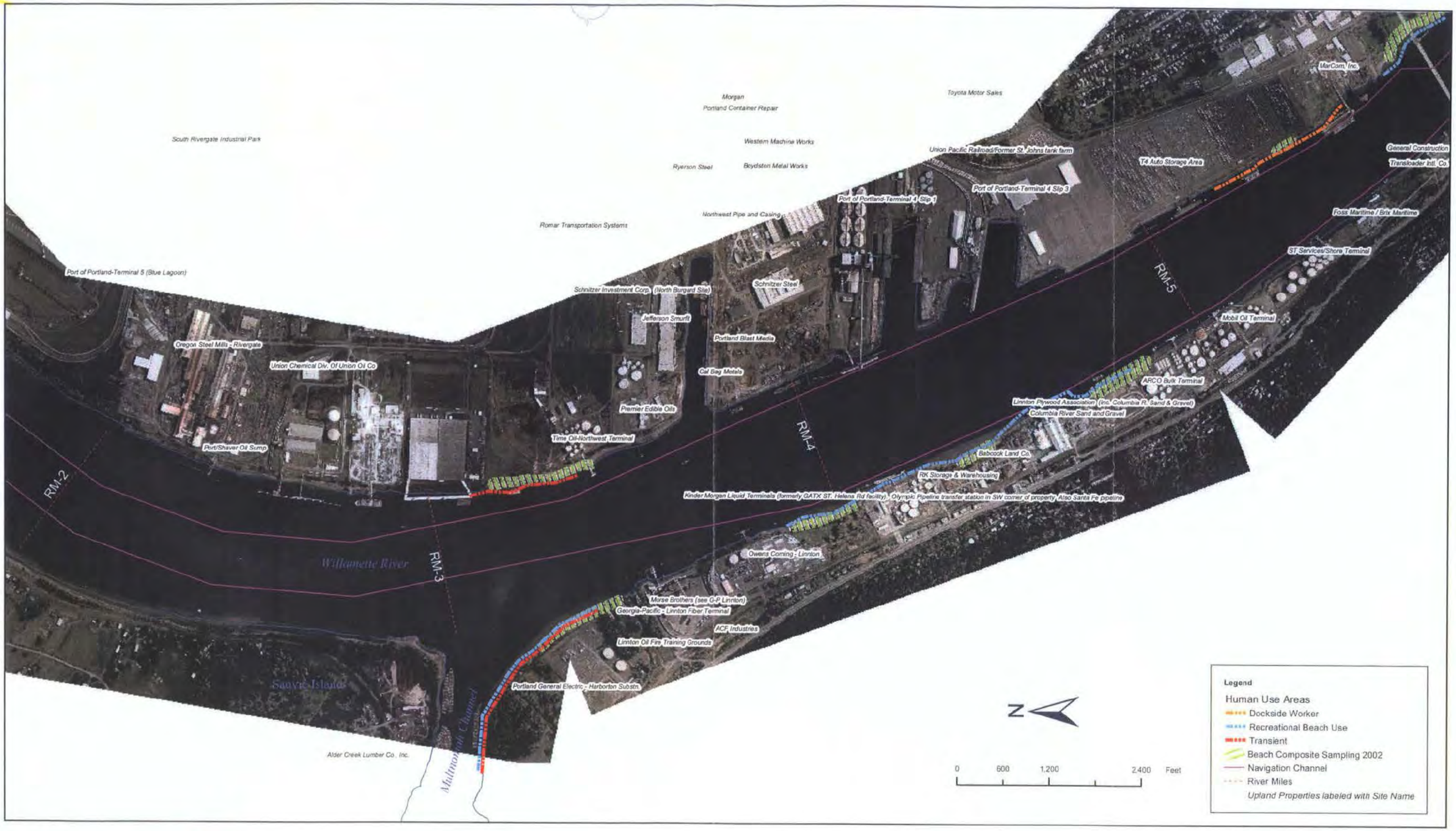
Chemical	Absorption Factor (ABS)
Arsenic	0.03
Cadmium	0.001
Chlordane	0.04
2,4-Dichlorophenoxyacetic acid	0.05
DDT	0.03
TCDD and other dioxins	0.03
if soil organic content is > 10%	0.001
Lindane	0.04
Benzo(a)pyrene and other PAHs	0.13
Aroclors 1254/1242 and other PCBs	0.14
Pentachlorophenol	0.25
Semivolatile organic compounds	0.1

EPA 2001

Table 22
Toxic Equivalency Factors for Dioxins, Furans and PCB Congeners

Chemical Class	Compound	TEF[1]
Dioxins	2,3,7,8-TCDD	1
	1,2,3,7,8-PeCDD	1
	1,2,3,4,7,8-HxCDD	0.1
	1,2,3,7,8,9-HxCDD	0.1
	1,2,3,6,7,8-HxCDD	0.1
	1,2,3,4,6,7,8-HpCDD	0.01
	OCDD	0.0001
Furans	2,3,7,8-TCDF	0.1
	1,2,3,7,8-PeCDF	0.05
	2,3,4,7,8-PeCDF	0.5
	1,2,3,4,7,8-HxCDF	0.1
	1,2,3,7,8,9-HxCDF	0.1
	1,2,3,6,7,8-HxCDF	0.1
	2,3,4,6,7,8-HxCDF	0.1
	1,2,3,4,6,7,8-HpCDF	0.01
	1,2,3,4,7,8,9-HpCDF	0.01
	OCDF	0.0001
Coplanar PCBs	3,3',4,4'-TCB (77)	0.0001
	3,4,4',5-TCB (81)	0.0001
	2,3,3',4,4'-PeCB (105)	0.0001
	2,3,4,4',5-PeCB (114)	0.0005
	2,3',4,4',5-PeCB (118)	0.0001
	2',3,4,4',5-PeCB (123)	0.0001
	3,3',4,4',5-PeCB (126)	0.1
	2,3,3',4,4',5'-HxCB (156)	0.0005
	2,3,3',4,4',5-HxCB (157)	0.0005
	2,3',4,4',5,5'-HxCB (167)	0.00001
	3,3',4,4',5,5'-HxCB (169)	0.01
	2,3,3',4,4',5,5'-HpCB (189)	0.0001
	2,2',3,3',4,4',5-HpCB (170)	–
	2,2',3,4,4',5,5'-HpCB (180)	–

(1) World Health Organization 1997 TEF.



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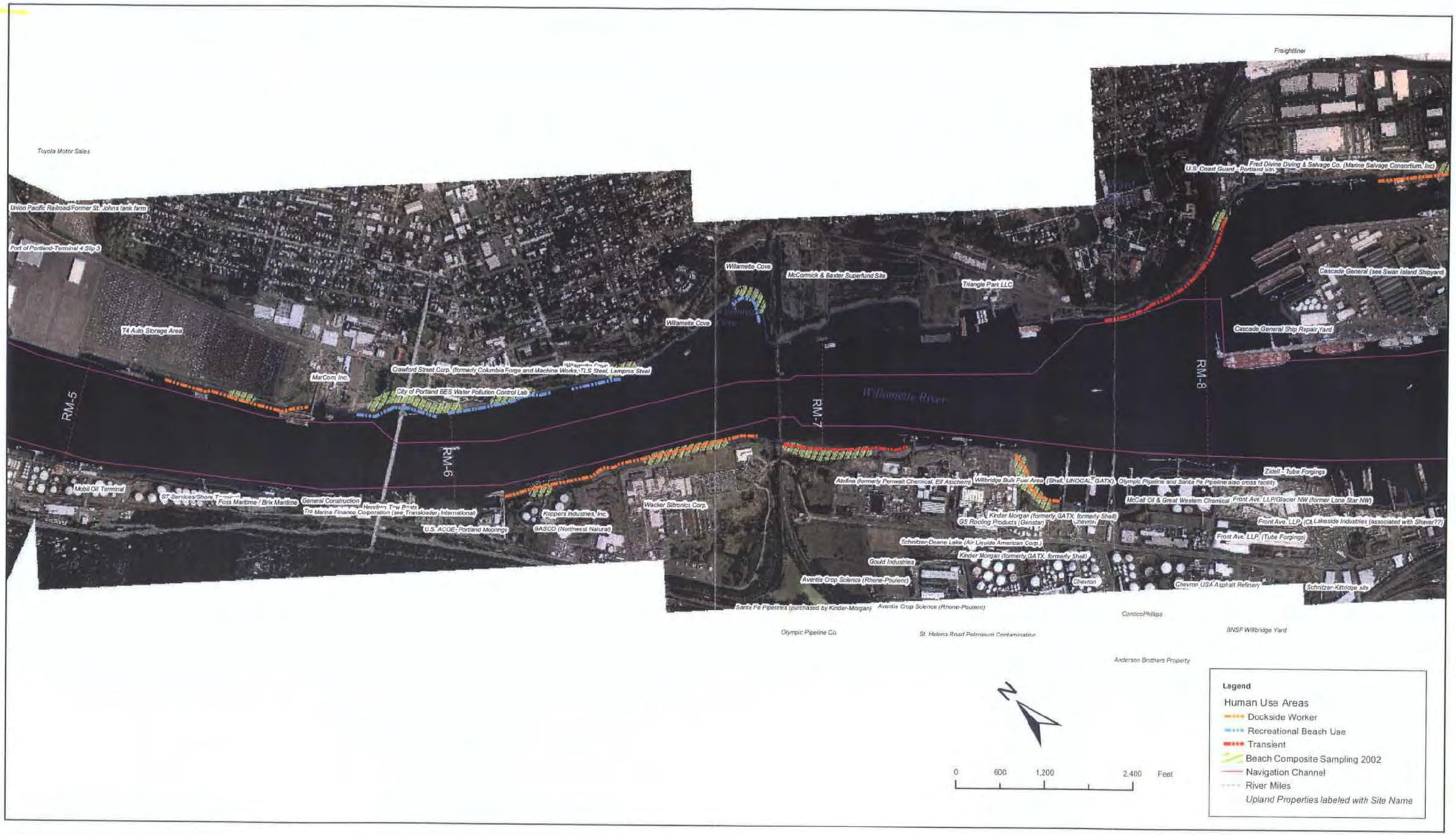
FEATURE SOURCES:
Mosaic digital photos: Geo-referenced Digital Ortho-photo Mosaics (fit on one CD). 4' and 8' mosaics were created during development of the 0.33' resolution
Date of Photography: 10-15-2001
Transportation, Water, Property, Zoning or Boundaries: Metro RLIS
Channel & River miles: Developed from US Army Corps of Engineers information
Human use areas Collected and collated from: Willamette River Atlas shape files December 2001and by referencing 10/15/01 aerial Ortho-photos and field conditions. (SEA & KJ)
Beach Composite Sampling 2002: Polygon shape file sketched surrounding the immediate vicinity of composite beach samples taken as part of Round 1 Field Sampling Program.
File name: WP-2003_4-4_Cultural-and-Human-Res.mxd
PLOT DATE: 09/18/03

Figure 1a
Portland Harbor RI/FS
Appendix C
Human Health Risk Assessment Approach
Human Use Areas



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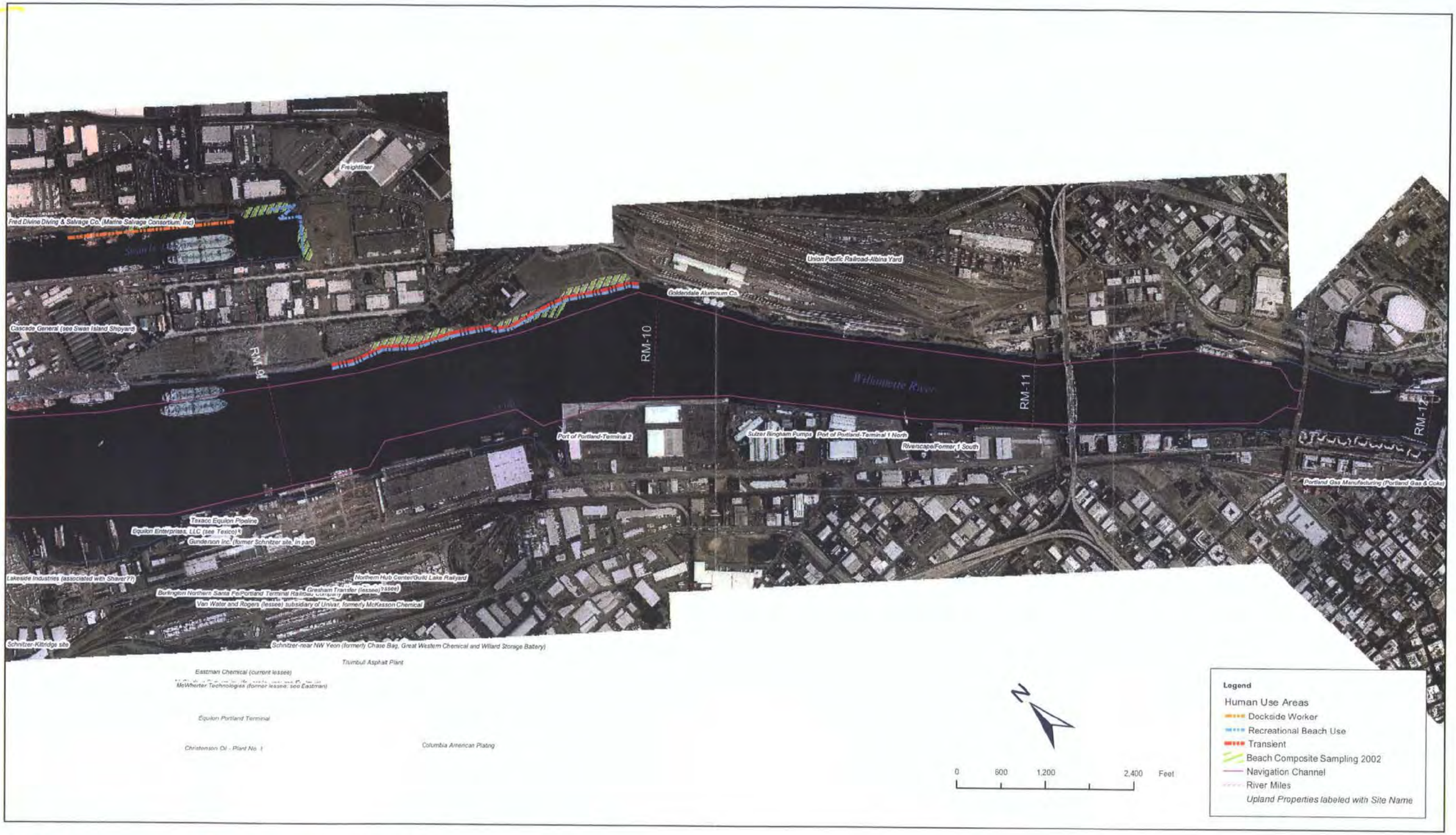
FEATURE SOURCES:
Mosaic digital photos: Geo-referenced Digital Ortho-photo Mosaics (fit on one CD). 4' and 8' mosaics were created during development of the 0.33' resolution
Date of Photography, 10-15-2001
Transportation, Water, Property, Zoning or Boundaries: Metro RLIS
Channel & River miles: Developed from US Army Corps of Engineers information
Human use areas Collected and collated from: Willamette River Atlas shape files December 2001and by referencing 10/15/01 aerial Ortho-photos and field conditions. (SEA & KJ)
Beach Composite Sampling 2002: Polygon shape file sketched surrounding the immediate vicinity of composite beach samples taken as part of Round 1 Field Sampling Program
File name: WP-2003_4-4_Cultural-and-Human-Res.mxd
PLOT DATE: 09/18/03

Figure 1b
Portland Harbor RI/FS
Appendix C
Human Health Risk Assessment Approach
Human Use Areas



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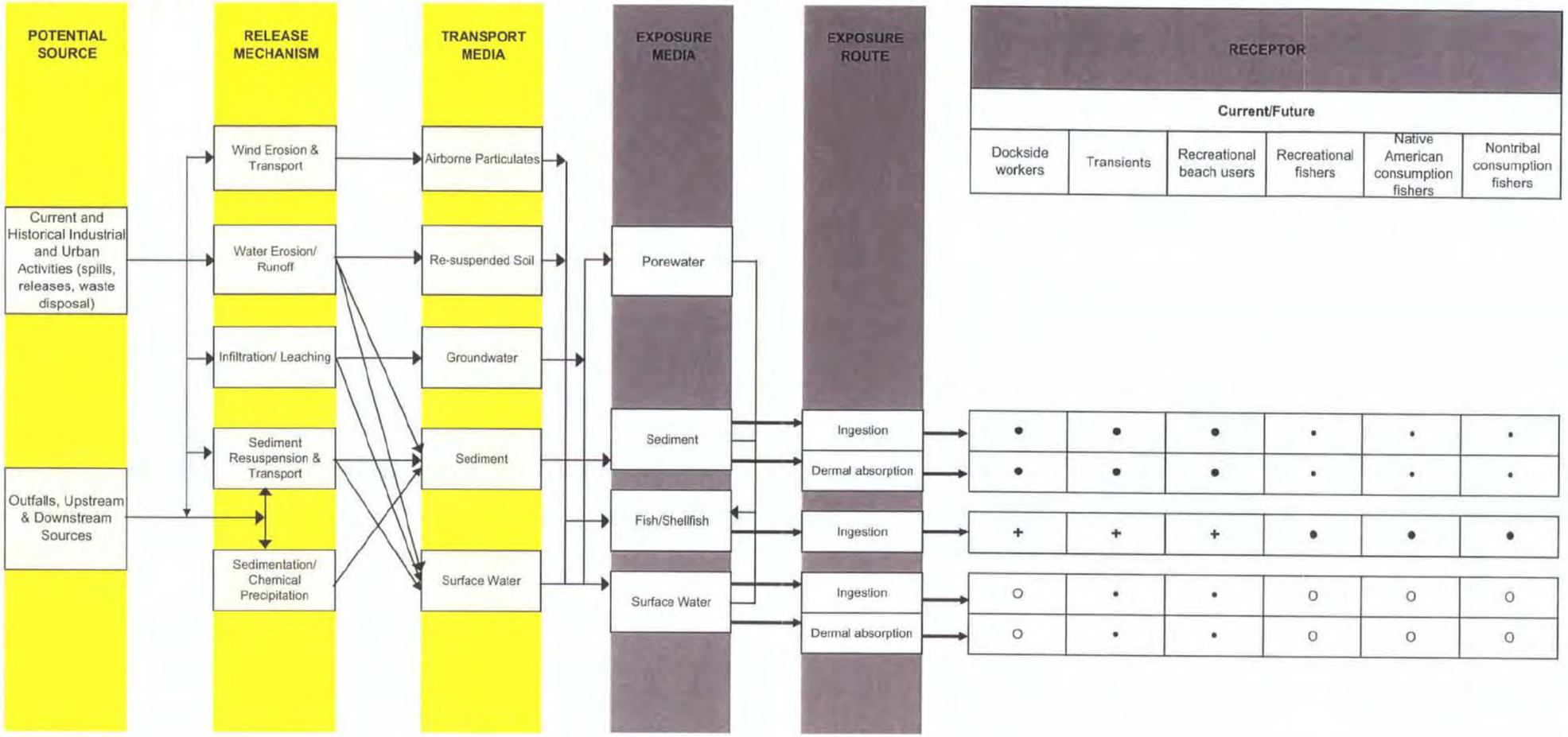
FEATURE SOURCES:
Mosaic digital photos: Geo-referenced Digital Ortho-photo Mosaics (fit on one CD). 4' and 8' mosaics were created during development of the 0.33' resolution.
Date of Photography, 10-15-2001
Transportation, Water, Property, Zoning or Boundaries. Metro RLIS
Channel & River miles: Developed from US Army Corps of Engineers information
Human use areas Collected and collated from: Willamette River Atlas shape files
December 2001and by referencing 10/15/01 aerial Ortho-photos and field conditions. (SEA & KJ)
Beach Composite Sampling 2002. Polygon shape file sketched surrounding the immediate vicinity of composite beach samples taken as part of Round 1 Field Sampling Program.
File name: WP-2003_4-4_Cultural-and-Human-Res.mxd
PLOT DATE: 09/18/03

Figure 1c
Portland Harbor RI/FS
Appendix C
Human Health Risk Assessment Approach
Human Use Areas

Figure 2 Preliminary Conceptual Site Model for Human Exposures



	Dockside workers	Transients	Recreational beach users	Recreational fishers	Native American consumption fishers	Nontribal consumption fishers
Sediment – Ingestion	•	•	•	•	•	•
Sediment – Dermal absorption	•	•	•	•	•	•
Fish/Shellfish – Ingestion	+	+	+	•	•	•
Surface Water – Ingestion	O	•	•	O	O	O
Surface Water – Dermal absorption	O	•	•	O	O	O

- • Potentially complete and significant pathway; quantitatively evaluated in the HHRA
- • Potentially complete and significance unknown pathway; quantitatively evaluated in the HHRA to determine significance
- O Potentially complete and insignificant pathway; not evaluated in the HHRA
- + Potentially complete pathway, but not included for this receptor category; pathway evaluated under a different receptor category

Appendix D

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PORTLAND HARBOR RI/FS PROGRAMMATIC WORK PLAN

APPENDIX D: CHANGE IN SEDIMENT VOLUME

REVISED DRAFT FINAL
November 13, 2003

Prepared for:
The Lower Willamette Group

Prepared by:
Striplin Environmental Associates, Inc.

APPENDIX D:

CHANGE IN SEDIMENT VOLUME

Parsons Brinckerhoff (2001) conducted an evaluation of historic bathymetric survey data collected in the federal navigation channel in Portland Harbor (RM 0 to RM 11.7). The bathymetry data were obtained from the U.S. Army Corps of Engineers (Portland District) and consisted of 13 single-beam, hydrographic surveys conducted from 1990 through 2000. These surveys were performed by the Corps in order to identify shoaling areas and determine maintenance dredging needs in the authorized channel.

Parsons Brinckerhoff obtained this survey data in digital format and used it to produce a digital terrain model for each survey. Subsequently, a bathymetric contour plot showing the river-bottom topography was produced for each survey. Difference contour plots were then created by overlaying sequential survey plots. These displayed the changes in bathymetric elevations (positive or negative) between sequential individual surveys. The changes in sediment volume (positive or negative) from survey to survey were then computed from these difference contour plots. These volume change calculations were computed on a river-mile-by-river-mile basis and tabulated in Parsons Brinckerhoff (2001).

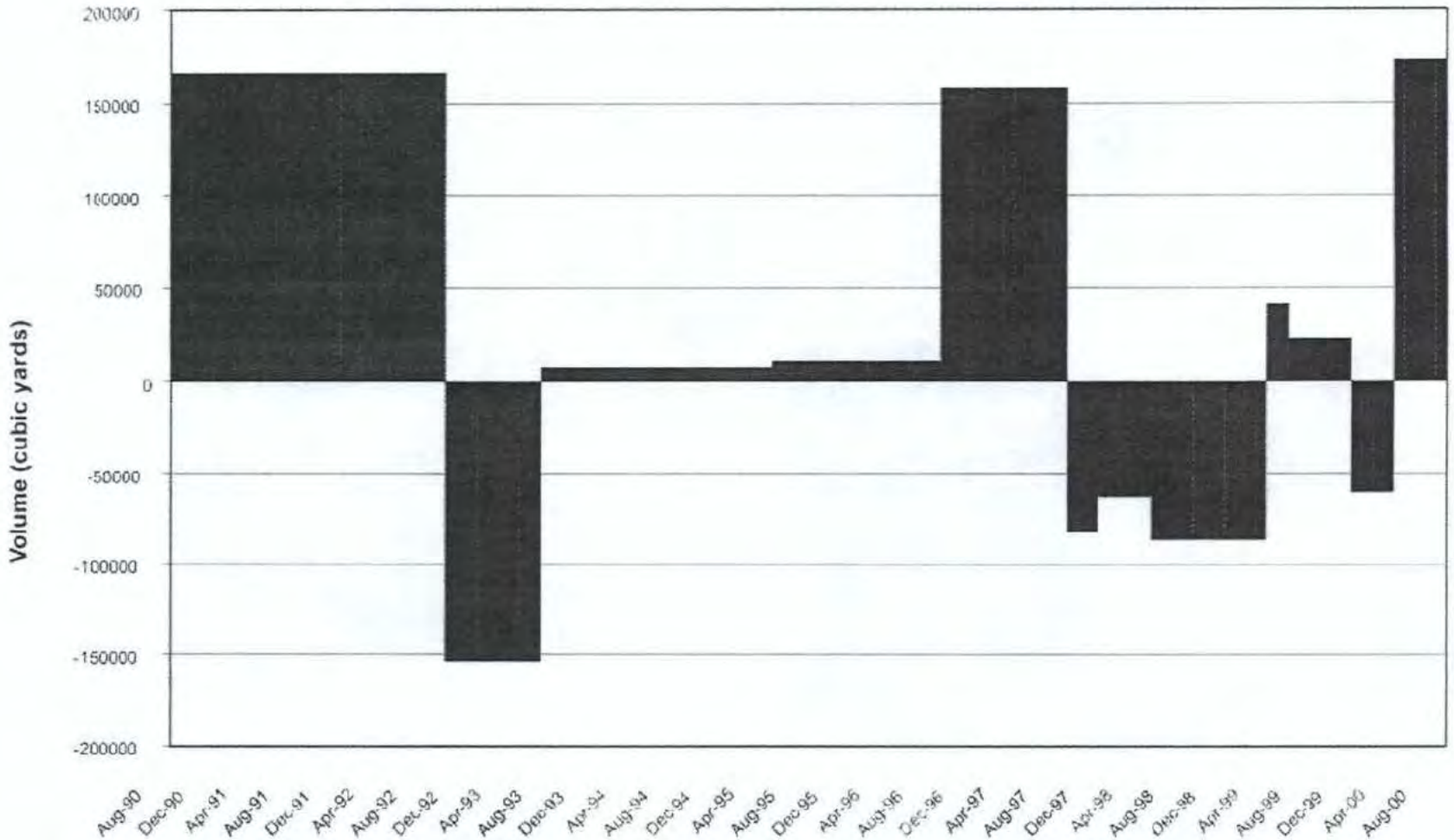
SEA produced the bar graphs shown on the following pages from the volume change data tabulated in Parsons Brinckerhoff (2001). The graphs plot the changes in the computed volumes from survey to survey for each river mile. It is important to note that the volumes graphed represent the *relative* change in sediment volumes (y-axis) from survey-time period to survey-time period (x-axis) for each river mile. Positive changes in volume indicate sedimentation or fill in that river segment over the indicated timeframe, and negative volume changes indicate erosion or scour. The "baseline" condition in these comparisons is the river-mile-wide riverbed elevation for the initial survey period for each temporal comparison pair and is not associated with any specific riverbed elevation (e.g., -40 feet CRD).

Because the Corps' bathymetric survey data were not generated with the objective of comparing time-series riverbed elevation, there are relatively large uncertainties associated with the volume-change estimates. Parson Brinckerhoff (2001) tried to minimize sources of error as they were compiling the data, and all inaccurate (illogical) survey points were removed from the analyses. Also, because individual Corps' surveys often covered unique subareas, changes in volume calculations between any two surveys were limited to areas within the navigation channel covered by both hydrographic surveys. It should also not be assumed that any changes in volume are uniformly distributed over the entire length of that river mile as changes in river bottom topography within a given river mile may be localized to a particular feature (e.g., dredged borrow hole). Nevertheless, the graphed approximations suggest that a significant volume of sediments is periodically deposited and/or eroded from different portions of the Portland Harbor navigation channel over time.

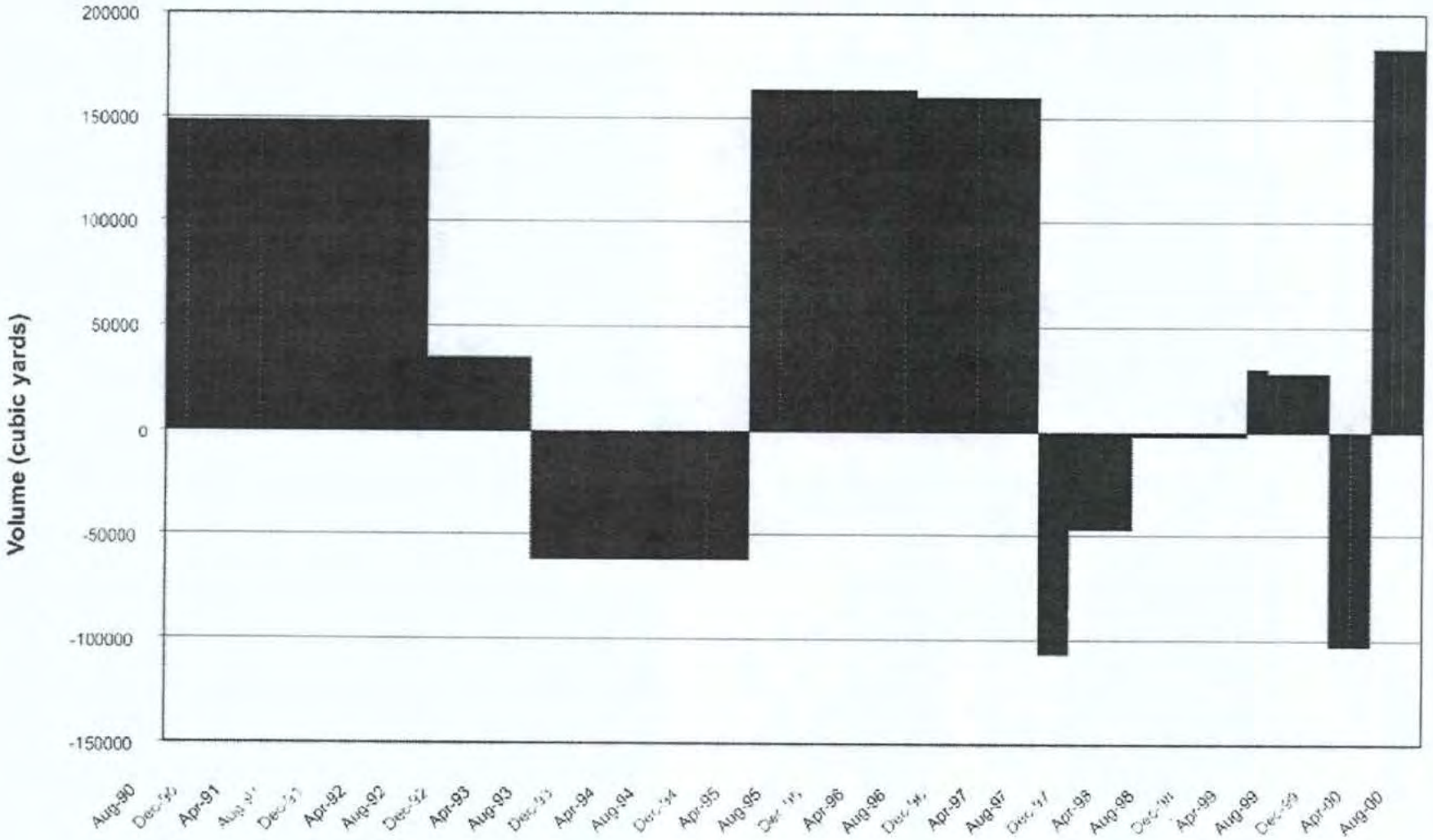
Reference Cited:

Parsons Brinckerhoff. 2001. Portland Harbor Bathymetry Analysis. Prepared for Striplin Environmental Associates, Olympia, WA, and Port of Portland. Portland OR. Parsons Brinckerhoff, Portland, OR.

River Mile 0-1



River Mile 1-2



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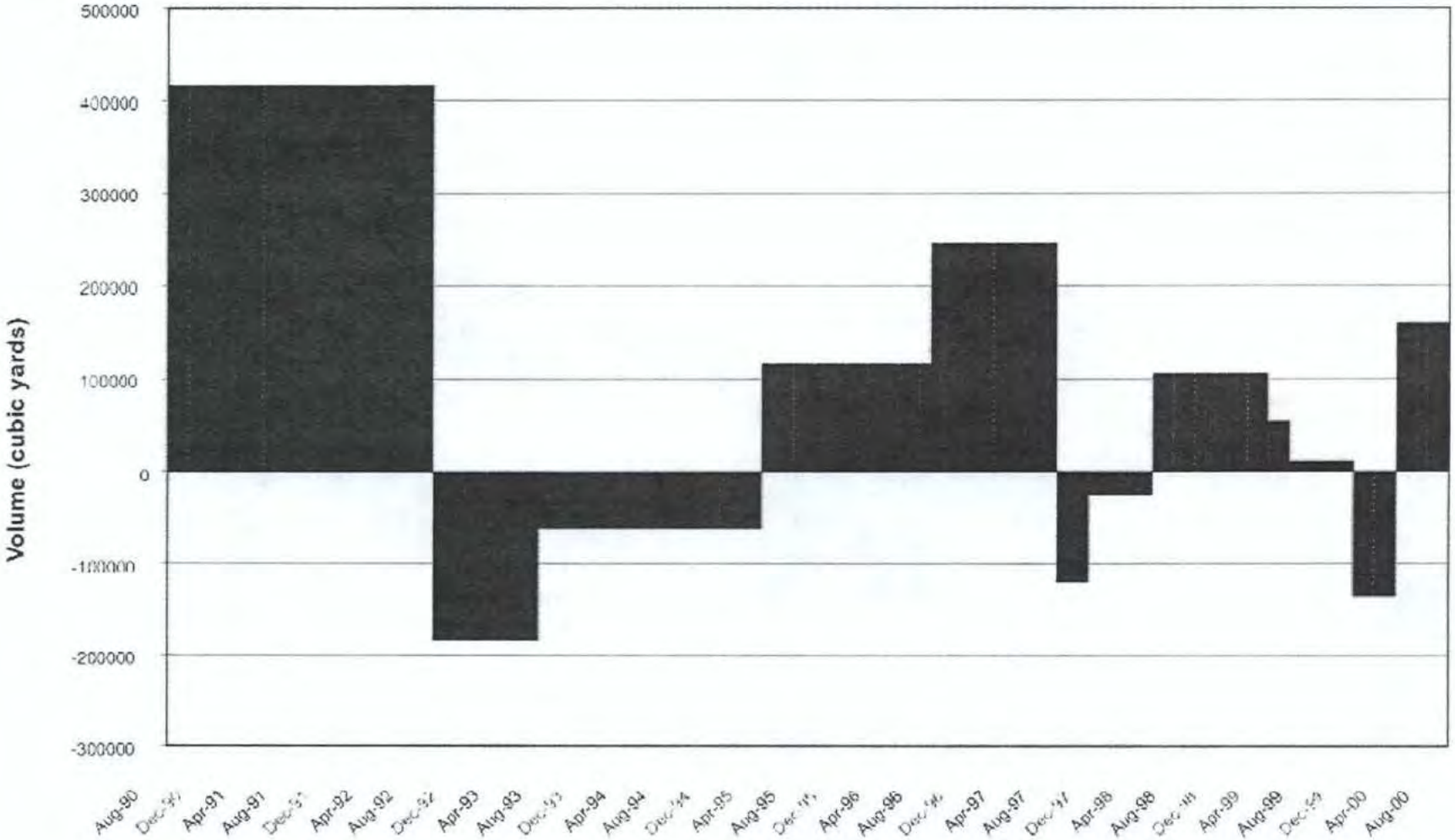

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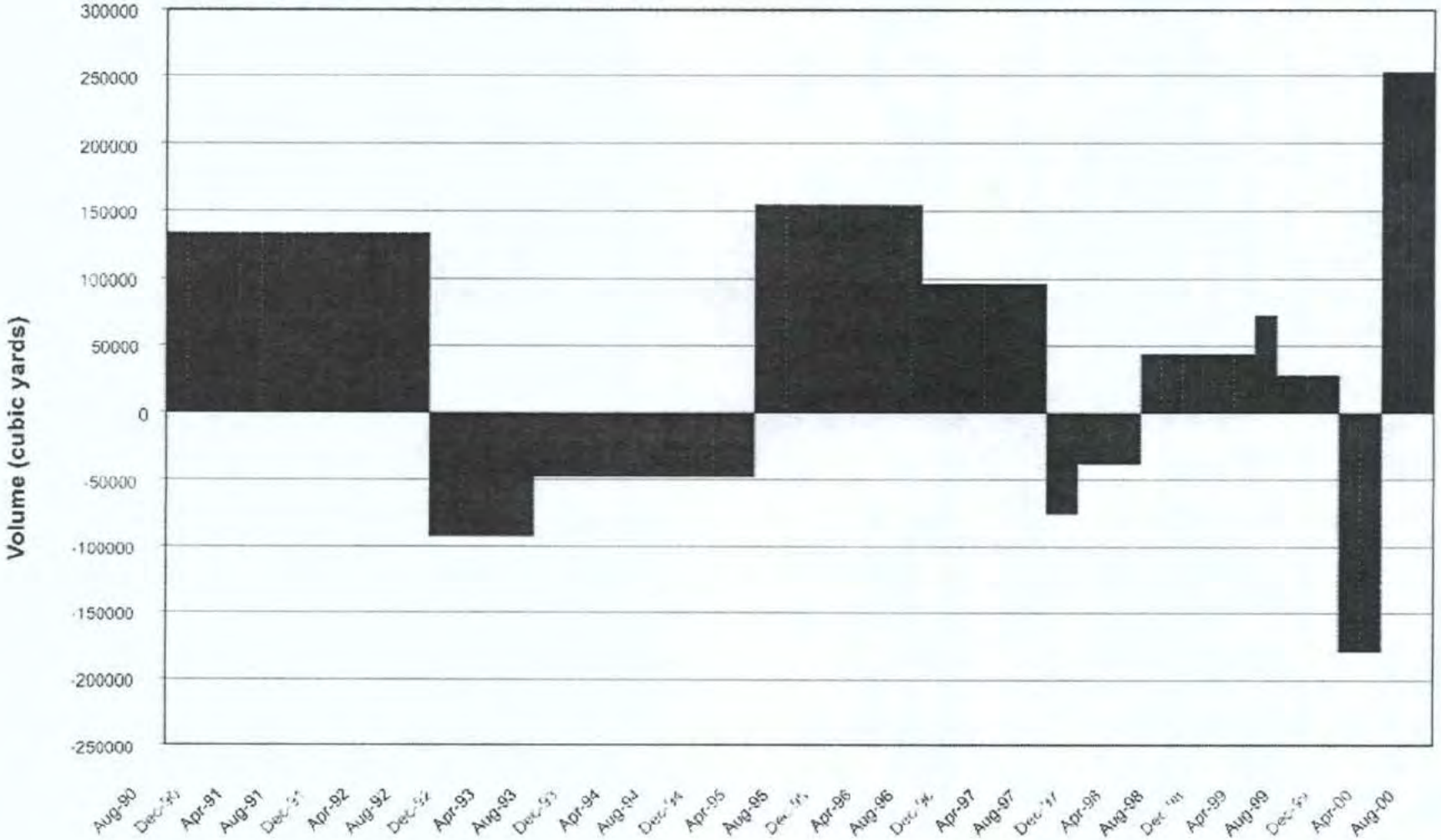

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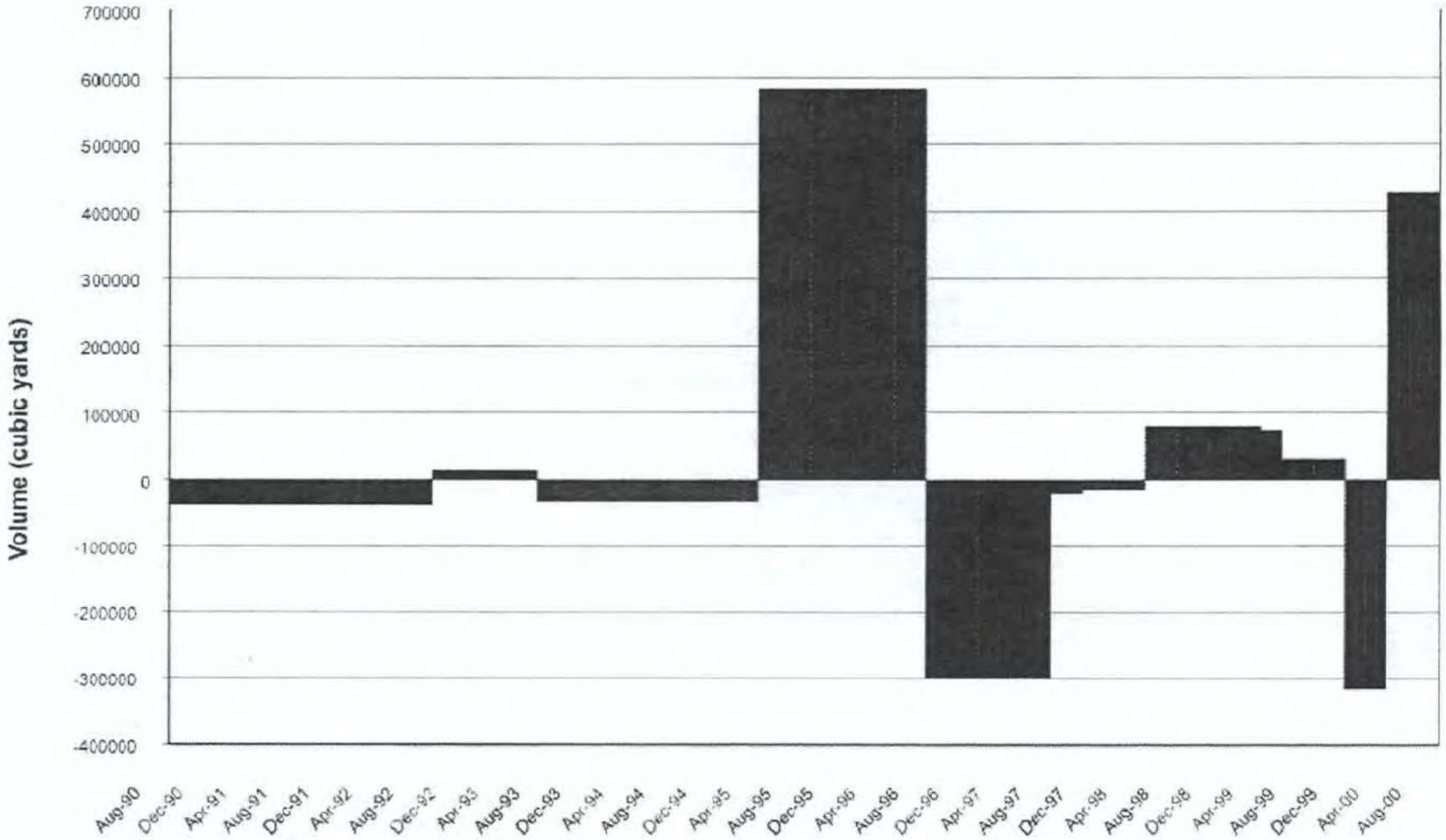

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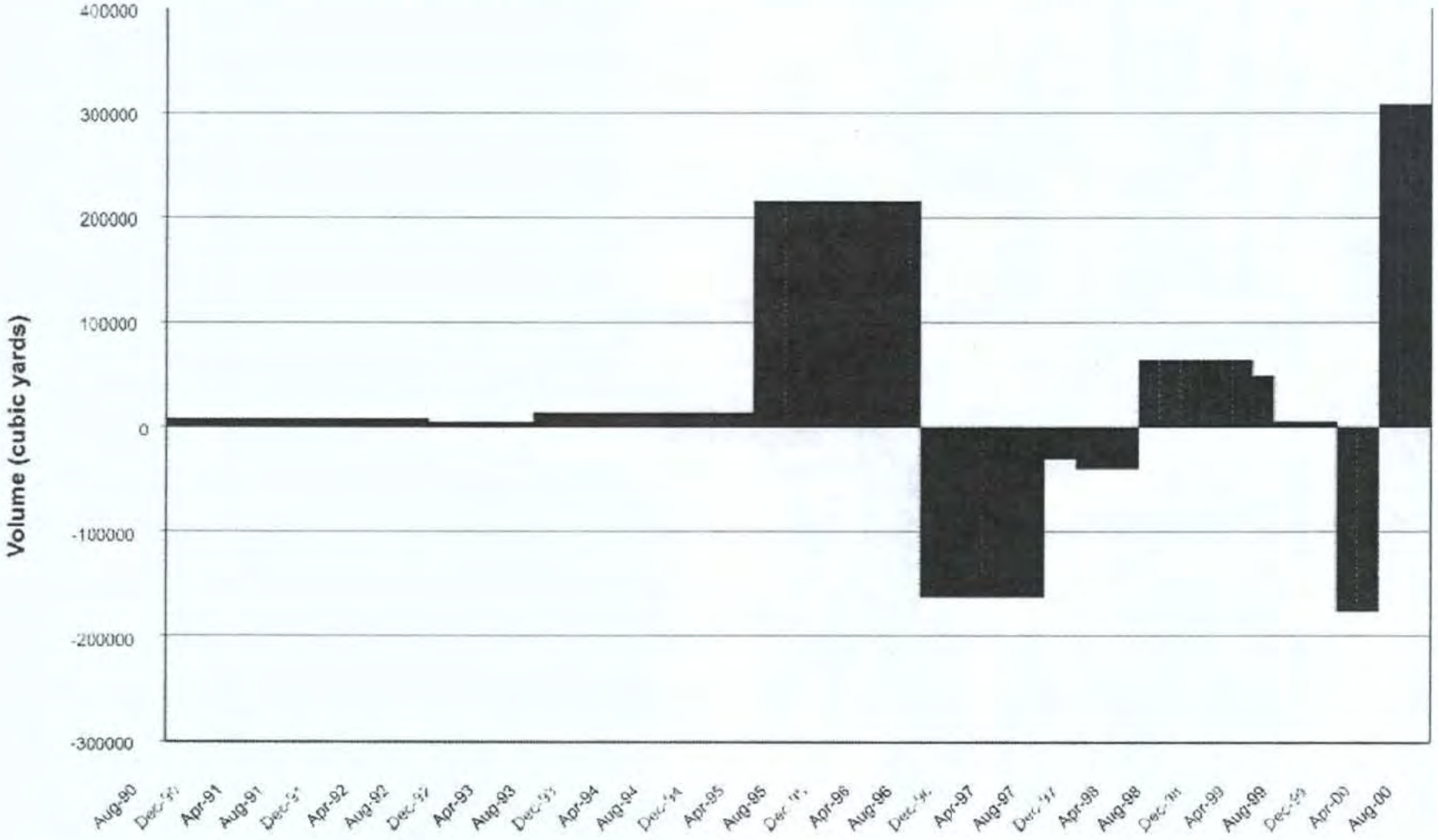

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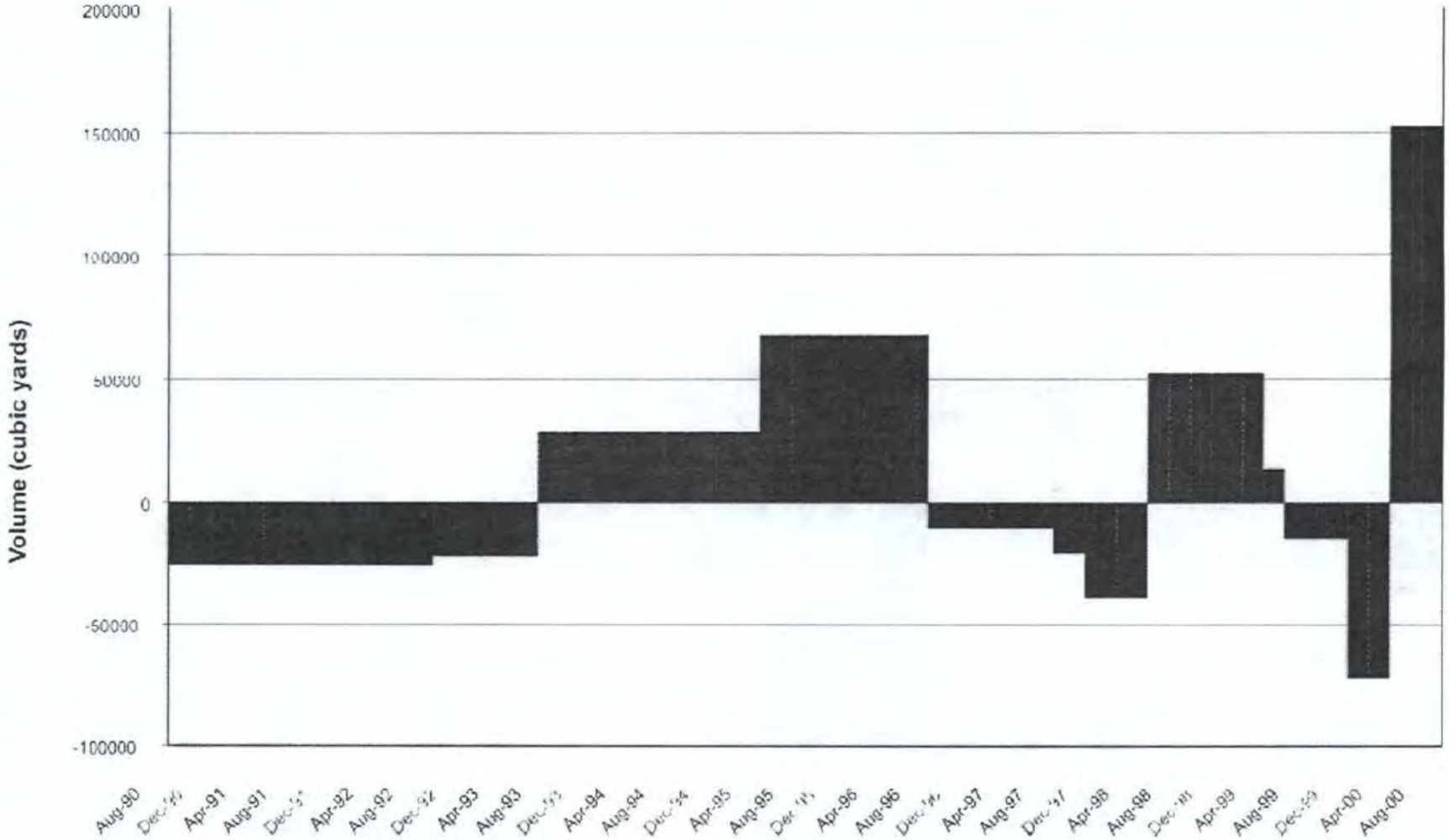

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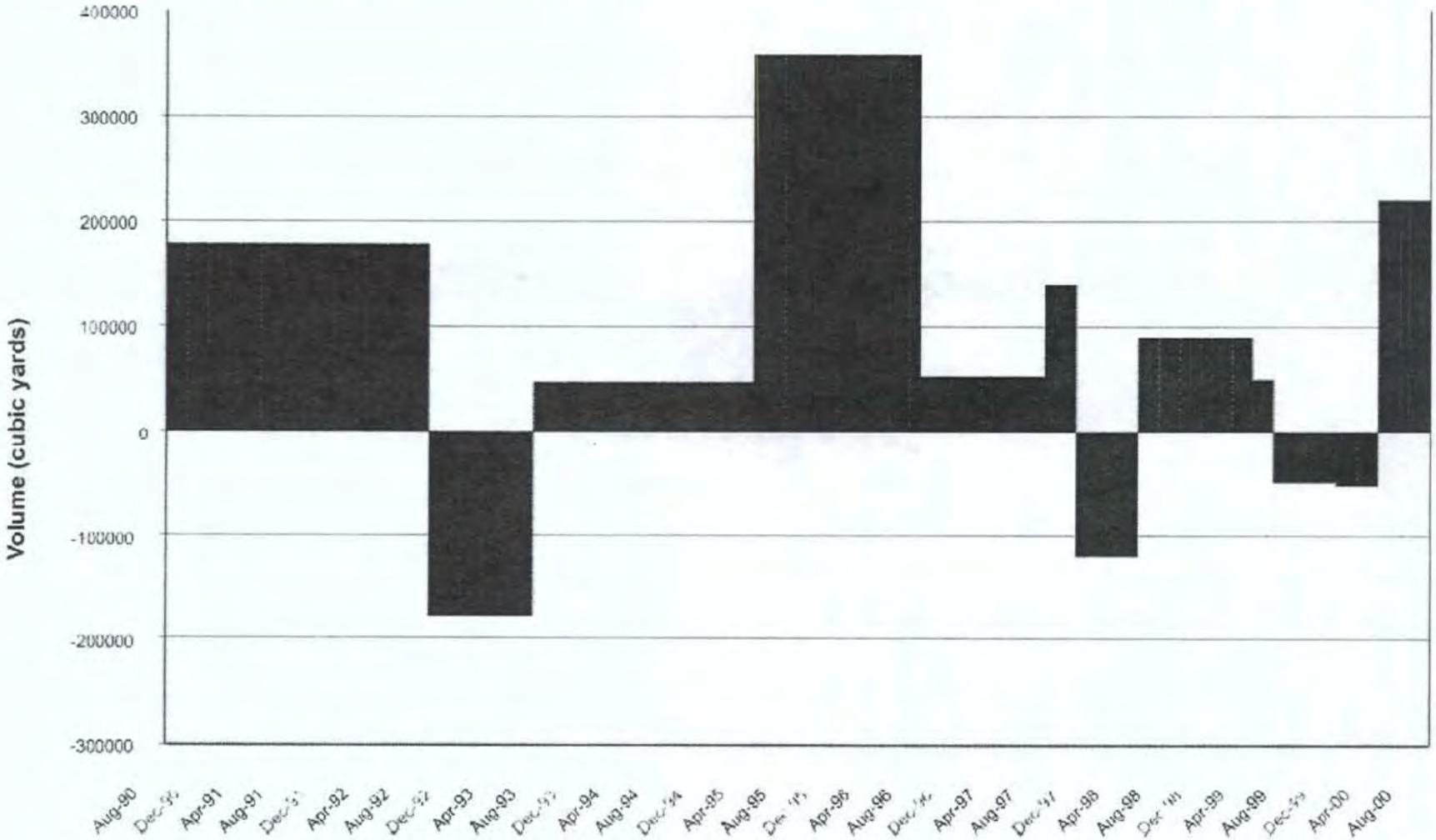

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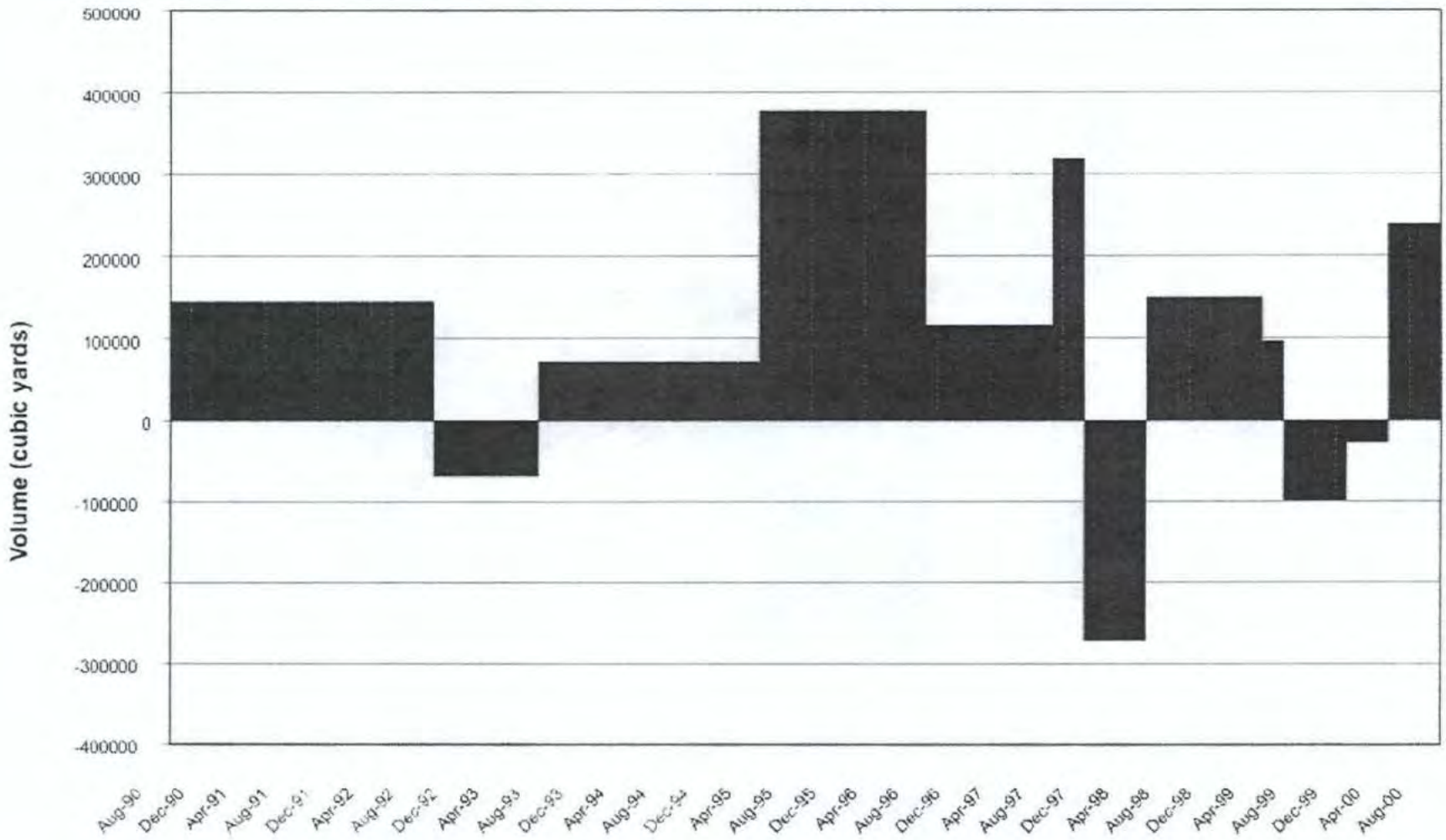

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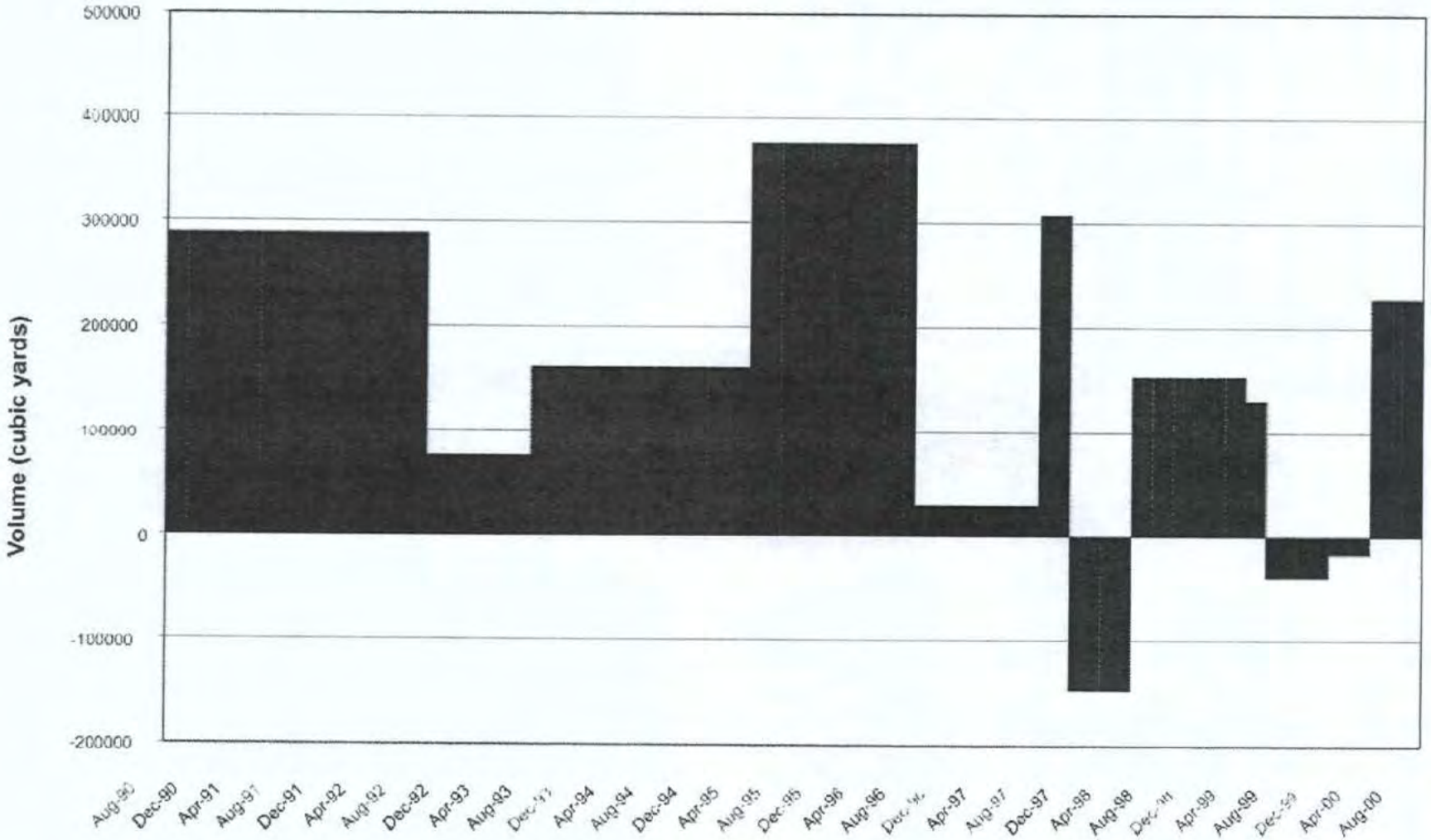

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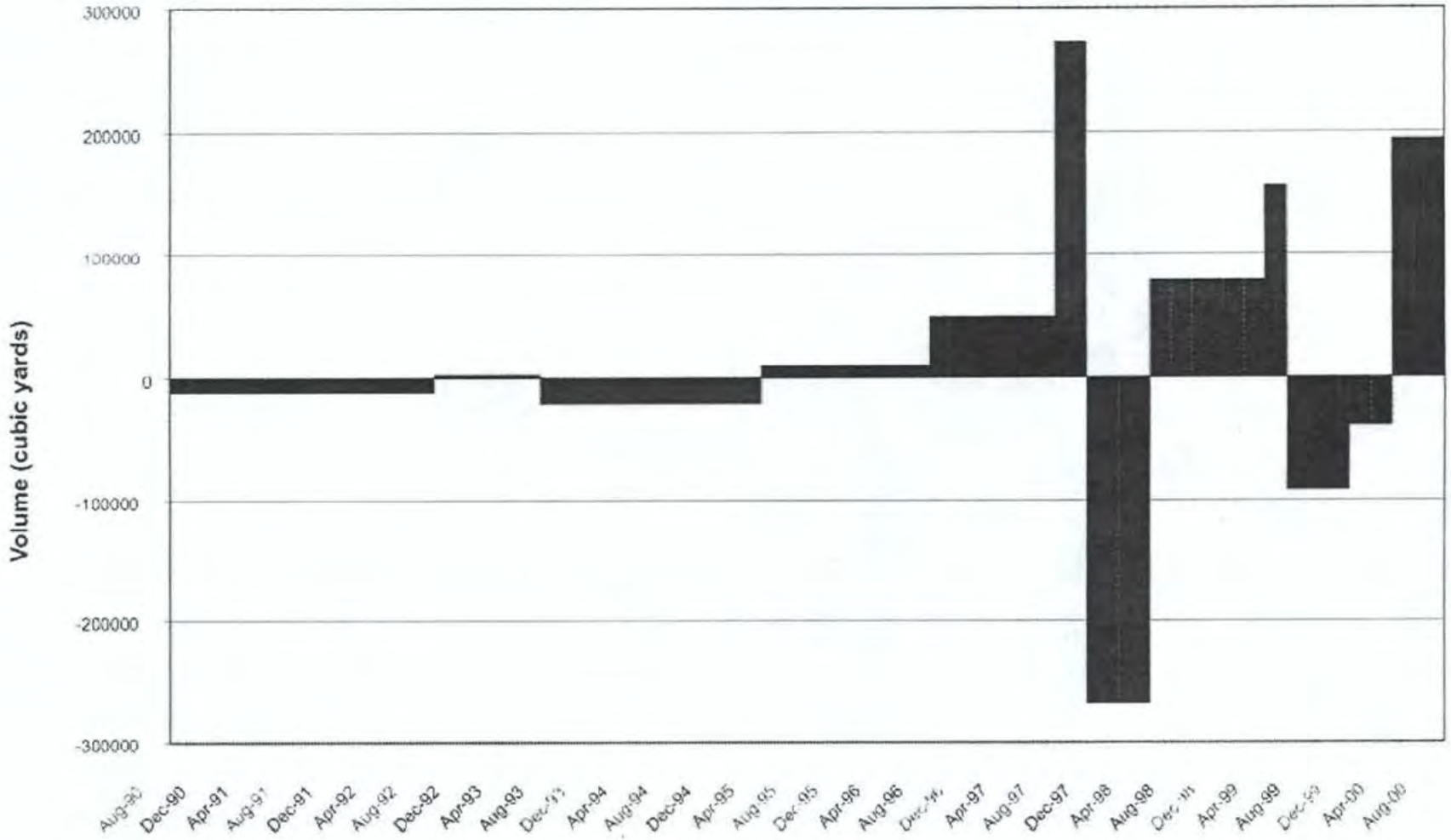
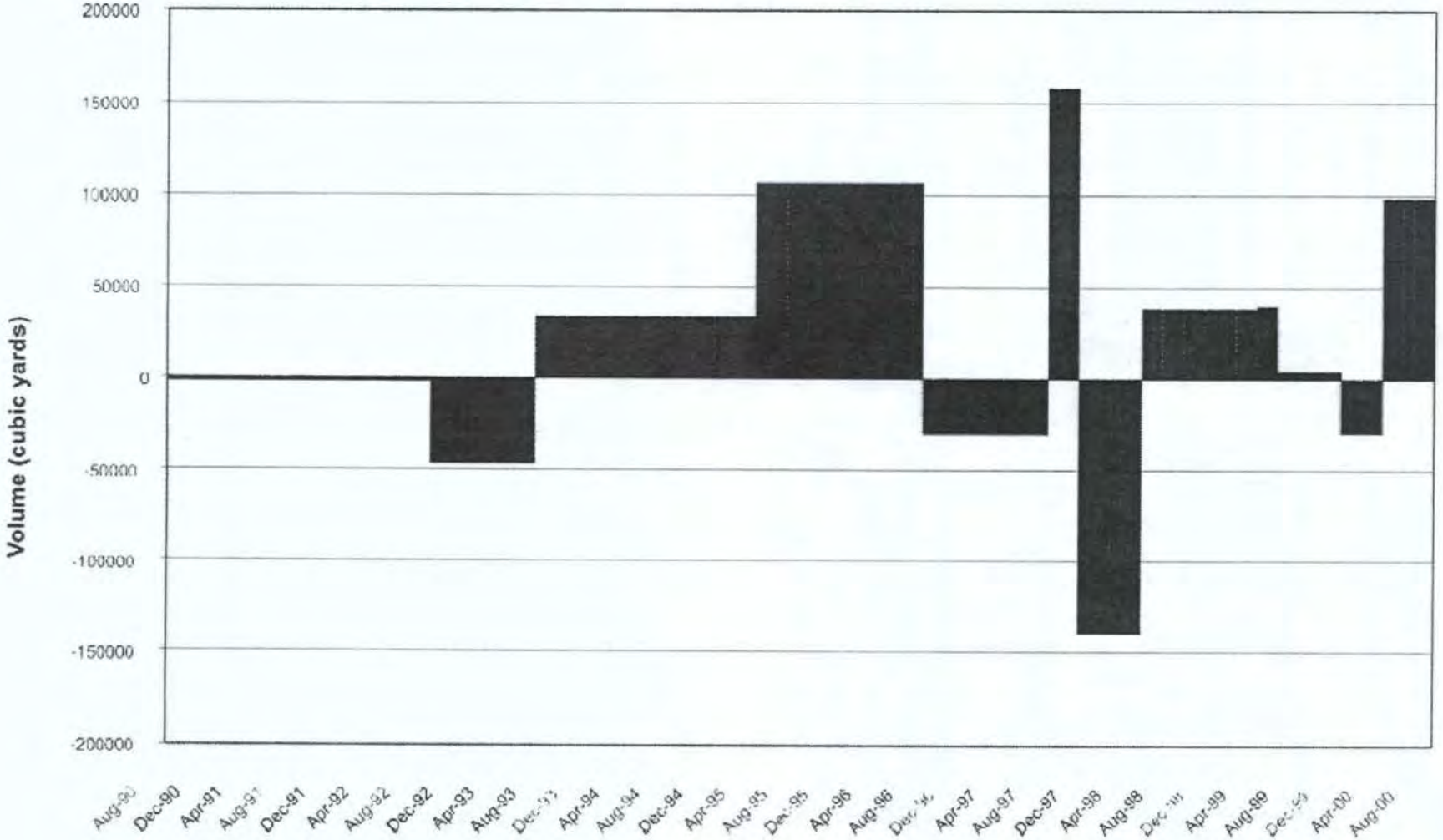


River Mile 11-11.7



Appendix E

LWG
LOWER WILLAMETTE GROUP

PORTLAND HARBOR RI/FS PROGRAMMATIC WORK PLAN

APPENDIX E: CHEMICAL SOURCES AND SPILL RECORDS

REVISED DRAFT FINAL
November 13, 2003

Prepared for:
The Lower Willamette Group

Prepared by:
Striplin Environmental Associates, Inc.

Table E-1. Facilities in Portland Harbor, Chemicals of Interest and Potential Pathways. (Information compiled from DEQ ECSI database, DEQ strategy recommendations, and site-specific reports).

Facility Name	ECSI #	Address	RM	Type of Industry	Chemicals of Interest (present in upland media or identified by DEQ)	Potential Pathway (current or historic)[1]				
						Stormwater	Wastewater Discharge	Groundwater	Spills/ Disposal	Product Handling/ Transfer
ACF Industries	794	12160 NW St. Helens Rd.	4.0	Current vacant. Former lumber mill, railcar painting and repair, wood crate and pallet fabrication.	PCBs, chlorinated solvents, PAHs, TPH, antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, silver, selenium, thallium and zinc	X	X	X		
Alder Creek Lumber Co., Inc.	2446	14456 NW Gillihan Loop Rd.	3.0	Lumber	wood waste/debris	X		no data		
Anderson Brothers Property	970	5275 NW St. Helens Road	8.0	Current use unconfirmed. Former trucking company hauling agricultural products, freight, and bulk oil and gas.	DEQ reported that materials associated with property include petroleum products, solvents (toluene, mineral spirits), and paint wastes.			no data		
ARCO Bulk Terminal	1520	9930 NW St. Helens Rd, Burlington	5.2	Petroleum product storage and transfer	PAHs, BTEX, isopropylbenzene, n-propylbenzene, arsenic, cadmium, chromium, copper, lead, merucyr, nickel, zinc	X		X	X	X
ATOFINA Chemcials (formerly Penwalt Chemical, Elf Atochem)	398	6400 NW Front Ave.	7.5	Former chemical and pesticide manufacture	DDT, DDD, DDE, chlorobenzene, chloroform, chlorinated solvents, chloral, 2-chlorophenol, hexavalent chromium, ammonia, monochlorobenzene	X	X	X	X	
Aventis Crop Science (Rhone-Poulenc)	155	6200 NW St. Helens Rd.	7.3	Former herbicide, insecticide, fertilizer manufacturing	Pesticides, herbicides, phenols, VOCs, PAHs, PCBs, arsenic, lead, mercury.	X	X	X	X	
Babcock Land Co.	2361	9933 NW 107th Ave.	4.8	Log and lumber storage; stee rail and railroad material storage	Unknown	X		no data		
Burlington Northern Santa Fe/Portland Terminal Railroad Company and lessees below			9.5							
Northern Hub Center/Guild Lake Railyard	100	3500/3930 NW Yeon Ave		Switching yard, bulk petroleum storage, loading/unloading, locomotive refueling	TPH (diesel), PAHs, benzene, toluene, phenolic compounds, solvents (TCE), metals, possibly creosote constituents	X		X	X	X
1) Kleen Blast (BNSF lessee)				Storage, packing, and distribution of copper slag media, spent abrasive grit blast.	see above					
2) Eastman Chemical (current leasee)/McWhorter Technologies/McCloskey Corp.	135	4155 NW Yeon		Chemical storage	see above					
3) Gresham Transfer (BNSF lessee)				Transfer of bulk materials (soda ash, lime, coal, roofing grit, cement, talc, plastic beads, sand, cornstarch) from rail cars to tractor trailers	see above					
4) Vopak/Van Water and Rogers (BNSF lessee) subsidiary of Univar, formerly McKesson	330	3950 NW Yeon Ave		Chemical supply; packaged and stored chemicals; distilled and recycled solvents	see above					
BNSF Willbridge Yard				Staging and loading rail tank cars with petroleum products	see above					
Cascade General (see Swan Island Shipyard)			8-9							
Christenson Oil - Plant No. 1	2426	3821 NW St. Helens Rd.	9.5	Bulk petroleum product storage and transfer	TPH, PAHs, BTEX, copper, lead, zinc	X		no data	X	X
Chevron USA Asphalt Refinery	1281	5501 NW Front Ave.	8.3	Asphalt refining	TPH, BTEX, PAHs, phenolic compounds	X		X	X	X
City of Portland BES Water Pollution Control Lab	2452	6543 N. Burlington Avenu	6.0	Analytical testing laboratory. Former lumber mill.				no data		
Columbia American Plating	29	300 NW 35th Ave	9.0	Metal finishing, electroplating	Cd, Cr, Pb, cyanide, zinc, TCE			X		
Columbia River Sand and Gravel - see Linnton Plywood	2351	10504 NW St. Helens Rd.	4.8	Sand and gravel storage and distribution, located on Linnton Plywood property.	see Linnton Plywood ESCI #2373.					
Crawford Street Corp. (formerly Columbia Forge and Machine Works, TLS Steel, Lampros Steel	2363	8424 Crawford St.	6.3	Metal forging, stamping, and fabrication; steel recycling and distribution,	PAHs, PCBs, arsenic, cadmium, chromium, copper, lead, nickel, and zinc	X		X		
Equilon Enterprises, LLC (see Texaco)	169	3800 NW St. Helens Road		Bulk petroleum facility.	TPH, BTEX, PAHs, MTBE, ethanol, lead	X				
Foss Maritime / Brix Maritime	2364	9030 NW St. Helens Rd.	5.7	Vessel dispatch, fueling, and maintenance	TPH, PAHs, BETX, VOCs, cadmum, chromium, lead	X		X	X	X
Fred Divine Diving & Salvage Co. (Marine Salvage Consortium, Inc)	2365	6211 N. Ensign	8.2	Storage and maintenance of boats and other marine salvage gear. Vessel refueling. Washing and storage of haz waste transportation equipment from 1989-1996.	PAHs, bis(2-ethylhexyl)phthalate, bis(2-chloroisopropyl)ether, arsenic, cadmium, copper, zinc	X		no data	X	X
Freightliner	115	5400 N. Basin Ave.	8.3	Truck parts manufacturing	Toluene, ethylbenzen, xylenes, vinyl chloride, other solvents/thinners (TCE, PCE, DCE)			X	X	
Freightliner	2366	6936 N. Fathom St.	8.3	Truck manufacturing	TPH, PAHs, solvents, antifreeze, phthalate esters, aryl phosphate esters, PCBs, methyl phenols, Ba, Cd, Cr, Cu, Pb, Hg, Zn			no data		
Front Ave. LLP (Tube Forgings)	1239	5200 NW Front Ave	8.5	Pipe fitting manufacturing	TPH, VOCs, SVOCs, and metals	X		X		
Front Ave. LLP (CMI/Hampton Lumber))	1239	4950 NW Front Ave.	8.5	Lumber and construction material storage and loading	See above					
Front Ave. LLP/Glacier NW (former Lone Star NW)	2378	5034 NW Front Ave.	8.5	Concrete batch plant	See above					
GASCO (Northwest Natural)	84	7900 NW St. Helens Rd	6.5	Liquid natural gas production, storage and distribution of creosote oil, coal tar pitch, diesel, and fule oil products. Formerly oil gasification (Portland Gas & Coke Company).	PAHs, phenols, naphthalene, BTEX, cyanide, arsenic, chromium, copper, lead, nickel and zinc	X	X	X	X	X
GATX/Kinder Morgan Liquid Terminals (formerly GATX ST. Helens Rd facility). Olympic Pipeline transfer station in SW corner of property Also Santa Fe pipeline	1096	11400 NW St. Helens Rd.	4.0	Bulk petroleum product storage and transfer	TPH, PAHs, lead, BTEX, MTBE, chlorobenzene, dichlorobenzenes		X	X	X	X
General Construction - See Transloader International (ECSI #2367)										
Georgia-Pacific - Linnton Fiber Terminal	2370	12222 NW Marina Rd.	3.5	Formerly wood chip export terminal, lumber storage, sawmill, creosoting plant.	TPH, PAHs; possibly arsenic and pentachlorophenol	X		X		X
Goldendale Aluminum Co.	2440	2600 N. River St.	10.0	Alumina off-loading, storage and transfer.	Metals, possibly PAHs	X		no data	X	X
Gould Industries	49	5909 NW 61st Ave	7.5	Battery manufacturing/recycling	Lead					
GS Roofing Products (Genstar)	117	6350 NW Front Ave	7.3	Manufactures asphalt roofing products	Fuel oil, asphalt, benzene, copper, zinc	X				X
Gunderson Inc. (former Schnitzer site, in part)	1155	4350 NW Front Ave	9.5	Ship dismantling, auto salvage	1,1,1-trichloroethane, PAHs, TPH, waste oil, BTEX, waste solvents, PCBs, metals (lead, chromium, copper, mercury, nickel, and zinc)	X		X	X	
Hendren Tow Boats - See Marine Finance (ECSI #2352)	2389									
Kinder Morgan - see GATX (ECSI #1096)										
Koppers Industries, Inc. (see GASCO ECSI #84)	2348	7540 NW St. Helens Rd (located on Wacker property)	7.0	Creosote and tar pitch distribution						
Lakeside Industries	2372	4850 NW Front Ave.	8.5	No information on current use. Former steel factory.	Unknown	X		no data	unknown	unknown
Linnton Oil Fire Training Grounds	1189	NW Marina Way	4.0	No current use. Formerly personnel training for extinguishing flammable fluid fires.	TPH, PAHs, benzene, shlorinated solvents, arsenic	X				
Linnton Plywood Association (inc. Columbia R. Sand & Gravel)	2373	10504 NW St. Helens Rd.	4.8	Currently inactive. Formerly plywood manufacture.	TPH, PAH, phthalates, VOCs, PCBs, cadmium, chromium, copper, lead, zinc	X		X	X	

Table E-1. Facilities in Portland Harbor, Chemicals of Interest and Potential Pathways. (Information compiled from DEQ ECSI database, DEQ strategy recommendations, and site-specific reports).

Facility Name	ECSI #	Address	RM	Type of Industry	Chemicals of Interest (present in upland media or identified by DEQ)	Potential Pathway (current or historic)[1]				
						Stormwater	Wastewater Discharge	Groundwater	Spills/ Disposal	Product Handling/ Transfer
MarCom, Inc.	2350	8970 N. Bradford St.	5.8	Ship repair, including machining, sandblasting, maintenance.	TPH, PAHs, organotins, chlorianted solvents, PCE, arsenic, chromium, copper, lead, mercury, zinc	X		X	X	X
Marine Finance Corporation	2352	8444 NW St. Helens Rd.	6.0	Tug maintenance, storage, houseboat and sailboat construction. Formerly ferry landing, oil storage, metal salvage, other.	PAHs, TPH, VOCs, phenols, PCBs, phthalates, SVOCs, butyltins, metals	X		X	X	
McCall Oil & Great Western Chemical	134	5550 NW Front Ave.	7.5	Petroleum product storage and transfer	TPH, chlorinated solvents, metals	X		X	X	X
McCormick & Baxter Creosoting Company	74	6900 N. Edgewater St.		Currently vacant. Formerly wood treating facility.	PAHs, pentachlorophenol, dioxins/furans, arsenic copper, chromium, cobalt, zinc	X	X	X	X	X
Mobil Oil Terminal	137	9420 NW St. Helens Rd.	5.3	Petroleum storage and distribution.	TPH, PAHs, BTEX, arsenic, copper and lead.	X		X	X	X
Morse Brothers - see G-P Linnton (ECSI #2370)										
Olympic Pipeline Co.	2374	11400 NW St. Helens Rd.	3.5-7.9	Petroleum products pipeline	PAHs, BTEX, TPH				X	X
St. Helens Road Petroleum Contamination	2630	NW St. Helens Road		Soil and GW contam. May be related to Olympic Pipeline leaks	Diesel, heavy oil, gasoline, PAHs, BTEX			X		
Oregon Steel Mills - Rivergate	141	14400 N. Rivergate Blvd.	3.0	Steel mill; steel plate and coil manufacturing.	TPH, PCBs, VOCs, and metals	X		X	X	
Owens Corning - Linnton	1836	11444 NW St. Helens Rd.	4.2	Asphalt and roofing manufacturer. Formerly wood treating and lumber related uses.	TPH, PAHs, arsenic, PCP	X				X
Portland Gas Manufacturing	1138	NW 2nd Aven	12.0	Currently inactive. Formerly coal/gas manufacturing.	Contaminants assoicated with other coal gas facilities include PAHs, TPH, BTEX, heavy metals, SVOCs.				X	X
Portland General Electric - Harborton Substn.	2353	12430 & 12500 NW Marina Way	3.5	Electrical substation.	TPH, PAHs. Possible (unconfirmed) chemicals include PCBs, BTEX, phthalates, PCP, and herbicides.	X		X		
Portland Shipyard - Swan Island	271	*NA*	9.0	Ship repair, dry dock	PAHs, TPH, PCBs, VOCs, chlroinated solvents, metals, organotins	X	X	X	X	X
Port of Portland-Terminal 1 North	3377	2200 NW Front Ave	10.5	Multiple lessees: aluminum window assembly; warehousing of building products; service dock for tour boats; paper product, lumber and wood products storage	TPH	X		X	X	X
Port of Portland-Terminal 1 South	2642	2100 NW Front Ave	10.5	Multiple lessees: refractory brick manufacture, patrol boat moorage, laminated wood products manufacturing	TPH, PAHs, phthalates, metals, VOCs, herbicides, pesticides, PCBs, organotins	X		X	X	X
Port of Portland-Terminal 2	2769	3556 NW Front Ave	10.0	Cargo (steel, lumber, plywood, and pulp) and container shipping and handling.	TPH, PCBs	X				X
Port of Portland-Terminal 4 - Slip 3	272	10400 N. Lombard	4.7	Marine shipping and handling	TPH, PAHs, BTEX	X		X	X	X
Port of Portland Terminal 4 - Toyota Motor Sales	172	10400 N. Lombard	5.0	Vehicle processing, shipping and unloading of autos	PAHs	X				
Port of Portland-Terminal 4 - Slip 1	2356	N. Lombard St.	4.3	Shipping terminal for grain, breakbulk cargoes, logs, minerals, liquid bulks	SVOCs, PAHs, cadmium, chromium, lead, mercury, zinc.	X		no data		X
Port of Portland-Terminal 5 (Blue Lagoon)	1686	North Lombard Street	1.0	Currently grain terminal, bulk mineral shipping, and fiber optic submarine cable manufacture. Formerly OSM slag disposal.	iron and manganese in groundwater; metals and PCBs at low levels.	X				
Port/Shaver Oil Sump	none	adjacent to Oregon Steel Mills main facility (sw corner)	2.5	No current use. Formerly oly bilge watewater discharge into ponds.	TPHs	X		X	X	X
RK Storage & Warehousing	2376	10225 NW Front Ave.	4.5	Current use unknown. Formerly log and lumber storage, also sand blast grit. West Coast Adhesives (ECSI #333) manufactured phenol formaldehyde glues on northern portion of property.	TPH, formaldehyde, phenolics, phthalate esters,	X		X	X	
Ross Island	2409	4315 SE McLoughlin Blvd	15.4	Disposal of contaminated dredged material	PCBs, PAHs, petroleum, metals, pesticides, herbicides					
Santa Fe Pipelines (purchased by Kinder-Morgan)	2104	6565 NW St. Helens Rd.	7.0	Fuel pipeline	TPH, PAHs, BTEX	X			X	
Schnitzer Investment Corp. (North Burgard Site)			3.7	Multiple lessees.						
Schnitzer Steel	2355	12005 N. Burgard Rd.	3.7	Ship dismantling, scrap metal recycling, including automobiles	Metals, PAHs, PCBs, TPHs, solvents	X		X		
Boydston Metal Works	2362	9002 N. Sever Court	3.7	Fabrication and painting of automobile transport trailers.	Metals, TPH, solvents, PCBs	X		X		
Cal Bag Metals	2454	4927 NW Front Ave.	3.7	Staging area for recycling non-ferrous metals.	Diesel fuel storage on site.	X			X	X
Morgan			3.7	Storage and distribution of urea and wood products for overseas shipment. Historically used for log storage	Fuel stored on site	X		X	X	
Northwest Pipe and Casing	138	12005 N. Burgard St.	3.7	Pipe manufcutring and coating.	PCBs, oil, gasoline, PAHs, solvents	X		X		
Portland Blast Media			3.7	Sandblasting, manufacture of protective coatings for recycling containers.	Metals, solvents, paints	X		X	X	X
Portland Container Repair	2375	9449 N. Burgard Way	3.7	Storage and maintenance of intermodal containers and chassis.	Oil, solvents, fuel	X		X		
Premier Edible Oils	2013	10400 N. Burgard Way	3.7	Food grade product storage	TPH, PAHs, BTEX, chlorinated solvents	X		X		
Romar Transportation Systems	2437	9333 N. Time Oil Rd	3.7	Warehousing	PCBs	X		no data	X	
Ryerson Steel	2441	9040 N Burgard Way	3.7	Manufacture and distribution of structural steel products	No data.	X		X		
Jefferson Smurfit	2371	9930 N. Burgard Way	3.7	Unknown.	Unknown	X		no data		
Western Machine Works			3.7	Metal machining, fabrication for industrial parts (primarily pulp and paper industry)	TPH, PAHs, metals, solvents, waste oils and paints	X		X	X	X
Schnitzer-Doane Lake (Air Liquide American Corp.)	395	6529 NW Front Ave		Acetylene manufacturing, disposal of auto shredder waste from other Schnitzer facilities	Calcium hydroxide, lead, arsenic, TPH, PCBs, chlorinated solvents (TCA, acetone, MEK, 1,1-DCA).	X	X	X	X	
Schnitzer-Moody Ave site	875	SW Moody Avenue		Currently vacant. Formerly ship dismantling, auto shredding, metals salvaging, process, pesticide manufacturing	DDTs, hexachloropentadiene, PCBs, TCE, acetone and other solvents, metals, PAHs	X		X	X	
Schnitzer-Kittridge site	2442	4959 NW Front Avenue	8.5	No info.						
Schnitzer-near NW Yeon (formerly Chase Bag, Great Western Chemical and Willard Storage Battery)		3720 NW Yeon Ave		Former multi-wall bag construction, hardware wholesale, chemical manufacture, storage battery manufacture	Chlorinated solvents (possibly PCE DNAPL), metals (particulary Pb)	X		X	X	X
Shaver Transportation Co.	2377	4900 NW Front Ave.	8.5	Tug dispatch, refueling and maintenance.	Materials handled on site include diesel fuel, paints, oils and solvents.	X			X	X
South Rivergate Industrial Park - see Terminal 5 (ECSI #1686), Oregon Steel Mills (ECSI #141)	2980	N. Rivergate Blvd.	<3.5							
Sulzer Bingham Pumps	1235	2800 NW Front Ave		Pump manufacturing	Petroleum products, chlorinated solvents, including BTEX, zinc	X		X	X	
Texaco Portland Bulk Pipeline	2117	4350 Front Ave. (Gunderson)		Petroluem product transfer.	TPH, PAHs, BTEX, MTBE, lead	X		X	X	
Texaco Portland Bulk Terminal (see Equilon ECSI #169)										

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						Stormwater	Wastewater Discharge	Groundwater	Spills/ Disposal	Product Handling/ Transfer
Time Oil-Northwest Terminal	170	10350 N. Time Oil Rd	3.8	Former bulk petroleum storage facility	TPH, BTEX, PAHs, PCP and other chlorinated phenols, dioxins/furans, metals, PCBs	X		X	X	X
Time Oil-Linnton Terminal	1989	9400 NW St. Helens Rd.	5.5	Bulk petroleum storage facility	TPH (gasoline), PAHs, BTEX				X	X
Triangle Park LLC	277	5828 N. Van Houten Pl.	7.5	Currently inactive. Former lumber mill, petroleum pipeline, fuel storage, marine construction, hazardous waste storage from 1908 to 1984.	Metals, PCBs, chlorinated solvents, PAHs, pentachlorophenol, possbily dioxins	X		X		
Transloader Intl. Co. (aka: Marine Finance Corp ECSI 2352.; Hendron Tow Boat #2389)	2367	8444 NW St. Helens Rd.	6.0	Current use unknown. Formerly log storage. No other information.	No upland data. Sediments do not appear to be impacted.			no data		
Trumbull Asphalt Plant	1160	3605 NW 35th Ave		Asphalt manufacturing	Petroleum hydrocarbons, diesel fuel, asphalt distillate	X		X	X	X
U.S. Coast Guard - Portland Station	1338	6767 North Basin Ave.	8.3	Docking, servicing and refueling of small boats. Limited sandblasting.	TPH, Pahs,metals (including mercury, tributylin). Possibly sovents, herbicides.	X			X	X
U.S. ACOE- Portland Moorings	1641	8010 NW St. Helens Rd.	6.2	Maintenance and repair of Corps vessels	TPH, PAHs, metals including TBT	X		no data	X	X
Union Pacific Railroad-Albina Yard	178	2745 N. Interstate Ave	10.0	Railroad yard, rail car painting and maintenance, locomotive refueling.	TPH, PAHs, other SVOCs, VOCs, metals, butyltins, PCBs	X		X	X	
Union Pacific Railroad pipeline and St. Johns tank farm	2017	6908 N. Roberts Ave		Currently vacant. Former bulk fuel facility. Pipeline extends to Terminal 4 - Slip 3.	TPH, PAHs, BTEX	X		X	X	X
Wacker Siltronics Corp.	183	7200 NW Front St.	7.0	Semiconductor manufacturing. Site has been impacted by past disposal practices at GASCO and Olympic Pipeline that transits the site.	PAHs, phenols, chlorinated solvents, BTEX, metals		X	X	X	X
Willamette Cove/St. Johns Riverfront	2066	N. Edgewater St.	7.0	No current use; proposed greenbelt. Formerly various industrial, including wood and lumber-related activities, dry dock, coal off-loading.	TPH, PAHs, TBT, PCP, PCBs, solvents, metals	X		X	X	X
Willbridge Bulk Fuel Area (includes facilities listed below). Olympic Pipeline and Santa Fe Pipeline also cross facility.	1549	NW Doane Ave.	7.8	Petroleum product storage and distribution. Includes three separately owned parcels.	TPHs, PAHs, BTEX, chlorinated and non-chlorinated solvents, DDT	X		X	X	X
Kinder Morgan (formerly GATX, formerly Shell)	160	5880 NW St. Helens Rd		Historically, pesticide, nonchlorinated solvents, ammonia, ethylene glycol, asphalt products storage at GATX.	see above					
TOSCO (formerly UnoCal)	177	5528 NW Doane Ave.		Petroleum product storage and distribution.	see above					
Chevron	25	5531 NW Doane Ave		Historically, naphtha solvents.	see above					
Zidell	689	3121 SW Moody Ave	14.0	Ship dismantling, barge construction, tube forging	Metals, PCBs, TPH, chlorinated solvents, TBTs, asbestos	X		unknown	X	X

[1]X = possible pathway, additional data may be required to confirm

Table E-2a. List of Non-city Outfalls Compiled by City of Portland in 2001. (Note: includes both active and abandoned outfalls).

City Designation[a]	Adjacent Business Name[b]	Outfall Diameter	Outfall Material
1	Sulzer Bingham	12"	composite
2	Sulzer Bingham	24"	steel
3	Sulzer Bingham	15"	steel
4	Sulzer Bingham	24"	composite
5	Sulzer Bingham	48"	steel
6	Rhone Poulanc	6"	steel
7	Tube Forgings		
8	McCall Oil	24"	composite
9	McCall Oil		
10	McCall Oil	8"	composite
11	Great Western Chemical	12"& 6"	pvc
12	Tosco	4"	pvc
13	Kinder Morgan T5	24"	composite
14	Chevron Transportation	4"	steel
15	NW Paper Box Mfg	10"	steel
16	NW Paper Box Mfg	10"	csp
17	Prodica	12"	composite
18	Prodica	12"	composite
19	Ash Grove Cement	24"	composite
20	Kinder Morgan T4	24"	composite
21	Schnitzer Steel (Premier Edible Oils)	36"	sump
22	Oregon Steel Mills	36"	steel
23	Oregon Steel Mills	24"	composite
24	Oregon Steel Mills	36"	pvc
25	Arco	6"	steel
26	Arco	4"	steel
27	Arco	6"	steel
28	GS Roofing/CertainTeed	10"	composite
29	GS Roofing/CertainTeed	24"	composite
30	Port of Portland	8"	composite
31	Port of Portland	8"	composite
32	Port of Portland	8"	composite
33	Port of Portland	8"	composite
34	Port of Portland	8"	composite
35	Port of Portland	8"	composite
36	Port of Portland	8"	composite
37	Port of Portland	8"	composite
38	Port of Portland		
39	Port of Portland	8"	composite
40	Cascade General	8"	composite
41	Cascade General		composite
42	Cascade General	8"	composite
43	Cascade General	8"	composite
44	Cascade General	24"	composite
45	Cascade General	18"	composite

Table E-2a. List of Non-city Outfalls Compiled by City of Portland in 2001. (Note: includes both active and abandoned outfalls).

City Designation[a]	Adjacent Business Name[b]	Outfall Diameter	Outfall Material
46	Cascade General	18"	composite
47	Cascade General	12"	composite
48	Cascade General	12"	composite
49	Cascade General	18"	composite
50	Cascade General	10"	composite
51	Cascade General	18"	composite
52	Cascade General	10"	steel
53	Cascade General	18"	composite
54	Cascade General	10"	
55	Cascade General		
56	Cascade General		
57	Cascade General	18"	composite
58	Cascade General	8"	steel
59	Cascade General	8"	composite
60	Cascade General	8"	composite
61	Cascade General	12"	composite
62	Cascade General	18"	composite
63	Cascade General	10"	composite
64	Cascade General	10"	composite
65	Cascade General	10"	composite
66	Wacker Siltronic		
67	Wacker Siltronic		
68	Eastern Oregon Fast Freight	12"	
69	Dallas & Mavis	12"	pvc
70	Christianson Elect/Gourmet Deli/UPS		
71	Dallas & Mavis/Foster Farms	9"	csp
72	Dallas & Mavis/Foster Farms	4"	pvc
73	Dallas & Mavis/Foster Farms	6"	pvc
74	Dallas & Mavis/Foster Farms	6"	pvc
75	Olympic Pipeline/GATX	15"	composite
76	Olympic Pipeline/GATX	4"	steel
77	Olympic Pipeline/GATX	15"	composite
78	Mobil Oil	15"	steel
79	Owens Corning Trumble	36"	csp
80	Owens Corning Trumble	24"	csp
81	Owens Corning Trumble	20"	steel
82	Schnitzer/Smurfit	18"	csp
83	Schnitzer/Smurfit/Morgan CFS	30"	
84	Schnitzer/Smurfit/Morgan CFS	30"	
85	Schnitzer Steel (Premier Edible Oils)	10"	csp
86	Marcom	8"	steel
87	US Army Corps of Engineers	4"	steel
88	US Army Corps of Engineers	4"	steel
89	US Army Corps of Engineers	6"	pvc
90	US Army Corps of Engineers	30"	steel

Table E-2a. List of Non-city Outfalls Compiled by City of Portland in 2001. (Note: includes both active and abandoned outfalls).

City Designation[a]	Adjacent Business Name[b]	Outfall Diameter	Outfall Material
91	US Army Corps of Engineers	6"	pvc&composite
92	US Army Corps of Engineers	6"	pvc
93	US Army Corps of Engineers	12"	steel
94	US Army Corps of Engineers	8"	steel
95	ATOFINA Chemicals	36"	fiberglass
96	ATOFINA Chemicals	36"	fiberglass
97	ATOFINA Chemicals	24"	fiberglass
98	ATOFINA Chemicals	30"	fiberglass
99	ATOFINA Chemicals Abandoned Outfall	24"	csp
100	ATOFINA Chemicals Abandoned Outfall	24"	steel
101	ATOFINA Chemicals Abandoned Outfall	36"	csp
102	Linnton Plywood	48"	csp
103	Linnton Plywood	18"	steel
104	Linnton Plywood	18"	composite
105	Linnton Plywood	18"	composite
106	Linnton Plywood	4",3",6"	
107	NW Natural Gas	12"	composite
108	Schnitzer Steel	24"	steel
109	Schnitzer Steel	24"	steel
110	Schnitzer Steel	24"	steel
111	Schnitzer Steel	30"	steel
112	Schnitzer Steel	24",12"	steel
113	Schnitzer Steel	45"	
114	Schnitzer Steel		
115	Schnitzer Steel		
116	Schnitzer Steel		
117	Schnitzer Steel		
118	Schnitzer Steel		
119	Schnitzer Steel		
120	Schnitzer Steel		
121	Schnitzer Steel		
122	Schnitzer Steel		
123	Ryerson/NW Pipe Co.	48"	csp
124	Schnitzer Steel	30"	steel
125	Schnitzer Steel/Ryerson	6"	csp
126	Linnton Plywood	36"	composite
127	Gunderson	6"	composite
128	Gunderson	6"	composite
129	Gunderson	6"	composite
130	Gunderson	6"	composite
131	Gunderson	6"	composite
132	Gunderson	6"	composite
133	Gunderson	6"	
134	Gunderson	12"	
135	Gunderson	10"	

Table E-2a. List of Non-city Outfalls Compiled by City of Portland in 2001. (Note: includes both active and abandoned outfalls).

City Designation[a]	Adjacent Business Name[b]	Outfall Diameter	Outfall Material
136	Gunderson	8"	
137	Gunderson	10"	
138	Gunderson	6"	csp
139	Gunderson	6"	composite
140	Gunderson	6"	composite
141	Gunderson	6"	composite
142	Gunderson	6"	composite
143	Gunderson	6"	composite
144	Gunderson	6"	composite
145	Gunderson	6"	composite
146	Gunderson	6"	composite
147	Gunderson	6"	composite
148	Gunderson	6"	pvc
149	Gunderson	6"	composite
150	Gunderson		
151	Time Oil Rivergate	12"	csp
152	Time Oil Linnton	6"	composite
153	Morse Brothers	36"	csp
154	International Raw Materials	6"	pvc
155	Cascade General	24"	composite
156	Cascade General	18"	
157	Cascade General		
158	Port of Portland	18"	steel
159	Port of Portland	12"	steel
160	Port of Portland	6"	steel
161	Port of Portland	8"	steel
162	Port of Portland	18"	composite
163	Port of Portland	12"	composite
164	Port of Portland	18"	csp
165	Alcatel	24"	composite
166	Port of Portland	24"	
167	Port of Portland	18"	
168	Port of Portland	36"	
169	Port of Portland	24"	
170	Port of Portland	6"	
171	Port of Portland	8"	
172	Port of Portland		
173	Port of Portland	3"	
174	Port of Portland		
175	Port of Portland		
176	Port of Portland	10"	
177	Port of Portland	18"	
178	Port of Portland	21"	
179	Port of Portland	21"	
180	Port of Portland	21"	

Table E-2a. List of Non-city Outfalls Compiled by City of Portland in 2001. (Note: includes both active and abandoned outfalls).

City Designation[a]	Adjacent Business Name[b]	Outfall Diameter	Outfall Material
181	Port of Portland	15"	
182	Port of Portland	18"	
183	Port of Portland	21"	
184	Port of Portland	10"	
185	Eastern Oregon Fast Freight	12"	
186	Eastern Oregon Fast Freight	12"	
187	Schnitzer Property	12"	composite
188	Schnitzer Property	10"	csp
189	Metro Property	24"	composite
190	Metro Property	6"	csp
191	Metro Property	4"	steel
192	Metro Property	4"	steel
193	Metro Property	5 Ofs	
194	McCormick & Baxter Abandoned		
195	McCormick & Baxter		
196	McCormick & Baxter Abandoned		
197	McCormick & Baxter Abandoned		
198	US Coast Guard	15"	composite
199	US Coast Guard	10"	composite
200	US Coast Guard	12"	composite
201	US Coast Guard	12"	composite
202	Arco/Mobil	60"	composite
203	Arco/Linnton Plywood	36"	composite
204	Olympic Pipeline/GATX	24"	
205	US Army Corps of Engineers	24"	steel
206	US Army Corps of Engineers	24"	csp
207	ODOT	24"	
208	ODOT	18"	steel
209	Mobil Oil	48"	
210	Foss Abandoned		
211	Stan Wagner	36"	composite
212	Foss Maritime		csp
213	Culvert	24"	composite
214	Reidel	6"	steel
215	Reidel	15"x2	steel
216	Savage Industries	12"	
217	Union Pacific RR	18"	
218	Union Pacific RR	30"	composite
219	Marcom	18"	steel
220	Fort James	30"	csp
221	Fort James	30"	csp
222	Port of Portland T1	2"	
223	Riverscape LLC	6"	
224	Riverscape LLC	12"	
225	Riverscape LLC	12"	

Table E-2a. List of Non-city Outfalls Compiled by City of Portland in 2001.
(Note: includes both active and abandoned outfalls).

City Designation[a]	Adjacent Business Name[b]	Outfall Diameter	Outfall Material
226	Riverscape LLC	12"	
227	Port of Portland T1	15"	
228	Port of Portland T1	8"	
229	Port of Portland T1	6"	
230	Port of Portland T1 (leased to other party)	15"	
231	Port of Portland T1 (leased to other party)	6"	
232	Port of Portland T1 (leased to other party)	15"	
233	Port of Portland T1 (leased to other party)	8"	
234	Port of Portland T1	6"	
235	Port of Portland T2	27"	
236	Port of Portland T2	36"	
237	Morse Brothers	12"	csp
238	Morse Brothers		
239	Morse Brothers	24"	csp
240	Goldendale Aluminum	12"	composite
241	Goldendale Aluminum	12"	composite
242	Goldendale Aluminum	12"	composite
243	Goldendale Aluminum		
244	Goldendale Aluminum		
245	Goldendale Aluminum		
246	University of Portland	24"	composite
247	University of Portland	12"	composite
248	Reidel	18"	steel
249	Shenanigans/Freightliner	36"	composite
250	Freightliner	12	composite
251	Freightliner	12"	composite
252	Freightliner	8"	pvc
253	Freightliner	12":	composite
254	Freightliner	12"	steel
255	McCormick & Baxter		
256	Hampton Lumber	18"	csp
257	Hampton Lumber	18"	csp
258	Portland Fire Bureau	10"	pvc
259	Fort James	12"	csp
260	Fort James	12"	csp
261	Fort James	12"	csp
262	Fort James	12"	csp
263	Fort James	12"	csp
264	Fort James	12"	csp
265	Fort James	12"	csp
266	Fort James	12"	csp
267	Fort James	12"	csp
268	Fort James	12", 6"	csp
269	Fort James	12"	csp
270	Fort James	12"	csp

Table E-2a. List of Non-city Outfalls Compiled by City of Portland in 2001. (Note: includes both active and abandoned outfalls).

City Designation[a]	Adjacent Business Name[b]	Outfall Diameter	Outfall Material
271	Fort James	12"	csp
272	Fort James	12"	csp
273	Fort James	12"	csp
274	Fort James	12"	csp
275	Fort James	12"	csp
276	Fort James	12"	csp
277	Fort James	12"	csp
278	Fort James	12"	csp
279	Fort James	12"	csp
280	Fort James	12"	csp
281	Fort James	12"	csp
282	Sakrete of Pacific NW	4"	pvc
283	Sakrete of Pacific NW	15"	composite
284	Pacific Terminal Services/emergency outfall	12"	hose
285	Pacific Terminal Services	4"	steel
286	Marcom abandoned	4"	pvc
287	Wacker Siltronic	12"	
288	US Army Corps of Engineers	6"	pvc
289	Dallas Mavis	10"	csp
290	Atofina	24"	metal
291	Sakrete	6"	csp
292	McCormick Pier Apartments	10"	csp
293	McCormick Pier Apartments	12"	composite
294	McCormick Pier Apartments	4"	metal
295	McCormick Pier Apartments	10"	csp
296	McCormick Pier Apartments	4"	metal
297	McCormick Pier Apartments	4"	metal
298	McCormick Pier Apartments	4"	metal
299	McCormick Pier Apartments	4"	metal
300	McCormick Pier Apartments	10"	csp
301	McCormick Pier Apartments	2"	metal
302	McCormick Pier Apartments	4"	metal
303	McCormick Pier Apartments	4"	pvc
304	McCormick Pier Apartments	4"	pvc
305	McCormick Pier Apartments	4"	plastic
306	ODOT	48"	csp
307	ODOT	48"	csp
308	ODOT	15"	csp
309	ODOT	36"	composite
310	ODOT	30"	composite
311	ODOT	12"	composite
312	ODOT	18"	composite
313	ODOT	18"	composite
314	ODOT	18"	composite
315	ODOT	24"	composite

Table E-2a. List of Non-city Outfalls Compiled by City of Portland in 2001. (Note: includes both active and abandoned outfalls).

City Designation[a]	Adjacent Business Name[b]	Outfall Diameter	Outfall Material
316	ODOT	18"	composite
317	ODOT	18"	composite
318	ODOT	18"	composite
319	ODOT	15"	composite
320	ODOT	15"	composite
321	ODOT	15"	CSP
322	ODOT	15"	
323	ODOT	42"	composite
324	ODOT	42"	csp
325	Albers Mill	12"	pvc
326	Albers Mill		
327	Columbia Grain	16"	csp
328	Columbia Grain	16"	csp
329	ADM		
330	ADM		
331	ADM		
332	ADM		
334	ADM		
335	ADM		
336	ADM		
337	ADM		
338	ADM		
339	ADM		
340	ADM		
341	Cargill	6"	pvc
342	Cargill	6"	pvc
343	Cargill	6"	pvc
344	Cargill	6"	pvc
345	Cargill	8"	pvc
346	Cargill	24"	metal
347	Fuel & Marine Marketing Abandoned	12"	valve
348	Louis Dreyfus		
349	Louis Dreyfus		
350	Glacier NW	12"	plastic
351	Glacier NW	12"	pvc
352	Glacier NW	12"	pvc
353	Glacier NW	6"	metal
354	Unknown Abandoned	6"	pvc

[a]The complete outfall designation number contained in City of Portland files included the prefix "WP" before the number.
[b]Adjacent business names are provided only to assist in locating the outfall. The listed business may or may not discharge via the outfall.

Table E-2b. List of City Outfalls (CH2M Hill 2000a,b; Sanders 2003).

City Designation	Discharge Type	Outfall Diameter	Construction Date
Within the ISA			
M1	Stormwater	60"	1964
M2	Stormwater	n/a	n/a
M3	Stormwater	60"	1989
S1	Stormwater	36"	1964
S2	Stormwater	36"	1963
S5	Stormwater	36"	1963
S6	Stormwater	36"	1964
18	Stormwater	72"	1955
19	Stormwater	42"	1977
22	Stormwater	60"	1973
22B	Stormwater	48"	1980
22C	Stormwater	84"	1978
24	Emergency Bypass	12"	<1923
48	Stormwater	n/a	1948
49	Stormwater	n/a	1997
50	CSO	n/a	1906
52	CSO	30"	1990[a]
52A	Stormwater	36"	1972
53	CSO	n/a	1970
Outside the ISA			
11	CSO	n/a	n/a
12	Stormwater	n/a	n/a
13	CSO	n/a	n/a
14	Stormwater	n/a	n/a
15	CSO	n/a	n/a
16	Stormwater	n/a	n/a
17	CSO	n/a	n/a
43	CSO	n/a	n/a
44	Stormwater	n/a	n/a
45	Stormwater	n/a	n/a
46	CSO	n/a	n/a
47	CSO	n/a	n/a
10A	Stormwater	n/a	n/a
44A	CSO	n/a	n/a
53A	Stormwater	n/a	n/a

[a]Drainages for Outfalls 51 and 52 were combined in 1990; original Outfalls 51 and 52 were constructed in 1920 and 1976, respectively.

Table E-3. Spills to the Lower Willamette River from DEQ's Spill Information Network.

YR	OERS	Site Name	Address	City	Date
95	53	EMANUAL HOSPITAL	2801 N GANTENBEIN	PORTLAND	29DEC1994
		DID NOT REPORT BECAUSE THEY WERE NOT SURE WHERE THE OIL WENT. INSPECTION CORINGS DETERMINED OIL WS RELEASED UNDER CONCRETE SLAB UNDER PARKING STRUCTURE.			
95	136	PORT OF PORTLAND	3556 NW FRONT AVE TERMINAL 2	PORTLAND	15JAN1995
		CRANE OPERATOR LOST LOAD OF PALLETS OF PAINT & THINNERS			
95	149	GATX WILLBRIDGE TERMINAL	5880 NW ST HELENS RD	PORTLAND	17JAN1995
		DRIVER PULLED AWAY WITH LOADING ARM STILL ATTACHED			
95	145	FOSS MARITIME	9030 NW ST HELENS RD	PORTLAND	18JAN1995
		TUG BOAT LEAKED AROUND SHAFT ALLEY			
95	335	PORTLAND HAZ MAT	SE 82ND & BURNSIDE	PORTLAND	16FEB1995
		CONST. PROJECT BROKE NATURAL GAS LINE			
95	381	LINNTON PLYWOOD	10504 NW ST HELENS RD	LINNTON	17FEB1995
		COMPLAINANT CALLED IN OIL SPILL			
95	352	GATX	5880 NW ST HELENS RD	PORTLAND	18FEB1995
		PIN HOLE IN LINE			
95	604	AIR LIQUID	6529 NW FRONT AVE	PORTLAND	21FEB1995
		MALFUNCTIONING OIL/WATER SEPARATOR RESULTED IN RELEASE OF OIL			
95	440	UNOCAL	5528 NW DOANE	PORTLAND	02MAR1995
		NIPPLE TANK COCK BROKE			
95	486	FOSS ENV.	9030 NW ST HELENS RD	PORTLAND	09MAR1995
		POWER STEERING LINE BROKE SPILLING FLUID			
95	480	ELF ATOCHEM	6400 NW FRONT	PORTLAND	09MAR1995
		LEAK IN FEED LINE TO BOILER			
95	491	TRUGREEN CHEMICALS	1405 NE 78TH	PORTLAND	11MAR1995
		VALVE LEFT OPEN DURING TRANSFER FROM TANKS			
95	512	CITY OF PORTLAND	2839 SW SAM JACKSON PARK RD	PORTLAND	15MAR1995
		ROCK SLIDE BURIED 3 TRANSFORMERS, BREAKING 1			
95	1067	BIGHAUS PETROLEUM & ENV.	1125 SE MADISON	PORTLAND	31MAR1995
		TANK ROLLED OVER DURING REMOVAL RELEASING RESIDUAL FILL			

95 661 NW NATURAL GAS 7900 NW ST HELENS RD PORTLAND 06APR1995
LEAK OF LIQUID SALT FROM SALT BATH HEATER

95 658 SOUTHERN PACIFIC R.R. SE 19TH & SE HOLGATE PORTLAND 06APR1995
RAIL CAR LEAKED 1 PT OF BATTERY ACID

95 677 SP RAIL ROAD 5424 SE MCLAUGHLIN PORTLAND 09APR1995
DERAILMENT WITHIN SWITCHING YARD

95 748 UNION PACIFIC 1135 N KNOTT ST PORTLAND 20APR1995
PARKED LACOMOTIVE HAS LEAK IN OIL PAN

95 777 NW NATURAL GAS PORTLAND 24APR1995
UTILITY EXCAVATION IN STREET

95 776 PORTLAND FIRE DEPT PORTLAND 24APR1995
OIL FOUND INSIDE BOOM AT OUTFALL

95 820 PACIFIC STATES GALVANIZING 820 NW 15TH ST PORTLAND 30APR1995
WATER LEFT ON CAUSED TANK TO OVERFLOW

95 834 ARCO OIL 9930 NW ST HELENS RD PORTLAND 04MAY1995
A LEAK DETECTED IN GASOLINE LINE

95 894 WASHINGTON PARK ZOO 4001 SW CANYON RD PORTLAND 11MAY1995
TINT COLOR WASHED INTO STORM DRAIN

95 913 MOBIL 9420 NW ST HELENS RD PORTLAND 14MAY1995
THE PIPE FOR BARGE LOADING STARTED LEAKING AT A COUPLING GASKET

95 923 GATX 5880 NW ST HELENS RD PORTLAND 16MAY1995

95 927 TEXACO BULK TERMINAL 3800 NW ST HELENS RD PORTLAND 17MAY1995
DRIVER FORGOT TO CLOSE VALVE

95 899 PORT OF PORTLAND 7201 N MARINE DR PORTLAND 19MAY1995
HYDRAULIC TOP LOADER

95 981 HAZ MAT TEAM I-5 NORTHBOUND PORTLAND 25MAY1995
TANKER ACCIDENT

95 991 DARIGOLD 2720 SE 6TH AVE PORTLAND 26MAY1995
APPROX 70 LBS OF AMMONIA LEAKED TO HOLDING TANK

95 1010 TIME OIL 5200 BLOCK SW MACADAM PORTLAND 29MAY1995
TANKER FILLING UST WHEN HOSE RELEASED

95 1025 PORT OF PORTLAND TERMINAL 5 PORTLAND 30MAY1995
VANDALS TOOK PIECE OF TRANSFORMER CAUSING IT TO LEAK

95 1046 5739 NE SELLNER PORTLAND 02JUN1995
EXCAVATORS HIT PIPELINE

95 1147 McDONALDS 1035 SW 6TH PORTLAND 15JUN1995
CONTAINER OF OIL & GREASE DROPPED & RUPTURED

95 1159 MCCALL OIL 5480 NW FRONT PORTLAND 16JUN1995
PUMP GASKET FAILURE

95 1168 PORTLAND FIRE BUREAU PORTLAND 17JUN1995
PASSENGER CAR COLLIDED W/FUEL TANK OF RYDER TRUCK

95 1175 FOSS MARITIME 9030 NW ST HELENS ROAD PORTLAND 19JUN1995
BILGE PUMPING INTO WATER FROM TUGBOAT KNAPPTON - TOO LATE TO RECOVER

95 1206 SUNSHINE DAIRY 801 NE 21ST PORTLAND 25JUN1995
MAY HAVE BEEN AMMONIA RELEASE

95 1240 ARCO STORAGE TERMINAL 9930 NW ST HELENS RD PORTLAND 30JUN1995
TRANSFERRING DIESEL OIL FROM DOCK TO BARGE

95 1280 WEST COAST SHIPPING RIVERGATE BLVD PORTLAND 06JUL1995
SLOW DRIP FROM RIVET IN BUNKER FUEL TANK OF SHIP "CORNUCOPIA"

95 1362 FOSS MARITIME ST HELENS RD PORTLAND 15JUL1995
SPILLAGE FROM LINES DURING REFUELING

95 1391 CHEMAX 5700 NW FRONT PORTLAND 19JUL1995
CHEMICAL REACTION CAUSED FIRE (HYD. FLUID DRIPPING ONTO SODIUM CHLORITE)

95 1450 FREIGHTLINER 6936 N FATHOM PORTLAND 24JUL1995
EMPLOYEE LEFT VALVE OPEN

95 1512 ELFATOCHEM 6400 NW FRONT AVE PORTLAND 01AUG1995
WET THERMISTER CRACKED

95 1525 HAZMAT 6 PORTLAND 03AUG1995
TRACTOR TRAILER SADDLE TANK BROKE - RELEASING FUEL

95 1540 OLYMPIC TUG & BARGE 2720 NW 35TH PORTLAND 07AUG1995
PRODUCT SPILLED DURING TRANSFER FROM SHIP TO BARGE

95 1555 PGE 121 SW SALMON PORTLAND 07AUG1995
SQUIRREL CAUSED SHORT/RUPTURE IN TRANSFORMER

95 1581 ARCO PRODUCTS 9930 NW ST HELENS RD PORTLAND 10AUG1995
GASKET FAILURE IN NONPRESSURIZED PIPELINE

95 1629 CARGILL GRAIN 800 N RIVER PORTLAND 18AUG1995
UNKNOWN SOURCE

95 1701 UNOCAL 5528 NW DOANE AVE PORTLAND 26AUG1995
LINE PREPARED FOR DEMOLITION HAD HOLE ALLOWING RELEASE OVER WEEKEND

95 1698 SUNRISE SHIPPING 121 SW SALMON PORTLAND 27AUG1995
DEBALLASTING

95 1718 AERO TRANSPORT 6350 NW FRONT PORTLAND 30AUG1995
LOOSE DOME COVER ON TANK

95 1727 INTERNATIONAL TERMINAL 12005 N BURGARD PORTLAND 31AUG1995
SHEEN ON RIVER - NOT DIESEL BUT GLOBS

95 1804 SUNRISE SHIPPING 121 SW SALMON PORTLAND 12SEP1995
BALLAST WATER BEING RELEASED CONTAINED OIL

95 1818 CHEVRON 5501 NW FRONT PORTLAND 13SEP1995
RUPTURED PIPE

95 1892 WACKER SILTRONICS 7200 NW FRONT PORTLAND 24SEP1995
FITTING RELEASED AMMONIUM HYDROXIDE

95 1926 UNOCAL 14003 N RIVERGATE PORTLAND 27SEP1995
VAPOR FLARE FAILURE CAUSED RELEASE

95 1984 HERCULES NW YEON PORTLAND 06OCT1995
THICK BROWN OIL

95 2006 CASCADE GENERAL 5555 NW CHANNEL PORTLAND 09OCT1995
oil in lines used to release ballast water spilled during dry dockage

95 2032 DARIGOLD 2720 SE 6TH PORTLAND 12OCT1995
SHORT LEAK WHILE REPAIRING VALVE

95 2069 CASCADE GENERAL 5555 N CHANNEL PORTLAND 17OCT1995
HYDRAULIC LINE BROKE ON SHIP

95 2061 FOSS MARITIME 2900 NW ST HELENS RD PORTLAND 18OCT1995
LOADING ONTO BARGE OBSERVED LEAKING THROUGH 3" CRACK

95 2127 MARSHALL HIGH SCHOOL SE PORTLAND PORTLAND 25OCT1995
ACCIDENTAL SPILL OF FORMALDEHYDE

95 2124 CASCADE GENERAL PORTLAND 25OCT1995
SHEEN ON RIVER

95 2158 USCG 12005 N BURGARD PORTLAND 30OCT1995
SHEEN ON RIVER

95 2178 ANHEUSER-BUSCH 5810 N. CUTTER RD PORTLAND 01NOV1995
AMMONIA RELEASE

95 2221 CHRISTENSEN OIL 3821 NW ST HELENS RD PORTLAND 06NOV1995
TRUCK ROLLED BACKWARD WHILE BEING FILLED & THE OIL RAN INTO RAINWATER & SPREAD

95 2242 PORT DELIVERY PO BOX 17069 PORTLAND 08NOV1995
CURB BROKE CROSS-OVER LINE WHILE DRIVER WAS BACKING UP

95 2241 FUTURE MOTOR FREIGHT 3150 NW 35TH PORTLAND 08NOV1995
TRUCK HIGHCENTERED & BROKE CROSSOVER LINE

95 2271 GATX TERMINALS 11400 NW ST HELENS RD PORTLAND 11NOV1995
PAST LEAKAGE HAVE RESULTED IN SHEEN ON RIVER

95 2315 3026 NE HOYT PORTLAND 14NOV1995
HOMEOWNER DROPPED & BROKE A BOTTLE OF PESTICIDE IN DRIVEWAY

95 2411 UNION PACIFIC R.R. 2745 N INTERSTATE AVE PORTLAND 28NOV1995
TRAIN ENGINE HIT TRAILER CHASSIS & TORE AN EXTERIOR MOUNTED CRANKCASE LINE

95 2454 HEUKER PROPERTY 7400 SW MACADAM PORTLAND 01DEC1995
APPEARS TO BE FROM ABANDONED HEATING OIL UST

95 2444 MOORE'S CUSTOM CLEANERS 3 MONROE PARKWAY LAKE OSWEGO 02DEC1995
TANK OVERFLOW

95 2450 UNOCAL 14003 N RIVERGATE BLVD PORTLAND 04DEC1995
FUEL LINE LEAK

95 2549 VIKING FREIGHT 9010 NE 13TH PORTLAND 07DEC1995
LEAK FROM TRAILER

95 6276 PGE SW 37TH & PAMONA ST PORTLAND 12DEC1995
STORM DOWNED POWER POLE

95 2646 CITY OF WEST LINN 19030 NIXON AVE WEST LINN 13DEC1995
POWER OUTAGE CAUSED OVERFLOW

95 2662 PGE 644 CABANA LANE LAKE OSWEGO 14DEC1995
STORM DOWNED POWER POLE

95 2712 ARCO 9930 NW ST HELENS RD PORTLAND 18DEC1995
OILY SHEEN ALONG SEAWALL

95 2772 ELF ATOCHEM 6400 NW FRONT PORTLAND 28DEC1995
CHLORINE LEAK

96 99 SCHNITZER STEEL DOCK 12005 N BURGARD PORTLAND 10JAN1996
DATE & TIME OF RELEASE UNKNOWN

96 104 PORTLAND HAZ MAT 5700 NW FRONT PORTLAND 11JAN1996
SPILL OF FLAMMABLE LIQUID

96 163 ROADWAY EXPRESS 6845 N CUTTER CIRCLE PORTLAND 18JAN1996
BROKEN DRIVE SHAFT DAMAGED FUEL LINE - DRAINED SADDLE TANKS

96 166 VALVOLINE 2308 N CLARK ST Portland 19JAN1996
SPILL OF OIL WHILE LOADING CONTAINER - BUCKET FELL & TOP CAME OFF

96 222 FOSS MARITIME 9030 NW ST HELENS RD PORTLAND 24JAN1996
.5 GALLON BILGE OIL INTO WILLAMETTE

96 338 DERRICK BARGE TERMINAL 2 PORTLAND 05FEB1996
NONE GIVEN

96 442 BLUE FLAME OIL 9830 SE POWELL PORTLAND 05FEB1996
HOLE N DELEVERY HOSE CAUSED RELEASE OF DIESEL PRIOR TO REFUELING OF AMTRACK TRAIN

96 405 BOAT OWNER 11919 N JANTZEN DRIVE PORTLAND 07FEB1996
BOAT SANK DURING REPAIRS DUE TO FLOOD

96 529 TEXACO 3800 NW ST HELENS RD PORTLAND 08FEB1996
FLOOD RELATED

96 766 FUEL PROCESSORS 4150 N SUTTLE RD PORTLAND 09FEB1996
FLOOD RELATED

96 -936 RESIDENT 5855 SW LOMBARD PORTLAND 15FEB1996
FLOOD RELATED

96 1368 CITY OF PORTLAND 2933 PERIANDER PORTLAND 22FEB1996
BROKEN SEWER LINE

96 1140 ELF ATOCHEM 6400 NW FRONT PORTLAND 23FEB1996
OVERFLOW OF PROCESS TANK AT CHEMICAL PLANT

96 1343 CASCADE COLUMBIA 2637 SE 12TH PORTLAND 19MAR1996
WHILE UNLOADING A BARREL A SPILL OF MURATIC ACID OCCURED

96 1401 FOSS MARITIME NOT GIVEN PORTLAND 27MAR1996
DIESEL OIL TO RIVER FROM SHIP ANSAC ASIA

96 1403 FOSS MARITIME 9030 NW ST HELENS RD PORTLAND 28MAR1996
DIESEL FUEL SPILLED ONTO WORK DECK & FUELING DOCK

96 1488 CASCADE GENERAL 5555 N CHANNEL AVE PORTLAND 09APR1996
NONE GIVEN

96 1485 CROWLEY MARITIME MCCALL OIL REFUELING DOCK PORTLAND 09APR1996
NONE GIVEN

96 1502 ARCHITECTURAL ENG. SUPPLY 1741 SE 10TH AVE PORTLAND 11APR1996
A BOTTLE WAS DROPPED DURING TRANSFER

96 1504 ADM MILLING 1362 NW FRONT PORTLAND 11APR1996
CYLINDER - FAULTY VALVE

96 1515 U.S.C.G. PIER 2 TERM 4 PORTLAND 14APR1996
BOAT SINKING CAUSED SHEEN ON WATER

96 2014 Swan Island Lagoon Portland 25JUN1996
Sheen on Willamette River, Swan Island Lagoon

96 2102 Swan Island 5555 N. Channel Portland 08JUL1996
While changing the ships ballast (Green Harbour) oil leaked out along the stern tube. USCG investigated and approved cleanup.

96 2150 Willamette Park Boat Docks West Linn 14JUL1996
VW bug in Willamette River at Willamette Park Boat Docks. Eugine block oil released. 30-40 foot sheen x 10 feet wide.

96 2393 Lagoon N. Channel Portland 14AUG1996
A substance that appears to be glue is coming out of a storm dran, is entering the lagoon at Cascade General/USCG area of the Swan Island Lagoon.

96 2402 UP Railroad 2745 N. Interstate Portland 15AUG1996
line failure

96 2633 Staff Jennings Sellwood bridge west Portland 15SEP1996
Rain water flushed a small amount of diesel from a fuel storage area and across a new asphalt. The oil and melted pavement caused a sheen in the Willamette River.

96 2706 Barbie Trucking Yeon Ave @ NW Nicolai Street Portland 16SEP1996
Truck hit a brake drum in the ramp of I-405 from freemont bridge. It cut the fuel tank cross over and released diesel. Fuel flowed down ramp and into storm drain.

96 2634 Cascade General 301 Cascade General Portland 16SEP1996
Unknown volume fuel/oil sheen

96 2816 Port of Portland 7201 N Marine Portland 02OCT1996
A line broke on a loader and Hyd fluid spilled onto parking lot

96 2852 USCG 6767 N Basin Ave Portland 08OCT1996
refueling a work boat from shoreside. Surge suppressor failed. No cleanup. Product dissipated.

96 3002 UPRR 12th & Clinton Portland 30OCT1996
Transfer from lake yard (westside) to Brooklyn yard (S.E.) Hopper door popped open.

96 3096 12005 N Burgard Rd Portland 14NOV1996
Ma Quan Hat (Korean vessel) suspect source

96 3102 Oak Grove Boat Dock 800 SE Oak Grove Blvd Milwaukie 15NOV1996

96 3279 St Johns Bridge 8010 NW St. Helens Rd. Portland 24NOV1996
Oil slick of Black Fuel Oil

96 3400 10415 SW Radcliff Ct. Portland 06DEC1996
Pink oily substance entering unnamed neighborhood creek. Source believed to be heating oil UST at unoccupied house. Overflow due to rain.

96 3524 McCall Oil & Chemical Terminal 5480 NW Front Portland 13DEC1996
Sause Brothers Tug Titan/bunkering incident, overflow of deck sounding plug.

97 2198 Pacific Detrail Diesel Basin Ave Portland 28AUG1997
Black waste oil spill from unknown source coming from outfall. 25 gallons.

97 2213 Hall-Buck Marine 15550 N. Lombard Portland 30AUG1997
Mechanical failure of head shut loading urea into ship approx 100-150 lbs into river.

97 2271 In front of Chevron facility 5924 Front St. Portland 08SEP1997
Unknown blue substance pooling on the river. No petroleum odor. Wind blowing substance upstream. Unocal/TOSCO also reported. USCG enroute. CG unable to detect substance. May want to check under the docks in the morning. Russian vessl

97 2352 West Linn Paper Co. 4800 Mill Street WestLinn 17SEP1997
5' X 200' slick at a dark oily substance. within the lock at Willamette Locks. Dissipating. Still investigating the source. Storm flushing an old hog fuel pile- dark water ran into locks.

97 2353 PGE Poyer Pole N. Buchanan and N. Lombard Portland 17SEP1997
MVA- car crash into power pole. Non PCB transformer oil spilled of pavement.

97 2378 Foss Maritime 9030 NW Street St. Helens Rd. Portland 22SEP1997
100 yards X 100 Feet silver sheen

97 2415 Cascade General Portland 27SEP1997
Mva Cascade General in Portland, 50 gallons Diesel. 20 yards in storm drain

97 2458 ELF Atochem 6400 NW Front Portland 02OCT1997
hlorine gas release to atmosphere, small but unknown quantity from break in loading hose. One person injured- treated for burns then transported to Emanuel. Source stopped, gas dissapated, no remaining cloud.

97 2489 Foss Maritime 9030 NW St. Helens Rd Portland 07OCT1997
300-400' long X 150' wide sheen from outfall

97 2543 Foss Maritime- Tug-Jim Moore River MIle 5.5 Portland 14OCT1997
Sheen near St. John's Bridge/came from downstream of Foss-washed upstream due to tide.

97 2553 USCG 8970 N. Bradford Portland 15OCT1997
50 gallons oil/water mix from bilge on lifeboat. Lifeboat damaged on 14 Oct, 1997 as it was being lowered during test. Very little oil (sheen) in contained/boomed area- release was expected.

97 2559 Gatex 11400 NW St. Helens Rd Linnton 16OCT1997
Valve crack at terminal. 1/2 gallon into river. Evaporated

97 2597 US Army Corp of Engineers 8010 NW St. Helens Portland 22OCT1997

Sheen coming from underground source, bubbling up from sediments possibly due to disturbance by vessel prop wash and core sampling done

97 2625 McCraken Trucking 3147 NW Front Portland 25OCT1997
Very small substance of yellow substance- possibly not haz, to storm drain. Probably washing operation during afternoon. Material spilled in semi-trailer, RP flushed it to storm drain.

97 2640 12005 N. Burgard Portland 28OCT1997
75' square sheen/near vessel star dover, came from a private outfall

97 2704 1130 NE 28th Portland 05NOV1997
Drug lab at storage lockers

97 2705 DEA 6936 NE Grand Apt 30 Portland 05NOV1997
DEA Requested ORP # for drug lab ORP936003446

97 2767 Cascade General 55 N. Channel Portland 13NOV1997
A line broke during pressure testing, 50-100 gallons of oil went into the water.

97 2828 ODOT I-5 southbound, Cook Street Portland 21NOV1997
Acid in a milk jug along shoulder of freeway. Hazmat 6 is responding. Metro will dispose of it.

97 2921 USCG East end Morrison Bridge Portland 01DEC1997
1 acre sheen on river at east end of Morrison Bridge.

97 2951 Steinfelds Products 10001 N Rivergate Portland 04DEC1997
400 gallons of diesel heating oil. Affected storm drain/surface water also. 100 gallons in the river. New AST installed. While applying air to prime the system, fuel was released from the pressure relief valve.

97 3074 Tosco Plant 5528 NW Doane Portland 19DEC1997
2000 gallons of lube oil released to cencrete containment around tank. Some soil areas in containment removed. Recovered 1800 gallons so far CET to steam clean tomorrow. Uniglide is product, saw glide oil- medium viscosity (50wf)

97 3098 Cascade General Facility 5555 N Channel Portland 23DEC1997
25-50 gallons diesel through the parking lot. Appears to be vandalism. Puddles on the pavement but no impacts to the river or water. They are using sand/sorbent to clean up. They are working with police to find the perpetrator.

97 3100 Oregon Steel 14400 N Rivergate Blvd. Portland 24DEC1997
Hydraulic system failure- synthetic hydraulic fluid spilled from equipment room for mold conveyor system. Initially thought to be contaminated. Some of the 40-70 gallons spilled and entered a catch basin and the River.

97 3215 Freeway Land Company 6400 SE 101st Portland 29DEC1997
Owner of property reports that an unknown truck broke a hydraulic line in their parking lot spilling less than 42 gallons of oil to a gravel and dirt parking lot. Spill and clean-up happened two days before on Monday.

98 3 USCG below Sellwood Bridge Portland 02JAN1998
Small sheen on Willamette river S Sellwood Bridge. USCG says it is dispating. They will not look or respond. PO Wolf

98 7 USCG Sellwood Bridge Portland 03JAN1998
50 yards by 10 feet rainbow sheen on Willamette River. Coast Guard let the sheen dissipate. Not recoverable.

98 67 Foss Maritime 9030 St Helens Rd Portland 12JAN1998
Oil/water separator disconnedted- caused small sheen was on board barge. 1-5 gallons

98 75 Foss Maritime 9030 NW St. Helens Road Portland 12JAN1998
Bilge pump problem. ~25 gallons spilled into the Willamette River. Pump shut off after 15-20 sec. Product contained in slip area. Boom and pads applied. Foss Environmental enroute. NRC #419463

98 111 Market Transport 3182 NW 26th Portland 14JAN1998
50 gallons from ruptured

98 156 Savage Industries near 4098 N. Port Center Way Portland 20JAN1998
Clay/water mixture coming from outfall.

98 182 Fritz Maritime 1650 NW Front Ave Suite 150 Portland 22JAN1998
2oz from broken hose on vessel (hydraulic line on ships crane) Already dissipated- 2oz hit the river/rest on deck <1 pint.

98 223 Vessel JA Rainbow 1650 NW Front Ave Portland 28JAN1998
Vessel JA Rainbow has a hydraulic leak into the river. A line burst on the rope tightener, spilling hydraulic oil onto the deck. 600 liters, 160 gallons total. 15-20 gallons into the water.

98 277 Citizen I-5 MP 299 1 block south of spaghetti fa Portland 03FEB1998
MVA multi-vehicle accident/saddle tanks (possible source?) ODOT storm drain system-outfill. Oil coming from outfill-boomed by hazmat

98 321 M/V Airston 1800 SW 1st Portland 09FEB1998
Cargo vessel "Airston" leaking hydraulic oil from rudder post due to a lubracation fitting-sheen dispersed-no cleanup possible.

98 337 Cargill 800 N. River Street Portland 12FEB1998
1/2 gallon hydraulic fluid-from drilling

98 346 USCG River mile 15 Portland 12FEB1998
USCG-PO McFadden-240-9301, On scene Larry Agnew 241-4962, Representing Portland Spirit, reports sheen on Willamette river mile 15 @ Salmon Street Springs. No source or spill found by fire or USCG.

98 389 Portland Fire Foot of SW Gains Portland 17FEB1998
Portland fire notified they used 1 gallon class A foam on a fire. Run off to the Willamette River. No fish killed. Coast Guard aware of release.

98 454 Schnitzer Steel 1200 s Burgard Rd Portland 27FEB1998
100 X 100 ft sheen on Willamette River near slip @ terminal 4 near outfall at slough. Snitzer steel has barges in the area.

98 529 USCG 1300 NW Front Portland 10MAR1998
vehicle found in river. (body found inside) Leaking unrecoverable fuel and oil.

98 844 Near Morrison Bridge Portland 10APR1998
Petroleum release to Willamette River, Portland Fire reports slight sheen.

98 2645 Helser Bros. Transfer Co. 7025 N Leaddetter Portland 11APR1998
5-10 gal spill-Nozzle fell out of tank during refueling/ rain moved it rapidly to catch basin (oil/water) sepurator and also a storm drain and stormwater retention pond (100' X 50')

98 870 Chevron Asphalt 5551 NW Front Portland 15APR1998
9100 gallons gasoline on a tanker truck. Truck hit a parked trailer next to the street and rolled over next to the asphalt loading rack and caught fire. Almost all gas burned, and about 10 gallons of fuel was captured from the storm drain

98 878 Outfall 3600 NW Front Portland 15APR1998
Heavy green algae-like material in flow-not floating. 1/4" acre area of logoon impacted-along south edge of lagoon for about 200 yards. Appears to be pollen or organic. No problem visible next morning.

98 1032 Cascade General Swan Island Portland 03MAY1998
Security guard at Cascade reported seeing guts and grease comming out of the storm drain at Linden farm chicken processor.

98 1044 USCG Portland 04MAY1998
Oil sheen around Evirmedon vessel at Columbia Grain. M/V Evirmedon- came from gullast tank-small leak in pipe running through tank

98 1551 Portland Fire 7720 SW MacAdam Portland 29JUN1998
Flourescent dye in creek. Probably dye test. Tide heading in creek; will turn soon

98 1662 FRITZ MARITIME - AGENT TERMINAL 5 Portland 13JUL1998
5 GAL BUCKET OF ACRYLIC WATER-BASED PAINT FELL FROM CARGO VESSEL - M/V WESTERN OPAL

98 2288 3821 NW St Helens Rd Portland 25SEP1998
200 gal chainsaw oil spilled onto dirt Containment area

98 2319 Schnitzer Steel dock Portland 30SEP1998
Vessel Juneau, 3' X 70' sheen near vessel

98 2359 GATX Docks 11400 NW St Helens Rd Portland 03OCT1998
Tri-City Voyager (Barge), Dockline broke-200 gal Willamette, Portland Fire Boat notified/ Foss Maritime hired by RP, Coast Guard- %03-240-9301-Responded-dissapating well Greg Lies- with GATX

98 2365 Portland 04OCT1998
Coast Guard Auxillary reports white 55 gal drum on bank-about 20' up Auxillary reports does not appear to be leaking-Milwalkie Fire will not respond W/O address. (Tina-Milwaulkie PD Dispatch- 503-659-2345)

98 2418 T-2 Berth 204- 3556 NW Front Portland 09OCT1998
Vessel "pac King" leahing hydraulic oil from broken pipe/hose on hatch cover system. On water response initiated. Estimeted 2 gal spilled, withb < 1 gal into river. Only sheen on water-rapidly dissopated.

98 2419 NASELO property 6340 SW Macadam Portland 09OCT1998
2 gal paint pigment- some into river.- Additional Hax Waste issues.

98 2439 5528 NW Doane - on the Willamette River Portland 11OCT1998
NRC Incident # 459405- Anonymous caller reported a sheen on the Willamette-15' X unknown length.

98 2461 Willamette River near OMSI Portland 12OCT1998
Sheen on the Willamette River-Approximately 50' X 200'-Dissipating. Non-recoverable and no source found.

98 2471 McCall Oil & Chemical 5480 NW Front Portland 13OCT1998
< 2 gal (Unrecoverable-Formed 75 X 20' Sheen) - Seporutor backed up due to absorbent pillows being washed around by rain-other seporutor had flow-through of site water W/oil

98 2484 Schnitzer Steel 12005 N. Burguard Portland 13OCT1998
Unrecoverable 100 yd X 2' wide sheen along log burrer USCG indicate, No clear evidence of source.

98 2500 McCall Oil Co 5480 NW Front Portland 16OCT1998
USCG reported 250' by 1/4 mile long light sheen near McCall Oil Dock. NO SOURCE FOUND-Unrecoverable

98 2507 Pacific Northern Oil 7900 NW St.Helens Portland 17OCT1998
MV Chesapeake, Blew fuel fill line wo/emptying the hose. Sprayed oil on dock and deck, some fell into river.

98 2525 Cascade General 5555 N. Channel Ave, berth 312 Portland 20OCT1998
25 gal from rented mobile generator- 5 gal reached river-creating 900' X 40' SHEEN- user discovered unplugged line on fuel tank- not certain of purpose but it atlowed release when tank was filled

98 2586 2600 N River St Portland 27OCT1998
White milky substance w/algae from storm drain to Willamette River at 2600 N. River St. in Portland, Or. (near Albina rr yard & Goldendale Alumaium Plant- USCG called OERS at 1800 & investigated at 18:26 on 10-27-98- No cleanup possible- e

98 2590 ? Portland 28OCT1998
Clam shell dredging causing sheen on river (believe it is from Creosote)

98 2637 Tosco Dock 5528 NW Doane Portland 03NOV1998
121' vessel "Pacific Falcon" - Overfill during refueling - 1Gallon into river

98 2652 I-405 at Glisan St Portland 06NOV1998
I-405 at Glison street, Tractor Trailer rollover released 7,000 gallons of liquid asphalt. Significant amount into storm drain.

98 2681 N Basin Ave Portland 09NOV1998
Sheen on river-From outfall- U.S.C.G. determined it to be unrecoverable.

98 2693 Ensign Ave Portland 10NOV1998
Oil coming from outfall-BES boomed it & looking for source outfall # m1

98 2747 I-5 N @ Morrison Bridge on-ramp Portland 18NOV1998
Semi jacknifed on I-5 northbound north of Morrison Bridge at on ramp. Approximately 75 gallons of diesel released to asphalt. Unknown amount to Willam
ette River Via storm drains.

98 3005 110 SE 2nd Portland 07DEC1998
50 gallons of diesel spilled into storm drain

98 3059 15550 North Lombard Portland 12DEC1998
2 tons potash in Willamette. Now dissapated.

98 3103 Willamette River Portland 18DEC1998
Don was on the river and found a tank floating, leaking diesel fuel. USCG hired Foss to recover the tank and conduct cleanup.

98 3119 Wacker Siltronix 7200 Front Ave. Portland 20DEC1998
Wacker Siltronic- Release From roof unit. Released "grow Pro"- KOH,MOLYBDATE,TOYTOBAZOLE-Fan broke- 250 gal solution 8-8.5 ph

98 3141 Willamette River below Sellwood Bridge Portland 23DEC1998

A drum in the Willamette leaking oil was observed below the Sellwood Bridge. Sheen also reported in the area. Fire boat could not locate the drum. Will wait for some other information- per USCG.

98 3147 TOSCO Bulk Plant 5528 NW Doane Portland 24DEC1998
Abandoned line charged with water ruptured from freezing and released water and 5 gallons gasoline to the Willamette. They placed booms but will release on USCG recommandation.

98 3230 I-5 SB just before Broadway Bridge Exit Portland 31DEC1998
Tanker Truck was forced to break heavily causing Diesel fuel to splash out of tank onto pavement- Lost 50 gallons.No water impacts.

99 45 Lone Star Sand & Graver 5400 Front Street Portland 08JAN1999
Worker dropped a bucket containing 1.5 gallons of oil into the Willamette River, then tried to catch it with the same bucket.

99 78 drum in river Portland 12JAN1999
U.S.C.G. picked up Drums in river- 2 Drums pesticides needed ORP# for disposal. ORP936003604

99 79 Trashco Service Inc. 1630 SE 8th Portland 13JAN1999
Spilled 20 plus gal diesel while siphoning washed it to storm drain-also cleaned out wasre oil catch pan (spillage pan?) at some time.

99 176 Precision Equipment 8440 N Kerby Ave. Portland 20JAN1999
Hole in liner in roll off box allowed chromium in water to escape, from chromic acid vointion/salts from plating process (D007 waste), material with rain water and flowed to storm drain.

99 171 Willbridge Terminal Front & St. Helens Rd. Portland 21JAN1999
Worker doing construction at BN Railway yard noticed heavy oders and diesel contamination near "moontrack" at Willbridge.

99 201 Foss Maritime 9030 NW St. Helens Rd. Portland 23JAN1999
Tug (Sora Brix) produced small sheen at her mooring after start up. Sheen stopped shortly after. Tug had not been started in some time likely a shaft ally/stuffing box release. Vessel 69'X19' 1500 hp twin screw 1949 vintage.

99 206 UST leak 2905 NE 54th St. Portland 23JAN1999
Citizen damaged UST fill spout causing water infiltcation and causing fuel to float out. Portland Haz Mat and BES responded & will handle.

99 256 Cascade General 5555 N. Channel Ave. Portland 29JAN1999
5 gallons of Hydraulic oil spilled on to Dry Dock and on to water.

99 257 MVA 143 & NE Sandy Portland 29JAN1999
Train VS Semi causing diesel fuel spill from the truck- Fire & Explosion resulted.

99 261 Freightliner 6936 Fathom Portland 29JAN1999
200 batteries, dumping sulfuric acid= 10 gallons into storm water and to storm drains

99 264 Willamette River mile 7 Portland 30JAN1999
One 55 gal Drum in Willamette River (blue poly drum) contents unknown (maybe empty) was in mid-channel U.S.C.G. did not do any recovery.

99 376 7th Taylor SW Portland 04FEB1999
Hydraulic line on cement Truck broke, 25 gal to asphult- rain may have washed some to storm drain

99 373 Tosco Fuel Dock 5528 NW Duane Portland 10FEB1999

Tug Boat lost 2-3 gal diesel- prior to refueling- came from hose Tidewater Tug "Definanic"- Tug crew unhooked line under pressure.

99 396 MVA 5900 SW McAdam Portland 13FEB1999
Hydraulic line failure on garbage Truck- 3 gal of hydraulic oil spilled onto pavement- Tracked all over street by vehicles- absorbent used on pavement & oil- absorbent sock used at adjacent storm drain by garbage hauler- City will notifyUSC

99 517 none 52nd & Henderson Portland 23FEB1999
Portland Haz Mat On-scene with 40-50 Quart containers of Chemicals on Street. Known drug area- Sgt. Larson responds & confirms- Drug Lab

99 519 McCall Oil 5480 NW Front Portland 24FEB1999
McCall Oil noticed Sheen on Willamette River U.S.C.G. and Portland Fire respond by boat-Oil 30'X50' light Sheen Unrecoverable

99 530 Air Mark 1848 NW 23rd Portland 24FEB1999
100 gallons overfill to asphalt & storm drain/catch basin about 20 gallons got to storm drain that discharges to City of Portland

99 696 Swan Island Area Portland 10MAR1999
Oil Sheen near Fred Divine outfall(outfall one mile) 400'X 1,000'- Unrecoverable

99 790 T-5/Columbia Grain Elevator 15660 N. Lombard Portland 22MAR1999
155 m Vessel "Alam Gula" dovked- Testing Fire Pump- Faulty valve sprayed oil into river(1/2 qt)- unrecoverable SHEEN.

99 1047 Providence Beginning Center 447 NE 47th St Portland 27APR1999
Chipping paint from older bldg, poss lead content, no cleanup or containment of chips (to 1"). Some washing to stormdrain with rain. Ptld BES to respond to site with sweeper. DEQ/NWR/HW DO notified.

99 2526 5528 NW Doane Ave Portland 02NOV1999
1/2 gallon diesel spilled during refueling, Tug "Howard Olsen"

99 2566 I-5 MP 296.5 NB Portland 08NOV1999
Semi jacknifed, 40 gal spilled (20 in storm drain). RP was very responsive and helpful according to cleanup crew.

99 2599 none I405 SB Portland 12NOV1999
Semi in accident lost 20-30 gallons diesel into a drain.

99 2649 Portland 17NOV1999
10 gal oil at construction site - being applied to concrete forms (incidental spillage) - complainant unwilling to go forward with this until he has found other employment - spill is close to river

99 2667 McCall Oil Chemical 5480 NW Front Ave Portland 19NOV1999
80 gal bunker from rail car on side of rail car and ground. Heating asphalt in tank overflowed top.

99 2694 I-405 NB @ Burnside Bridge Portland 24NOV1999
Deisel spilled - 30 gallons - during truck and several car MVA. Caught some in storm drain inlet, boom being placed in outfall.

99 2854 Tosco Dock 5528 Doane Ave Portland 11DEC1999
Fueling a tug at the dock. The Foss "Howard Olson" overfilled tank.

99 2936 Cascade General 5555 N Channel Ave Portland 21DEC1999
sheen observed under pier

99 2950 Cascade General Ship Repair 5555 N Channel Portland 23DEC1999
~2 gal bunker fuel and diesel spilled to Swan Island Lagoon within a preboomed area. While cleaning a barge they found hose was still under pressure and fuel was released onto deck and water. Cleaned with pads.

0 47 USCG Portland 05JAN2000
USCG MSO PDX informing OERS of abandoned drum on the Will. River on the west bank, south side of Freemont Br.. The drum is not leaking. OERS notified Fire Boat and BES. No request for help from either

0 139 unknown unknown Portland 13JAN2000
Thick black liquid being discharged from pipe beneath surace of water, does not mix with water,5 diameter SD, at least 5 days on/off, wasn't today, Thunderbird Way and cosby, 1" intersection then lato road Tp river then oft rpd of ship.

0 244 USCG 300N River Portland 27JAN2000
Sheen 1/8 mile long - unrecoverable/light - no discernable source

0 297 Oregon Steel Mill 14400 Rivergate Blvd Portland 05FEB2000
1-2 gallon Hydraulic fluid to storm drain then to river, Cleaned up/boomed out fall, hydraulic line on mold ruptured (steel mold) fluid leaked through seam where floor meets walls and went to storm drain.

0 320 9030 NW St Helens Road Portland 07FEB2000
Burp is sounding tube on tug. Lewiston tug. Boomed, pads applied.

0 354 Columbia Grain Elevator 15998 N Lombard Portland 12FEB2000
Yong An 11, Pumping bilges and valge got stuck open. Bunker oil.

0 1104 Consolidate Metco 13940 N Rivergate Portland 19FEB2000
200 gallons of water soluble oil spilled to the pavement. 70 gallons to the storm drain. 130 gallons captured as liquid. 6-7 oil. Recovering liquid from storm drain and measuring outfall. Portable tank not secured and fell off fork lift.

0 431 Port of Portland Berth #603 vessel name = Fanal Merchant Portland 22FEB2000
10 gal loading equiment leaking inside freight container - improperly stored. Leaked oily substance - assumed to be hydraulic fluid. Not shipping company's fault, USCG pursuing enforcement of cosigner (packager) due to improper loading

0 437 none Portland 23FEB2000
10 gal spilled during generator testing ~1 gal reached river new generator's on new barge - injector plug had a leak - sheen noticed next morning - delay in reporting - had to track down accurance of spill trhough maintenance records

0 550 Larsons Automotive 1727 SE 11th Portland 12MAR2000
200 gals of caustic, oil & sludge released from caustic dip tank in shop. Ran out of shop & fire diked to contain. BES & PDX Fire advised RP to call CU contractor. Leak was caused by tank & valve failure. Shop was unattended weekend leak.

0 579 USA COE 8010 NW St. Helens Road Portland 16MAR2000
heavy oil being blown up river by wind - unknown source - very small amount - subsequently USA COE determined one of their staff had spilled oil (tiny bit) while carrying a drain pan over a dock - will submit report

0 601 tug "John Brix" McCall Oil Dock Portland 19MAR2000
fuel tank of tug "John Brix" burped while refueling at McCall Oil Dock in Portland Harbor - most of oil contained on deck - 1-2 gallons in water

0 612 Portland Shipyard 5555 N. Channel Avenue Portland 21MAR2000
fueling power barge - check ball valve failed with release of ~ 5 gal diesel into river - no drinking water intakes impacted

0 724 Portland 04APR2000
River patrol - USCG auxiliary - spotted 12 drums along high water mark - see OERS 00-762

0 741 Cascade General 5555 N. Channel Ave. Portland 05APR2000
.5 gal to water

0 749 0315 SW Montgomery Portland 05APR2000
Citizen reporting gasoline odor and sheen at Riverplace Marina. - determined to be diesel

0 755 Terminal 4 Portland 06APR2000
Hydraulic cylinder blew <1 liter into water "Century Leader 3" car carrier vessel

0 762 Sauvie Island Portland 07APR2000
12 barrels - look like they've been there a long time - 3 water, 1 tar, rest empty - see OERS 00-724

0 770 Portland Shipyard 5555 N. Channel Ave. Portland 09APR2000
Vessel "Chevron Colorado" released hydraulic oil during maintenance work at berth 302 Swan Island ship yard.

0 807 Willamette River Portland 13APR2000
Sheen observed on Willamette - appears to have come from storm drain

0 961 none 6458 N Basin Portlnad 02MAY2000
MVA with 80 gallons of diesel going to a storm drain - semi leaking. Drain is 500 - 1000 yards fromt he river. Fire boat on scene - product not yet visable on river. BES enroute. USCG contacted

0 1008 Scnitzer Steel Dock 120005 N Burggard Road Portland 09MAY2000
Barge fuel valve left open.

0 1055 5655 Chanel Street Portland 14MAY2000
Polar spirit, 11,000 ft. tanker in layup residential oil is sea chest. Partside bubbles of crude on large leak. Coast Guard, PDX Fire called by OERS will also call ODFW Clean Rivers and ship boomed

0 1086 River above the Falls West Linn 17MAY2000
Large sheen at West Linn, possible gasoline very thin and no odor.

0 1147 Cascade General 5555 N Channel Ave Portland 22MAY2000
3 gallon fuel can of diesel got knocked over, was not on contained (oil/water separator) area of dock.

0 1175 none Ross Island Lagoon Portland 26MAY2000
Hydraulic line burst on dredge relasing 6 gal. at Hogate slough, Foss to cleanup.

0 1187 OR Steel Mills 1400 Rivergate Portland 27MAY2000
All Pump looking for authorization to pump/transport sewage fro OR Steel Mills septic tank. Cascade Phillips on scene already pumping/request denied. DEQ managers need to discuss this. Authorization not within job scope of duty officer.

0 2187 Chevron 5531 NW Doane Road Portland 01JUN2000
Underground pipe at bulk facility failed - 3,260 gallons of fuel addiive released to subsurface.

0 1284 Portland 06JUN2000

Drydock just d/s oil St. Johns Bridge in PDX Harbor. Lanolite is enviornmentally friendly substance. accidentally discharged into Will. River, wheen on water 50x100' booms & absorbent pads used to contain & clean up spill.

0 1304 Tanker Pacific Management Swan Island Portland 09JUN2000
NRC#531537, Alaska Jewl/Cascade Gen. Ship yrd./PEXT28942, Cowlitz Clean Sweep enroute. Testing fire pump, foam is mixed with Hydrolic oil/discharge on deck & over the side.

0 1339 Tosco 5528 NW Doane Portland 14JUN2000
Light sheen on river, unknown source, quickly dissipated.

0 1356 Cascade General 15JUN2000
1 gal leaked from overpressurized stern tube seal (propellor) MSC Paul Buck a US merchant Marine marine Tanker.

0 1479 5480 NW Front Avenue Portland 29JUN2000
overfill during refueling of tug Jesse caused 2 gallon diesel spill - 1 gallon reached river.

0 1612 Holgate Slough Portland 13JUL2000
sheen observed on water - unknown source

0 1679 Front Street Portland 19JUL2000
unrecoverable (per USCG) sheen observed downstream of outfall under old Albers Mill by Broadway Bridge/Front Street. Portland BES to investigate

0 1724 Tosco Outfall #22 Nw Front/Doane Portland 25JUL2000
petroleum groundwater contamination entering storm sewer through joints in pipe

0 1755 Near Tosco near 5528 NW Doane Portland 28JUL2000
200 sq. ft. patch of milky substance with brown spots collecting near dock and vessel - unknown source - dissipated rapidly.

0 1959 Riverplace Marina Portland 19AUG2000
unconfirmed mystery sheen from unknown source - reported by anonymous caller

0 2185 Tosco 5528 NW Doane Portland 12SEP2000
continuing occurrence of chronic release/contamination.

0 2189 Columbia Grain Dock Portland 12SEP2000
Suspected vandalsim caused the release of 5 gallons waste oil.

0 2214 Portland 13SEP2000
Citizen report of oil from home auto repair going down drain.

0 2219 River Place Marina Portland 15SEP2000
USCG investigated unrecoverable sheen from unknown source.

0 2263 John's Landing Marina Portland 20SEP2000
100 yd sheen - vessel "Coot" leak from bilge

0 2265 Chemical Plant 3366 Yeon Portland 20SEP2000
Hercules exceed total Cl- level discharge for AQ permit

0 2283 John's Landing Boat Club Portland 22SEP2000

vessel "Coot" cracked fuel line and bilge automatically pumped

0 2345 UPRR Brooklyn Yard 424 SE McLoughlin Portland 29SEP2000
UPRR train accident - release to Brooklyn yard

0 2359 SW 18th & Jefferson Portland 30SEP2000
Combined sewer system - out manhole

0 2377 Portland Shipyard 5555 N. Channel Avenue Portland 01OCT2000
FGE power barge "Rio Daluz" - had sump pump overfilled from rain - spilled lube oil

0 2400 Cascade General 5555 N. Basin Portland 04OCT2000
5 gal of lube oil due to faulty valve on waste removal line - to water between barge and dry dock

0 2402 McCall Oil & Chemical 5480 NW Front Portland 04OCT2000
150 gal of bunker C #6 - plug failed on meter at tank farm - into bermed containment

0 2454 Chevron Products 5924 NW Front Ave. Portland 12OCT2000
Vessel hose was prepared to be moved when one cup of boscan crude oil was spilled

0 2500 Cascade General 5555 N. Channel Ave. Portland 17OCT2000
spill of bunker-like oil (bilge slops) due to failed gasket during cleaning of slop line

0 2509 Foss Maritime Dock 9030 SW St. Helens Road Portland 18OCT2000
fire boat spilled during refueling - from hole in gas tank - weld failed from previous repair

0 2577 Terminal 2 3556 NW Front Avenue Portland 25OCT2000
small lube oil/diesel spill from unknown source

0 2596 Greenway 45th & Palatine Portland 28OCT2000
White substance in ditch

0 2646 Cargill/Irving 800 N. River Portland 04NOV2000
Black oil discovered between a loading cargo ship and the shore

0 2648 5340 SE Taylor Portland 04NOV2000
Hose leaked while delivering fuel to a house.

0 2703 near Schnitzer Steel Portland 11NOV2000
Sheen 50' X 100' - unknown source

0 2730 USCG Dock 6767 N. Basin Portland 15NOV2000
Unknow material resembling blast grit is "floating" near dock - sinks when touched

0 2792 NW Skyline Rd. & NW Bridge Rd. Portland 25NOV2000
Sheen of oil on roadway - washed into unnamed creek - non-recoverable

0 2806 Cascade General Portland 27NOV2000
1 gal vegetable- based hydraulic oil from burst hose

0 2855 Gresham 02DEC2000

River City called to get permission to pump sewage at Barlow HS due to Barlow's truck failure

0 2864 Marquam Bridge Portland 03DEC2000
MVA - semi flipped on Marquam Bridge releasing fuel to bridge deck - 10-20 gallons reached drains and Willamette River

0 2894 Cascade General 5555 N. Channel Ave Portland 06DEC2000
Residual oil spilled from equipment being loaded onto a barge - most contained on barge - .5 gal into Willamette River

0 2896 5400 N. Basin Ave. Portland 07DEC2000
MVA - Semi flipped over - one trailer contained 6,000# 7% NaOH and activator in five totes, (2NaOH, 3 Activator) - one of five leaked. Second trailer
contained 393# of class III fireworks on pallets - no spill. Some diesel spilled.

0 2910 Columbia Grain Elevators Portland 08DEC2000
Vessel "Liberty C" released sheen on Willamette

0 2993 Cascade General ship yard Portland 19DEC2000
Dredge/barge "Essayons" spilled hydraulic while working on lines - discovered during USCG inspection.

0 3060 Portland 28DEC2000
Urea spilled during off loading from a ship.

1 7 Albina Fuels Dock Portland 01JAN2001
F/V "Michelle Renee" taking on fuel - human error - mismeasured tank - lost quantity to dock - ~5 gal to river

1 86 Cascade General 5555 N. Channel Portland 12JAN2001
Oil sheen released from dry dock #4 during the re-float of Navy ship "Tippecanoe"

1 108 J.R. Simplot 14003 N. Rivergate Portland 15JAN2001
Water flushing from a conveyor system washed oil and debris into river while repairs were being made.

1 144 Cascade General Shipyard Portland 19JAN2001
Vessel Global Sentinal ruptured hose in bow thruster.

1 223 Swan Island lagoon area Portland 31JAN2001
Light sheen discharge from outfall - 50'X50'

1 229 marine dock @ Tosco 5528 NW Doane Portland 31JAN2001
Pipe fitting leaking "cutter stock" oil to river

1 241 Con Metco 13940 N. Rivergate Portland 01FEB2001
White plume in Willamette - traced to Con Metco - sump releaseing water soluable cutting oil to a storm drain.

1 300 Port of Portland Terminal #6 Portland 09FEB2001
Several drums of varnish leaking on vessel.

1 339 Portland 13FEB2001
White mass in water 20 yds diameter

1 346 800 N. River Street Portland 16FEB2001
Sheen on Willamette, 50' X 200', between V. Comos Verde and river bank.

1 364 Portland 19FEB2001
Semi punctured fuel tank spilling 50-70 gal. of fuel along Yeon Steet - fuel on pavement and into catch basin.

1 386 Berth 503 - Terminal 5 Portland 20FEB2001
Conveyor belt over load - soda ash released to river (sodium carbonate)

1 434 Gunderson, Inc. 4350 NW Front Portland 26FEB2001
Solvent spill on dock - 1.5 gal leaked through to river - gtea-415 & toluene - from bucket sitting on dock.

1 451 MCP Bulk Terminals 5300 McLoughlin Portland 27FEB2001
High fructose spilled to asphalt, then to storm drain during loading of a trailer - due to failure to close valve.

1 979 Oregon Steel Mills 14400 N. Rivergate Blvd. Portland 27FEB2001
Explosion reported at Oregon Steel Mill. Injuries from the explosion, no fire, no release to water.

1 453 near Hawthorne Bridge Portland 28FEB2001
Sheen on east side of Willamette river, 50'x15' - source seems to be under water pipe/outfall - caused by asphalt on bridge work being cooled by running water on it

1 587 Portland International Terminl Portland 05MAR2001
Fuel spill on board vessel - crew used degreaser/dispersant to clean spill - escaped over board through breach of scuppers - not closed correctly

1 526 Terminal 4 Portland 06MAR2001
"Axon Queen" vessel reported to be belching smoke

1 531 Portland 08MAR2001
OIl is flowing out of curb drain pipe on to the street - only during rain storm

1 541 4350 NW Front Ave. Portland 09MAR2001
Paint spill on soil and report of sludge shoveled into 55 gallon drums - paint may be flammable

1 573 Portland 14MAR2001
"big sheen" on river

1 594 SW Yamhill & SW Park Portland 16MAR2001
Less than 3 gallons dumped in a storm drain basin - no impact to water

1 602 Portland 18MAR2001
Storm water with oil sheen at Hawthorne Bridge - sheen

1 603 Portland 18MAR2001
8-10,000,000 gallons release at Ankeny Pump Station - PGE equipment failure - power outage

1 682 Tosco 5528 NW Doane Portland 26MAR2001
Tug refueling operations - diesel to water

1 715 Schnitzer Steel 12005 N. Burgard Portland 29MAR2001
M/V "Big Blue" spilled unknown quanity of oil/water from ballast pumping at the slip

1 779 Mar Com 8970 N. Bradford Portland 05APR2001
Sheen on the Willamette under St. John's Bridge - upriver from Mar Com - one "greased goose" observed on a piling.

1 799 Port of Portland Portland 08APR2001
Ship leaking intermediate through cracks in hull.

1 1023 Oregon Steel Mill 14400 N. Rivergate Blvd. Portland 03MAY2001
Broken hydraluic line on heavy equipment - release to soil

1 1245 plant & dock 14003 N. Rivergate Portland 29MAY2001
Crane unloading granular urea barge spilled max. 500 lbs onto dock, ship deck and water

1 1254 T-2, berth 414 Portland 30MAY2001
169 meter M/V "Amori Willow" - bunker oil spill to deck during internal transfer - 1 gal to water

1 1271 JR Simplot 14003 N. Rivergate Portland 01JUN2001
M/V "Med Intergrity" was at the dock when rain washed an oil sheen of its deck

1 1296 Portland 04JUN2001
Contractor cleaning pipes caused release to storm drain leading to river

1 1352 Portland 10JUN2001
Sheen reported at Willamette River and Columbia Slough

1 1497 Berth 313 700 NE Multnomah Portland 25JUN2001
M/V "Dansus" - faulty cap caused release

1 1524 Portland 29JUN2001
MVA - semi and jeep head-on - jeep punctured semi 100-150 gal fuel tank - 25-50 into storm drain

1 1708 McCall Oil 5480 NW Front Portland 13JUL2001
A line coupling failed and allowed oil in a separator to back flow into river.

1 1861 Portland 29JUL2001
Porta-potty floating in Willamette near waterfront

1 1899 Precision Cast Parts 4600 SE Harner Portland 02AUG2001
Worker fatality - fell into vat of 40-60% NaOH.

1 1980 Cascade General 5555 N. Channel Avenue Portland 10AUG2001
Slight sheen on Willamette.

1 2062 Willamette Cove Portland 16AUG2001
30' cabin cruiser partly submerged in Willamette River. Sheen noted when discovered.

1 2085 Portland Harbor Portland 19AUG2001
Unknown heavy black liquid substance flowing into river from storm drain - sinks in water.

1 2089 RR Bridge Portland 20AUG2001
Oil slick reported on Willamette River.

1 2191 Portland Harbor Portland 30AUG2001
Sheen - 100x50 yards from a passing barge - stirred up sediments. Not a spill.

1 2205 Willamette River Portland 31AUG2001
Sheen on Willamette River - 100' X 1500'

1 2369 Willamette River Portland 19SEP2001
Sheen - unknown source - up against ship at dock

1 2410 Cascade General Shipyard Portland 23SEP2001
Oil sheen at Cascade Shipyard 4'x12'

1 2412 Multnomah Harbor 12900 NW Marina Portland 23SEP2001
25' power boat in process of sinking. 25' sheen.

1 2449 Tosco 5528 NW Doane Portland 28SEP2001
Transferring fuel from tank to barge (Tidewater) sheen on river under dock. Leak from barge fromf racture on bulkhead of tank.

1 2451 4900 NW Front Avenue Portland 29SEP2001
Tug boat sank - no sheen. "Sandy" 41'

1 2626 M/V Vanis Greva Portland 17OCT2001
M/V "Vanis Greva" release of hydraulic fluid due to equipment failure.

1 2662 Sea River Maritime Portland 18OCT2001
Sheen on Willamette from T/V "SR Galena Bay"

1 2671 2925 SE 50th Apt 26 Portland 18OCT2001
Drug lab with 10 containers at residence.

1 2682 Cascade Shipyard, Berth 313 Portland 19OCT2001
Leak in the lube oil cooler in engine room. Rainbow sheen 10' x 10'

1 2685 construction site 3223 NE Killingsworth Portland 19OCT2001
Paint being washed into storm drain. Construction in area.

1 2743 Portland 24OCT2001
Sheen from box & oil containers that were dropped into river

1 2755 corner of 8th & Grant Portland 25OCT2001
Abandoned car lab at the corner of 8th & Grant - one anhydrous cylinder, small Nazi lab.

1 2808 Portland 29OCT2001
Sheen near M/V Roger. Sheen old, grey & weathered - not from vessel.

1 2898 Cascade Steel 14400 N Rivergate Blvd. Portland 07NOV2001
300 gallons of hydraulic fluid release due to equipment failure - to gravel.

1 2913 Pacific Terminal Services 7900 NW St. Helens Road Portland 08NOV2001
40 gal spill to containment area - pump seal failure - small amount to ground

1 2962 Chevron Portland 13NOV2001
Chevron Colorado - leak from blade seal on controlable pitched propeller

1 2964 JR Simplot 14003 N. Rivergate Blvd. Portland 13NOV2001
Light sheen washed from absorbent pads by rains - oil was released during maintenance on a hydraulic unit on barge "Alastra"

1 3070 Willamette River RM 11.4 Portland 24NOV2001
Sheen reported to NRC - 200' by 10' - gray color.

2 44 West Linn Paper Co. 4800 Mill Street West Linn 06JAN2002
Paper company equipment failure - 3-5 gallons of high consistency pulp went to waste water treatment, which broke a shaft in the transfer station, which dumped sludge over the cliff and into the river.
INDUSTRIAL PLANT SOLID WASTE 5 GAL SURF

2 177 warehouse SE 10th & Salmon Portland 20JAN2002
Large warehouse fire impacting two pole mounted transformers - release to asphalt. Amt in each transformer 30 gallons.
BUSINESS OIL - TRANSFORMER 60 GAL PAVE

2 184 Portland 21JAN2002
Ship gantry hydraulic line failure - releasing one to two liters of hydraulic oil to Willamette from the "General Via" Phillapine vessel
VESSEL - CARGO OIL - HYDRAULIC 1 GAL SURF

2 276 7900 NW St. Helens Road Portland 28JAN2002
Barrel of oil knocked over on barge being loaded with trash.
DRUM (55-GAL) OIL - WASTE OIL 2 GAL SURF

2 294 Oregon Steel Mills 1440 Rivergate Blvd. Portland 31JAN2002
Oregon Steel Mills reporting sheen in parking lot.
MOTOR VEHICLE - PRIVATE OIL - UNKNOWN 2 GAL PAVE

2 465 I-205 Bridge I-205 MP 25.7 NB Portland 20FEB2002
MVA - semi on bridge - spill to roadway
MOTOR VEHICLE - COMMERCIAL OIL - DIESEL 75 GAL PAVE

2 519 River Place Marina Portland 28FEB2002
Report of sheen on Willamette at River Place Marina.
OTHER (DESCRIBE) OIL - UNKNOWN 1 OTH SURF

2 559 NW 17th between Hoyt & Irving Portland 05MAR2002
Commercial truck hose failure - hydraulic oil spill - some to storm drain.
MOTOR VEHICLE - COMMERCIAL OIL - HYDRAULIC 40 GAL PAVE

2 559 NW 17th between Hoyt & Irving Portland 05MAR2002
Commercial truck hose failure - hydraulic oil spill - some to storm drain.
MOTOR VEHICLE - COMMERCIAL OIL - HYDRAULIC 40 GAL SURF

2 630 300 SW Salmon Portland 14MAR2002
Truck spilled 20 gal of diesel on street - some went to storm drain.

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MOTOR VEHICLE - COMMERCIAL     OIL - DIESEL                      20 GAL  PAVE

  2   630                              300 SW Salmon                          Portland          14MAR2002
Truck spilled 20 gal of diesel on street - some went to storm drain.
MOTOR VEHICLE - COMMERCIAL     OIL - DIESEL                      20 GAL  SURF

  2   740                                                                     Portland          29MAR2002
Alder Street Outfall - grey chucks going into Willamette.  Cellulose grout from storm sewer work upstream.
SEWER                          SEWAGE                             1 OTH  SURF

  2   824 Willamette River                                                    Portland          08APR2002
Overturned tanker on St. John's Bridge filled with anhydrous ammonia - no release.
MOTOR VEHICLE - COMMERCIAL     OTHER (DESCRIBE)                   0 LBS  NONE

  2   870 Cascade General Ship yard                                           Portland          11APR2002
Release of 2 liters of oil into Willamette from ship @ pier 304
VESSEL - CARGO                 OIL - LUBE                         1 GAL  SURF

  2   911 Cascade General              5555 N. Channel                        Portland          18APR2002
Sheen between the USN Yukon and the containment boom at berth 314, Portland shipyard
VESSEL - PUBLIC                OIL - UNKNOWN                      1 GAL  SURF

  2   926 Hawthorne Inn                181 NE Halsey                          Portland          20APR2002
Chlorine imbalance in swimming pool - 13 children transported to 3 local hospitals with skin irritation and swollen eyes.
OTHER (DESCRIBE)               CHEMICAL PRODUCT                   1 GAL  NONE

  2  1144 Owens Corning                11910 NW St. Helens Road               Portland          17MAY2002
Fire and explosion - 110,000 gal AST containing asphalt - no release to water, run off contained.
BULK PETROLEUM STORAGE         OIL - UNKNOWN                      1 OTH  AIR

  2  1150                              7900 NW St. Helens Road                Portland          18MAY2002
Tanker car valve failed and broke, spilling bunker on private rail spur.
RAILWAY                        OIL - HEATING                    200 GAL  SOIL

  2  1185                              SW Capital Hwy & 41st                  Portland          23MAY2002
A can of green paint fell off a pick up truck - stain 6' x 40' on 41st Street
CONTAINER                      OTHER (DESCRIBE)                   5 GAL  PAVE

  2  1272 Riverplace Marina            SW Montgomery                          Portland          03JUN2002
Unknown yellow film on river - 100' long.
OTHER (DESCRIBE)               OTHER (DESCRIBE)                   1 OTH  SURF

  2  1308 Oregon Steel                 14400 N. Rivergate Blvd.               Portland          06JUN2002
Spill from large piece of contractor equipment - soil impacts.
HEAVY EQUIPMENT                OIL - HYDRAULIC                   65 GAL  SOIL

  2  1371                              1150 SE 26th                           Milwaukee         13JUN2002
MVA - 40 gallons - all in catch basin.
MOTOR VEHICLE - PRIVATE        OIL - GASOLINE                    40 GAL  PAVEMENT
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  2  1378                                                                Scappoose          13JUN2002
MVA - semi and car.  100 gallons of diesel and 10-15 qts. of motor oil to road shoulder and ditch.
MOTOR VEHICLE - COMMERCIAL     OIL - DIESEL                      100 GAL  SOIL

  2  1501 Texaco                        5124 SE 17th Ave.                   Portland           27JUN2002
Retail customer tore hose off dispenser at gas station - 33 gal to pavement and collected in catch basin.
UST                            OIL - GASOLINE                     33 GAL  PAVE

  2  1514                               1705 SE Oaklodge Ln.                Milwaukie          28JUN2002
Pump station failure - bypass sewage to Willamette.
SEWER                          SEWAGE                              1 OTH  SURF

  2  1579 PGE                           SE Mill between 10th & 11th         Portland           07JUL2002
PCB transformer blew and started fire - bushing failed.
ELECTRICAL EQUIPMENT           PCB                                 2 GAL  SOIL

  2  1595                               9030 NW St. Helens Road             Portland           08JUL2002
Tug "Lewiston" lost 5 gal while fueling - tug was pre-boomed.
VESSEL - TUG                   OIL - DIESEL                        5 GAL  SURF

  2  1793 Lakeside Industries           4850 NW Front Ave.                  Portland           26JUL2002
Shut off on pump nozzle failed, oil spilled to a concrete pad.
OTHER (DESCRIBE)               OIL - DIESEL                       20 GAL  PAVE

  2  1832 Tosco Facility                5528 Doane Avenue                   Portland           31JUL2002
Oil released from AST relief valve after a fuel transfer.  Spill into containment basin.
AST                            OIL - LUBE                         50 GAL  SOIL

  2  1911 Office Depot                  5885 N. Basin                       Portland           09AUG2002
MVA - Delivery truck at office depot hit a curb and damaged radiator.
MOTOR VEHICLE - COMMERCIAL     OTHER (DESCRIBE)                   10 GAL  PAVE

  2  2012 McCuddy's Marina              6767 N. Basin                       Portland           18AUG2002
Diesel spill from bilge of tug "St. Nicholas".  400' x 100'
VESSEL - TUG                   OIL - DIESEL                       10 GAL  SURF

  2  2044                               3628 and 3622 SE 13th               Portland           21AUG2002
A private sewer line backed up and spewed waste into two basements.
SEWER                          SEWAGE                            100 GAL  SOIL

  2  2201                               2721 SE 101st                       Portland           09SEP2002
Report of persons pouring oil onto roof of residence.
OTHER (DESCRIBE)               OIL - UNKNOWN                       1 OTH  NONE

  2  2400 JR Simplot                    14003 N Rivergate                   Portland           28SEP2002
Release of anhydrous amonia due to equipment failure during transfer.
INDUSTRIAL PLANT               HAZARDOUS WASTE                     1 LBS  AIR

  2  2411 Conoco Phillips               5528 NW Doand Road                  Portland           29SEP2002
Sheen on Willamette.
BULK PETROLEUM STORAGE         OIL - UNKNOWN                       1 GAL  SURF
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  2  2728 Cascade General ship yard      5555 N. Channel Avenue                    Portland            09NOV2002
Sheen on Willamette.
UNKNOWN                        OIL - UNKNOWN                        1 GAL  PS/BC Fresh Water

  2  2728 Cascade General ship yard      5555 N. Channel Avenue                    Portland            09NOV2002
Sheen on Willamette.
UNKNOWN                        OIL - UNKNOWN                        1 GAL  SURF

  2  2896                                6018 Boise Street                         Portland            05DEC2002
Citizen complaint of engines and transmission fluid on neighboring property.
OTHER (DESCRIBE)               OIL - UNKNOWN                       10 GAL  PS/BC Land

  2  2896                                6018 Boise Street                         Portland            05DEC2002
Citizen complaint of engines and transmission fluid on neighboring property.
OTHER (DESCRIBE)               OIL - UNKNOWN                       10 GAL  SOIL

  2  2913 BES - pump station             Hwy 43 & Radcliff Road                    Portland            07DEC2002
Sewage release at pump station.
PIPELINE                       SEWAGE                             600 GAL  PS/BC Fresh Water

  2  2913 BES - pump station             Hwy 43 & Radcliff Road                    Portland            07DEC2002
Sewage release at pump station.
PIPELINE                       SEWAGE                             600 GAL  SURF

  2  3112                                                                          Portland            28DEC2002
Sheen on Willamette near international shipping dock - Schnitzer.
BUSINESS                       OIL - UNKNOWN                        1 GAL  PS/BC Fresh Water

  2  3112                                                                          Portland            28DEC2002
Sheen on Willamette near international shipping dock - Schnitzer.
BUSINESS                       OIL - UNKNOWN                        1 GAL  SURF
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Table E-4. Summary of Spills to Willamette River, Portland, Reported to National Response Center, 1982 - 1989[1].

Date	Location	Substance	Quantity	Source
1982				
28-Mar-82	Swan Il Ship Yard Portland Org Sub Station No 5	PCB	Unknown	Transfomer / Leaking
17-May-82	Northwest Marine Ironwork Shipyard, Swan Island	Lube Oil	2 Gallons	Tail Shaft Being Pulled While Ship Was In Wet Berth In The Shipyard
24-May-82	River Dock	Marine Diesel	Few Drops	Cargo Line/Valve Malfunc
10-Jun-82	Steel Bridge At Albina Or MP .60	Creosote	1/8 Gal	Accidental Spill From Can
20-Jul-82	Union Oil Docks	Diesel Fuel	2000 Gal	Transfer Line From Dock To Tank Barge Broke
26-Jul-82	1 Mi N Of St Johns Brdge In Portland OR	Unknown Oil	Unknown	Unknown Poss Suspect : Refineries Along Bank
26-Jul-82	Willamette River 11400 St Helens Rd Portland, OR	Unknown Oil	Unknown	Unknown/ Coming From Underneath A Piling Bulkhead
13-Dec-82	Same As Adr	Oils: Diesel	2310 Gal	Truck Pulled Out From Pump With Out Disconnecting Hose And Tore Hose From Pump, Matl Entered Storm Drain And Entered River
1983				
22-Mar-86	Willamette River Between Salty And Ross Island Bridges	Unknown Oil	Unknown	Unknown Source//A Sighting
24-Oct-83	Arco Terminal Docks In Linton,OR Part Of Portland, OR.	Oils, Miscellaneous: Lubricating	Unknown Amt Small Sheen	Possible Source - T/V Bald Butte // Have Noticed Oil Bubbling Up From Under Vsl And A Sheen Is Appearing. // Transfer Ops From Ship To Terminal
09-Dec-83	Shell Oil Dock On The Willamette Rvr	Oils: Diesel	>5 Gals	Bleeder Valve Busted Off As A Result Of Metal Fatigue
1984				
18-Jul-84	Above, Dock	Oils: Diesel	150 Gals	Hole In Tank Of Barge Tidewater 36

Table E-4. Summary of Spills to Willamette River, Portland, Reported to National Response Center, 1982 - 1989[1].

Date	Location	Substance	Quantity	Source
28-Aug-84	Willamette River Underneath Steel Bridge. Portland OR	Unknown Oil		Unknown. 1/2 Mi Long Slick.
11-Sep-84	1208 N River Rd Portland OR Up Stream From The Freemon	Other Oil	Unknown	Unknown
1985				
18-Mar-85	Terminal Four Berth 416,415,410 Portland	Unknown Oil	Unknown	Unknown
02-May-85	Marine Dock At Same Address	Oils: Diesel	15 Gals	Fueling Tug/Overflowed Tank
1986				
13-Feb-86	6400 NW Front Ave., Portland, OR - Outfall To River	Ammonium Hydroxide (<28%	1200 Gals	Leak Developed In The Tubes Of Their Sys Inner-Cooler
04-Mar-86	200 SE Spokane St Portland	Oils, Miscellaneous: Transformer	<5 Gals	Transformer On Houseboat Dock/Houseboats Broke Loose From Moorings Pulling On Electerical Connections And Rupturing Bushing In Transformer
18-Mar-86	3245 North Willamette Ave In Portland, OR - Storm Sewer To River	Mineral Oil	Est 20 Gallons	Vehicle Struck A Pole With Transformer Atop
23-Apr-86	Drydock #4 Swan Island Shipyard Portland	Alaska North Slope Crude	Est 1 Cup	Discharge Pipeline/Oil In Line/Discharging Ballast
16-Jun-86	Swan Island Shipyard, Columbia Rvr In Portland, OR	Hydraulic Oil	Less 1 Gal	Hydraulic Line Parted on the M/V Chevron
25-Jun-86	West End Of Hawthorne Bridge, Portland OR	Paint (Possibly Red Lead)	Est 1-2 Gals	Company Painting Bridge W/O Drop Cloth, Paint Spilled Into River Below; Appeared To Be A Company Boat Trying To Break Up Spillage In The Water
05-Aug-86	At above address	Hydraulic Oil	Est 60 Gals	Filter On Hydraulic Line Failed

Table E-4. Summary of Spills to Willamette River, Portland, Reported to National Response Center, 1982 - 1989[1].

Date	Location	Substance	Quantity	Source
1987				
04-Jun-87	Chevron Willow Bridge Dock	Dello/ 6040	3 Gal	Loading Onto Tugboat/ Flexible Hose Fitting Gave Way
11-Jun-87	Swann Island	Diesel Fuel	20 Gal	32' Boat/ Sank/ Unknown Reason
31-Oct-87	Chevron Dock	#2 Diesel Fuel	50 Gal	Overflow From Fueling A Tug Boat
1988				
16-Nov-88	11400 North West St Helens Rd., Behind GATXTerminal	Unknown Oil	Unknown Sheen Size And Color	Unknown
1989				
29-Jan-89	Willamette River Near St Johns Bridge	#2 Diesel Oil	400 Yds X 150 Yds Sheen	Unknown/ Unknown Sheen. Silvery Flowing In With Tide
15-Feb-89	Shell Docks In Willbridge	100 TQ Lube Oil	?	Loading Lube Oil/Material In Hose When Disconnected
30-Jun-89	Chevron Dock	Diesel Fuel	Amount Of Diesel Fuel In Material Was A Small Perc	Ruptured Facility 16 Inch Pipeline Due To An Unknown Cause During Transfer To Tank Ship. Asphalt And D
28-Dec-89	Swan Island Shipyard, Willamette River	Motor Oil	Sheen 10 Sq Ft	Dredge Essayons, While Transferring To Dredge

[1]Locations and abbreviations are reported verbatim from the NRC database.

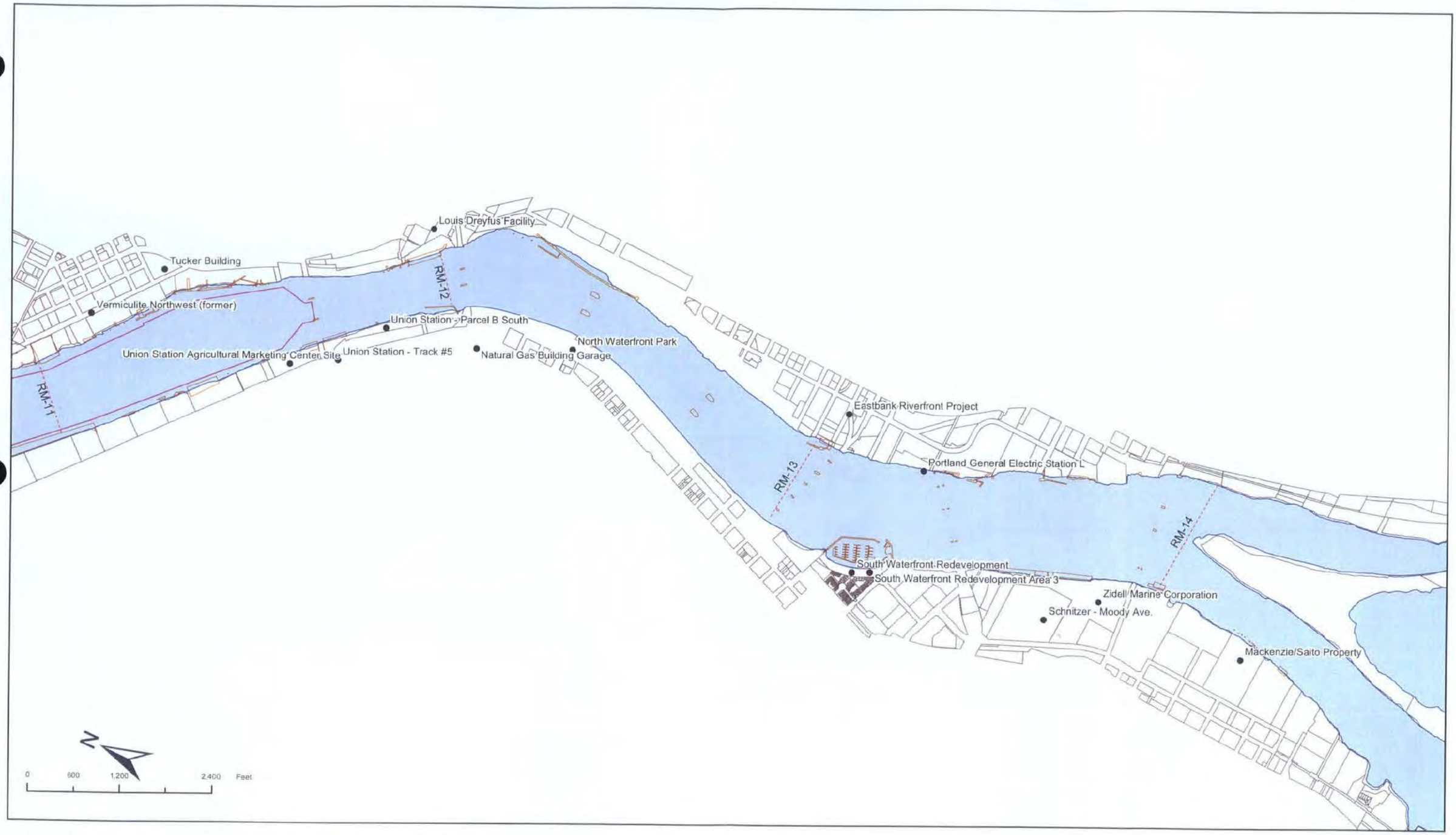
Table E-5. Shoreline or Nearshore Facilities Upstream of RM 11 that are Listed in DEQ's ESCI Database. (All information was compiled from DEQ Site Summary Reports; see Figure E-1 for facility locations).

ESCI #	Facility/SiteName	Address	Type(s) of Operation	Hazardous Substances/Waste Types	Detected Chemicals in Upland Samples[1]	Potential Pathways to River[2]
1962	Union Station Agricultural Marketing Center Site	NW Naito Pkwy Portland, OR 97209	railyard	PAHs, petroleum hydrocarbons, lead, arsenic	arsenic (S), lead (S), PAH (S), TPH (S)	
1414	Union Station - Track #5	Union Station Portland, OR 97209	Amtrak refueling of diesel locomotives	diesel fuel	LPAH(B), HPAH(B), diesel(S), ethylbenzene(B), toluene(S), xylenes(S)	DR, SW, GW
1885	Union Station - Parcel B South	between Union Station and Naito Parkway Portland, OR 97209	residential housing (1997 to present, railyard (1890's to 1996)	PAHs, petroleum hydrocarbons, lead, arsenic	arsenic(S), lead(S), PAH (GW), TPH (S)	
2761	Vermiculite Northwest (former)	2303 N Harding St. Portland, OR 97227		asbestos		
3036	Tucker Building	2110 N Lewis Ave. Portland, OR 97227		asbestos, petroleum, PCB	petroleum(S)	
1394	Louis Dreyfus Facility	(foot of) N Holladay St. Portland, OR 97227		petroleum	TPH(S)	DR, GW(unknown)
1138	Natural Gas Building Garage (aka Portland Gas Manufacturing Site)	221 NW 2nd Ave. Portland, OR97209	former coal/gas manufacturing (Portland Gas and Coke)	coal and oil tars, spent iron oxide, process wastewaters		
876	North Waterfront Park	NW Front Ave. Portland, OR 97209		benzene, toluene, xylene, ethylbenzene	benzene(GW), ethylbenzene(B), toluene(B), xylenes(B)	SW, GW
2414	Eastbank Riverfront Project	Portland, OR 97214		lead, petroleum	lead(S), petroleum(S)	
151	Portland General Electric Station L	1841 SE Water Ave. Portland, OR 97214	steam electric plant, electrical equip. maintenance and warehousing	PCBs, heavy metals, BTEX, PAHs	PCB(S)	DR, GW
602	South Waterfront Redevelopment	SW River Dr. Portland, OR 97201	inactive power plant	PAHs, lead, arsenic, asbestos, PCBs	lead(B), oil(S)	DR, GW
2492	South Waterfront Redevelopment Area 3	SW River Pkwy Portland, OR 97201		PAHs, metals, diesel, lead, oil	PAHs(B), cadmium(GW), chromium(GW), diesel(S), lead(GW), oil(S)	GW
875	Schnitzer - Moody Ave.	Units A, B, & C Moody Ave. Portland, OR 97201	vacant property, former metals salvaging, processing, & pesticides formulation	DDT, hexachloropentadiene, PCBs, TCE, 1,2 DCE, acetone, barium, lead, cadmium, chromium, lead, zinc, carbon disulfide, benzene, toluene, 4-methyl-2-pentanone, ethylbenzene, cineole, cyanide	DDT(S), lead(S), mercury(S), PCBs(S), PAHs(S), zinc(S)	SW, GW
689	Zidell Marine Corporation	3121 SW Moody Ave. Portland, OR 97201	ship dismantling, barge construction, tube forging	metals, petroleum hydrocarbons, asbestos, PCBs	antimony(B), arsenic(S), benzene(GW), chromium(S), lead(S), nickel(B), oil(B), PCBs(B), PAHs(S), tributyltin(S)	DR, GW, SW
1925	Mackenzie/Saito Property	690 SW Bancroft St. Portland, OR 97201	lumber mill (former)	oil-range hydrocarbons, PAHs	benzene(GW), PAHs(GW), ethylbenzene(GW), oil(S), toluene(GW), xylenes(GW)	GW
2409	Ross Island Sand & Gravel Co.	Hardtack Island - Willamette River Milepost 15 Portland, OR 972HH		PCBs, PAHs, petroleum, metals, pesticides/herbicides	copper(S), PCBs(S), PAHs(S), tributyltin(S)	GW
883	Willamette Oaks Building	6721 SW Macadam Ave. Portland, OR 97201	dry-cleaning (former), rubber company (former)	PCE, TCE, other solvents associated with dry-cleaning	chlorinated solvents(GW), dichloroethylenes(GW), tetrachloroethylene(GW), trichloroethylene(GW), vinyl chloride(GW)	GW

Table E-5. Shoreline or Nearshore Facilities Upstream of RM 11 that are Listed in DEQ's ESCI Database. (All information was compiled from DEQ Site Summary Reports; see Figure E-1 for facility locations).

ESCI #	Facility/SiteName	Address	Type(s) of Operation	Hazardous Substances/Waste Types	Detected Chemicals in Upland Samples[1]	Potential Pathways to River[2]
3104	Rodda Paint Building (former)	6932 SW Macadam Ave. Portland, OR 97219	paint making operation (former)	toluene, xylene-based solvents, mineral spirits, paint wastes containing metals, water-based resins, petroleum hydrocarbons, chlorinated VOCs	acetone(S), butylbenzenes(S), chloroform(GW), cumene(B), dichloroethane(GW), dichloroethylenes(GW), ethylbenzene(S), propylbenzene(B), tetrachloroethylene(GW), toluene(GW), trichloroethane(GW), trichloroethylene(GW), trichloromonofluoromethane(GW), trimethylbenzene(GW), vinyl chloride(GW), xylenes(GW)	GW, SW, WW, DR
123	Huntington Rubber Corp.	7030 SW Macadam Ave. Portland, OR 97219	rubber products manufacturer	petroleum	petroleum-contaminated waste water	WW
1006	Oaks Bottom Landfill	1S/1E/S23 Portland, OR 97202	closed solid waste landfill	former demolition debris and brush landfill		
1258	Abes Main St. Cleaners	10863 SE Main St. Milwaukie, OR 97222	laundry/dry cleaner	perchloroethylene, trichloroethylene, Stoddard solvent	tetrachloroethylene(B)	GW, WW
2613	Willamette View Inc.	12705 SE River Rd. Portland, OR 97222	retirement home	diesel-range TPH, lead (offsite source suspected)	TPH(B)	GW
812	BLE Inc.	101 Foothills Rd. Lake Oswego, OR 97034	inactive public water supply wells	PCE, TCE, cis-1,2-DCE	VOCs(GW)	GW
2616	Erickson's Automotive	102 Foothills Rd. Lake Oswego, OR 97034		Petroleum, PAHs, VOCs (benzene, toluene, ethylbenzene, xylenes, and chlorinated hydrocarbons)	dichloroethylene(GW), naphthalene(GW), tetrachloroethylene(GW), trichloroethylene(GW)	GW
71	Martin Electric	91 Foothills Rd Lake Oswego, OR 97034	electrical equipment firm	PCBs from transformer waste oils	PCB 1221(S)	
1066	Gross Property Disposal Site	3S/1E/S2 West Linn, OR 97068	vacant farm land	PCBs	PCBs(S)	
2301	Clackamette Cove Area	16288 Main St. Oregon City, OR 97045		gasoline(BTEX, PAHs), heavy metals, asphalt, diesel & lube oil-range TPH, PAHs, chlorinated hydrocarbons	arsenic(B), chlorobenzene(GW), chromium(S), dichlorobenzene(GW), iron(GW), lead(B), TPH(S)	GW
129	(b) (6) Residence	(b) (6) Oregon City, OR 97045	private home	PCBs, oil	oil or fuel related compounds(S), PCBs(S)	
283	Willamette Falls Locks	West Linn, OR 97068	water transportation, freight	heavy metals, ammonia, methylene chloride, oils, latex, clarified white water	ammonia(S), arsenic(S), chromium(S), lead(S), methylene chloride (surface water)	DR
263	West Linn Paper Company	4800 Mill St. West Linn, OR 97068	wood pulping and specialty paper mill	oil, PCBs	oil or fuel related compounds(S), PCB 1221(S)	DR, GW
2114	Sullivan Electrical Substation	5600 Willamette Falls Dr. West Linn, OR 97068	electrical substation			

[1]S=soil or sediment, GW=groundwater, B=both
[2]Pathways Identified in ECSI Site Summary Reports: GW = groundwater, SW = stormwater/surface runoff, WW = wastewater discharge, DR = direct release, spill



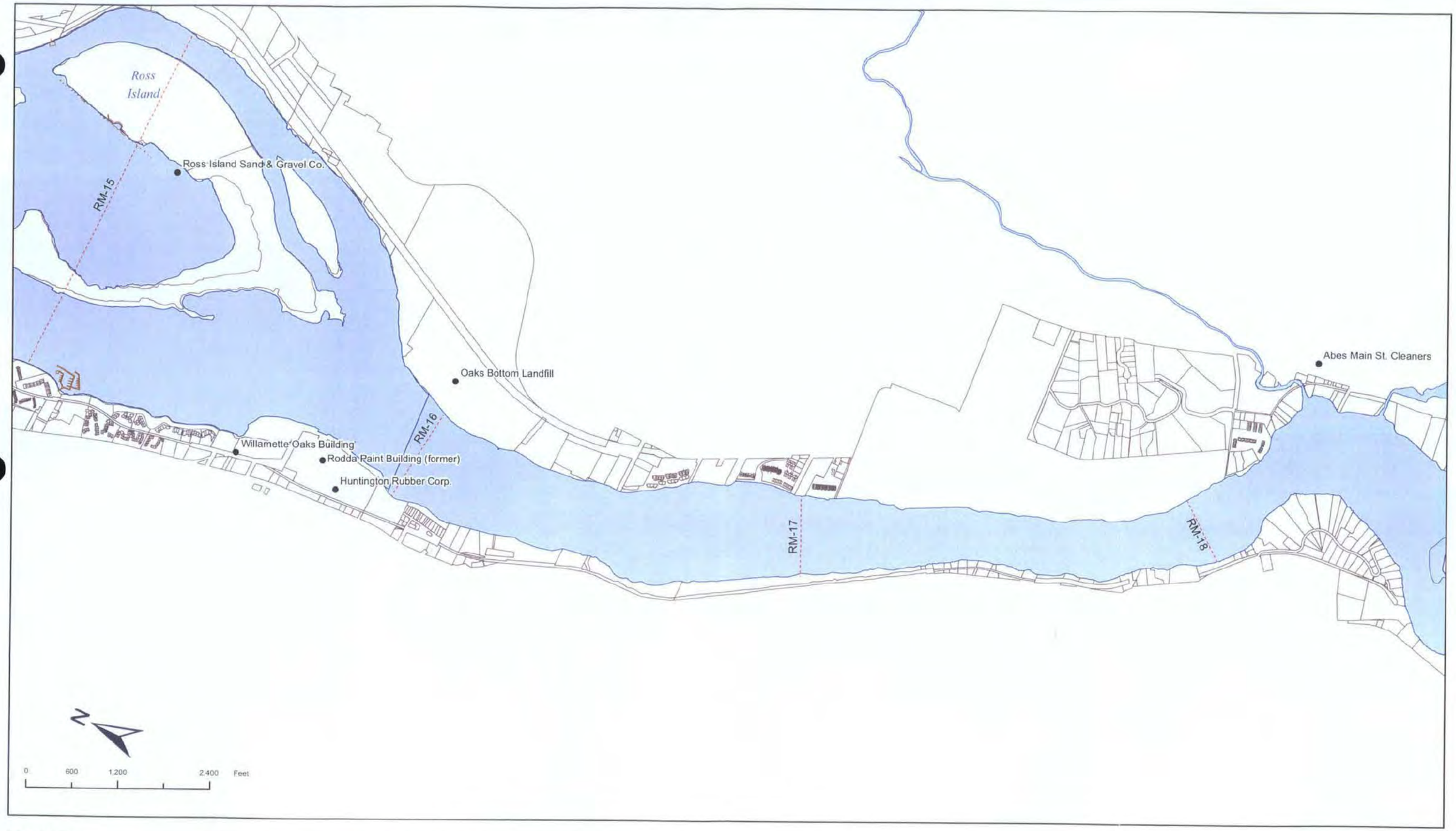
LWG
Lower Willamette Group

Triplin Environmental Associates

FEATURE SOURCES:
Transportation, Water, Property, Zoning or Boundaries: Metro RLIS.
Channel & River miles: Developed from US Army Corps of Engineers information.
River Edge: created by heads-up digitizing from the October 2001 0.33 ft. resolution color orthophotos.
Docks & In-water Structures: created by heads-up digitizing from the October 2001 0.33 ft. resolution color orthophotos.
Historic Sampling Locations: Created from Category 1 and 2 LWG Surface Sediment Data with tag where sampling occured prior to dredging event.
Round 1 sampling locations: LWG database query of sediment samples.
File name: WorkPlan2003_Ap-F_NON-ISA-FacilitiesLocatorMap.mxd
PLOT DATE: 02/11/03

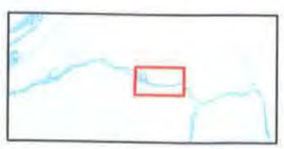
Legend
- ECSI Upstream Facilities
- Navigation Channel
- River Miles
- Docks & in-water structures - 2001
- Waterfront Taxlots

Figure E-1a
Portland Harbor RI/FS
Appendix E
ECSI Facilities Upstream of River Mile 11
(See Table E-5)



LWG
LOWER WILLAMETTE GROUP

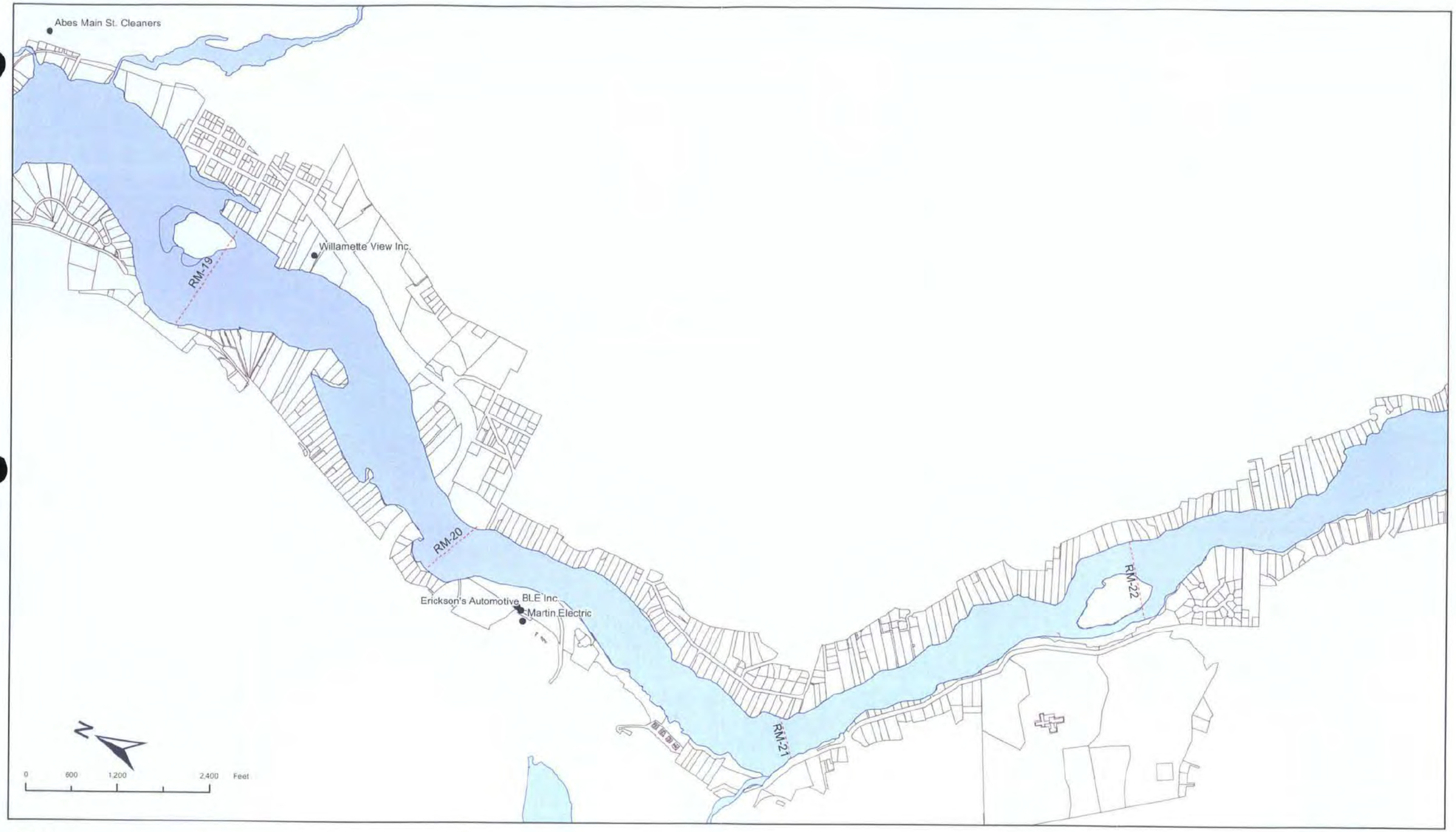
TRIPLIN Environmental Associates



FEATURE SOURCES
Transportation, Water, Property, Zoning or Boundaries: Metro RLIS
Channal & River miles: Developed from US Army Corps of Engineers information.
River Edge: created by heads-up digitizing from the October 2001 0.33 ft. resolution color orthophotos
Docks & In-water Structures: created by heads-up digitizing from the October 2001 0.33 ft. resolution color orthophotos.
Historic Sampling Locations: Created from Category 1 and 2 LWG Surface Sediment Data with tag where sampling occured prior to dredging event.
Round 1 sampling locations: LWG database query of sediment samples
File name: WorkPlan2003_Ap-F_NON-ISA-FacilitiesLocatorMap.mxd
PLOT DATE: 02/11/03

Legend
- ECSI Upstream Facilities
- Navigation Channel
- River Miles
- Docks & in-water structures - 2001
- Waterfront Taxlots

Figure E-1b
Portland Harbor RI/FS
Appendix E
ECSI Facilities Upstream of River Mile 11
(See Table E-5)



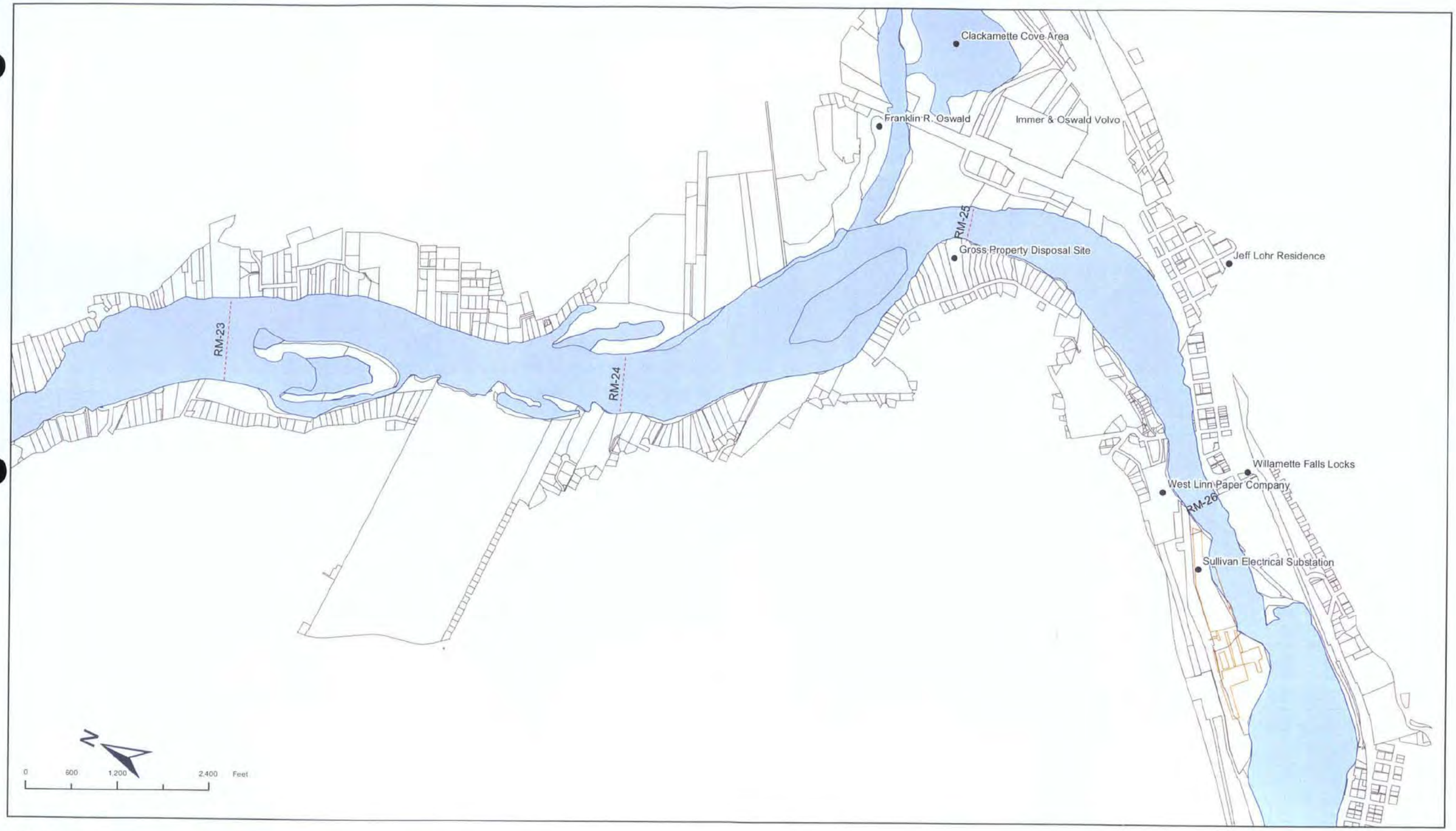
LWG
Lower Willamette Group

Triplin Environmental Associates

FEATURE SOURCES
Transportation, Water, Property, Zoning or Boundaries: Metro RLIS.
Channel & River miles: Developed from US Army Corps of Engineers information.
River Edge: created by heads-up digitizing from the October 2001 0.33 ft. resolution color orthophotos.
Docks & In-water Structures: created by heads-up digitizing from the October 2001 0.33 ft. resolution color orthophotos.
Historic Sampling Locations: Created from Category 1 and 2 LWG Surface Sediment Data with tag where sampling occured prior to dredging event.
Round 1 sampling locations: LWG database query of sediment samples.
File name: WorkPlan2003_Ap-F_NON-ISA-FacilitiesLocatorMap.mxd
PLOT DATE: 02/11/03

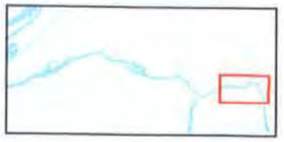
Legend
- ECSI Upstream Facilities
- Navigation Channel
- River Miles
- Docks & in-water structures - 2001
- Waterfront Taxlots

Figure E-1c
Portland Harbor RI/FS
Appendix E
ECSI Facilities Upstream of River Mile 11
(See Table E-5)



LWG
LOWER WILLAMETTE GROUP

TRIPLIN Environmental Associates



FEATURE SOURCES
Transportation, Water, Property, Zoning or Boundaries: Metro RLIS
Channel & River miles: Developed from US Army Corps of Engineers information
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Historic Sampling Locations: Created from Category 1 and 2 LWG Surface Sediment Data with tag where sampling occured prior to dredging event.
Round 1 sampling locations: LWG database query of sediment samples
File name: WorkPlan2003_Ap-F_NON-ISA-FacilitiesLocatorMap.mxd
PLOT DATE: 02/11/03

Legend
- ECSI Upstream Facilities
- Navigation Channel
- River Miles
- Docks & in-water structures - 2001
- Waterfront Taxlots

Figure E-1d
Portland Harbor RI/FS
Appendix E
ECSI Facilities Upstream of River Mile 11
(See Table E-5)

National
Response
Center

Our Response Communications Today Helps Better The Environment Tomorrow

1(800)424-8802

Oct. 16, 2003

Betsy D. Striplin
Striplin Environmental Assoc., INC.
15111 8th Avenue SW, Suite 303
Seattle, WA 98166

FREEDOM OF INFORMATION REQUEST (USCG CONTROL NUMBER 03-2149)

Dear Ma'am:

I have received your letter request date 12 Sep 2003 for copies of discharge (spill) reports submitted to the National Response Center (NRC) concerning any releases to the Williamette River between mile marker 0-26.5 in Oregon.

The NRC database was searched using the following criteria:

State: %OR%
Location: %Williamette River%

The "%" sign is a wildcard in our database that brings up all reports fitting the criteria.

Based on that search, the information you requested is enclosed. This information is based upon reports received by the NRC. Since the database only contains information "as reported" to the NRC, the information may not reflect the actual number of releases (spills) that occurred, the amount of material released (spilled), or complete information on the location. There are no other offices within the Coast Guard in which responsive records are likely to be found. The remainder of our database, 1982-1989, can be searched on our website at www.nrc.uscg.mil.

You may appeal this determination within 30 days from the date of this letter. Address your appeal to:

Commandant (G-CIM-2)
2100 Second Street SW
Washington DC 20593-0001

Your appeal should include reasons for reconsideration.

If the NRC can be of any further assistance, please call (202) 267-2675.

Sincerely,

S. L. EDWARDS
Lieutenant Junior Grade
U.S. Coast Guard
By direction

National Response Center

Our Response Communications Today Helps Better The Environment Tomorrow

1(800)424-8802

Oct. 16, 2003

Betsy D. Striplin
Striplin Environmental Assoc., INC.
15111 8th Avenue SW, Suite 303
Seattle, WA 98166

FREEDOM OF INFORMATION REQUEST (USCG CONTROL NUMBER 04-0065)

Dear Ma'am:

I have received your letter request date 12 Sep 2003 for copies of discharge (spill) reports submitted to the National Response Center (NRC) concerning any releases to the Williamette River between mile marker 0-26.5 in Oregon.

The NRC database was searched using the following criteria:

State: %OR%
Location: %Williamette River%

The "%" sign is a wildcard in our database that brings up all reports fitting the criteria.

Based on that search, the information you requested is enclosed. This information is based upon reports received by the NRC. Since the database only contains information "as reported" to the NRC, the information may not reflect the actual number of releases (spills) that occurred, the amount of material released (spilled), or complete information on the location. There are no other offices within the Coast Guard in which responsive records are likely to be found. The remainder of our database, 1982-1989, can be searched on our website at www.nrc.uscg.mil.

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Sincerely,

S. L. EDWARDS
Lieutenant Junior Grade
U.S. Coast Guard
By direction

NATIONAL RESPONSE CENTER - PUBLIC FAX
xxxGOVERNMENT USE ONLYxxxGOVERNMENT USE ONLYxxx
DO NOT RELEASE this information to the public without
permission from the NATIONAL RESPONSE CENTER 1-800-424-8802

Incident Report # 644071

INCIDENT DESCRIPTION

xReport taken by: CIV RAWLS at 14:42 on 05-MAY-03
Incident Type: STORAGE TANK
Incident Cause: UNKNOWN
Affected Area: WILLIAMETTE RIVER
The incident was discovered on 29-APR-03 at 19:30 local time.
Affected Medium: WATER WILLIAMETTE RIVER

SUSPECTED RESPONSIBLE PARTY

Name: UNKNOWN

XX

Type of Organization: UNKNOWN

INCIDENT LOCATION

County: CLACKAMAS
City: OREGON CITY State: OR
THE WILLIAMETTE RIVER JUST BELOW THE OREGON CITY FALLS. OREGON CITY, OR

RELEASED MATERIAL(S)

CHRIS Code: UNK Official Material Name: UNKNOWN MATERIAL
Also Known As:
Qty Released: 0 UNKNOWN AMOUNT Qty in Water: 0 UNKNOWN AMOUNT

DESCRIPTION OF INCIDENT

//WEB REPORT//MYSTERY DRUM IN WILLIAMETTE RIVER. UNKNOWN CONTENTS.

INCIDENT DETAILS

Description of Tank: BLACK PLASTIC DRUM
Tank Above/Below Ground: ABOVE
Transportable Container: YES
Tank Regulated: UNKNOWN
Tank Regulated By:
Tank ID:
Capacity of Tank: 55 GALLON(S)
Actual Amount:
---WATER INFORMATION---
Body of Water: WILLIAMETTE RIVER
Tributary of:
Nearest River Mile Marker:
Water Supply Contaminated: NO

DAMAGES

Fire Involved: NO Fire Extinguished: UNKNOWN
INJURIES: Hospitalized: Empl/Crew: Passenger:

FATALITIES: Empl/Crew: Passenger: Occupant:
EVACUATIONS: Who Evacuated: Radius/Area:

Damages:

Closure Type	Description of Closure	Hours Closed	Direction of Closure
Air: N			
Road: N			Major Artery: N
Waterway: N			
Track: N			

Media Interest: NONE Community Impact due to Material: NO

REMEDIAL ACTIONS

MSO PORTLAND HIRED FOSS ENVIRONMENTAL TO REMOVE DRUM, WHICH THEY DID 30 MAY 03.
Release Secured: UNKNOWN
Release Rate:
Estimated Release Duration:

WEATHER

Weather: UNKNOWN, :F

ADDITIONAL AGENCIES NOTIFIED

Federal:
State/Local:
State/Local On Scene:
State Agency Number:

NOTIFICATIONS BY NRC

ATSDR OR ATTN: THEODORA TSONGAS
05-MAY-03 14:53 (503)7314025
NOAA 1ST CLASS BB RPTS FOR OR
05-MAY-03 14:53 (206)5266344
NATIONAL RESPONSE CENTER HQ ME
15-OCT-03 17:57
MSO PORTLAND, OR PO BEEBE
05-MAY-03 14:55 (503)2409379
OREGON EMERGENCY MANAGEMENT
05-MAY-03 14:53 (800)4520311

ADDITIONAL INFORMATION

A MYSTERY DRUM WAS SIGHTED BY TUALATIN VALLEY, HAZMAT 9 AND TO MSO PROTLAND, OR. MSO PORTLAND HIRED FOSS ENVIRONMENTAL TO REMOVE DRUM.

xxx END INCIDENT REPORT 644071 xxx
Report any problems or Fax number changes by calling 1-800-424-8802
PLEASE VISIT OUR WEB SITE AT http://www.nrc.uscg.mil

NATIONAL RESPONSE CENTER - PUBLIC FAX
xxxGOVERNMENT USE ONLYxxxGOVERNMENT USE ONLYxxx
DO NOT RELEASE this information to the public without
permission from the NATIONAL RESPONSE CENTER 1-800-424-8802

Incident Report # 406565

INCIDENT DESCRIPTION

xReport taken by: MST3 CHANCELLOR at 14:06 on 07-OCT-97
Incident Type: UNKNOWN SHEEN
Incident Cause: UNKNOWN
Affected Area:
The incident was discovered on 07-OCT-97 at 10:50 local time.
Affected Medium: WATER WILLIAMETTE RIVER

SUSPECTED RESPONSIBLE PARTY

Name: UNKNOWN

XX

Type of Organization: UNKNOWN

INCIDENT LOCATION

9030 NW ST HELENS ROAD County: MULTNOMAH
NEAR DOCK
City: PORTLAND State: OR Zip: 97267

RELEASED MATERIAL(S)

CHRIS Code: OUN Official Material Name: UNKNOWN OIL
Also Known As:
Qty Released: 0 UNKNOWN AMOUNT Qty in Water: 0 UNKNOWN AMOUNT

DESCRIPTION OF INCIDENT

UNKNOWN / UNKNOWN SHEEN SIGHTING, SHEEN SIZE: 400 BY 150 FT /
COLOR:RAINBOW

INCIDENT DETAILS

Platform Rig Name:
Platform Letter:
Location Area ID:
Location Block ID:
OCSG Number:
OCSP Number:
State Lease Number:
Pier Dock Number:
Berth Slip Number:

DAMAGES

Fire Involved: NO Fire Extinguished: UNKNOWN
INJURIES: Hospitalized: Empl/Crew: Passenger:

FATALITIES: Empl/Crew: Passenger: Occupant:
EVACUATIONS: Who Evacuated: Radius/Area:
Damages:

Hours Direction of

Closure Type Description of Closure Closed Closure
Air: N

Road: N Major N Artery:

Waterway: N

Track: N

Media Interest: Community Impact due to Material: NO

REMEDIAL ACTIONS

NONE
Release Secured: UNKNOWN
Release Rate:
Estimated Release Duration:

WEATHER

ADDITIONAL AGENCIES NOTIFIED

Federal:
State/Local:
State/Local On Scene:
State Agency Number:

NOTIFICATIONS BY NRC

ATSDR OR ATTN: ELIZABETH ESSEKS	?????
07-OCT-97 00:00	(503)4944278
ATSDR WA ATTN: LUCY HARTER	?????
07-OCT-97 00:00	(360)5865529
NOAA 1ST CLASS BB RPTS FOR OR	?????
07-OCT-97 00:00	(202)5266329
NATIONAL RESPONSE CENTER HQ	ME
15-OCT-03 18:03	
MSO PORTLAND, OR	PO KLARMANN
07-OCT-97 14:13	
OREGON EMERGENCY MANAGEMENT	?????
07-OCT-97 00:00	(503)5881378
WA STATE EMERGENCY MANAGEMENT	?????
07-OCT-97 00:00	(360)4387395

ADDITIONAL INFORMATION

WX/CURRENT:LOW WIND:SW 5 KTS COVER:CLDY TEMP:60

xxx END INCIDENT REPORT 406565 xxx
Report any problems or Fax number changes by calling 1-800-424-8802
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Incident Report # 93331

INCIDENT DESCRIPTION

xReport taken by: MST3 WIKER at 17:19 on 22-OCT-91
Incident Type: UNKNOWN SHEEN
Incident Cause: UNKNOWN
Affected Area:
The incident was discovered on 19-OCT-91 at 09:03 local time.
Affected Medium: WATER WILLIAMETTE RIVER

SUSPECTED RESPONSIBLE PARTY

Name: UNKNOWN

XX

Type of Organization: UNKNOWN

INCIDENT LOCATION

WILLAMETTE RIVER County: UNKNOWN
MILE 8.2
City: PORTLAND State: OR
Latitude: 45 Degrees 34' 1" N
Longitude: 122 Degrees 43' 6" W

RELEASED MATERIAL(S)

CHRIS Code: OHY Official Material Name: HYDRAULIC OIL
Also Known As:
Qty Released: 5 GALLON(S) Qty in Water: 5 GALLON(S)

DESCRIPTION OF INCIDENT

UNKNOWN / UNKNOWN

INCIDENT DETAILS

Platform Rig Name:
Platform Letter:
Location Area ID:
Location Block ID:
OCSG Number:
OCSP Number:
State Lease Number:
Pier Dock Number:
Berth Slip Number:

DAMAGES

Fire Involved: NO Fire Extinguished: UNKNOWN
INJURIES: Hospitalized: Empl/Crew: Passenger:

FATALITIES: Empl/Crew: Passenger: Occupant:
EVACUATIONS: Who Evacuated: Radius/Area:
Damages:

Hours Direction of

Closure Type Description of Closure Closed Closure
Air: N

Road: N Major N Artery:

Waterway: N

Track: N

Media Interest: Community Impact due to Material: NO

REMEDIAL ACTIONS

4 GALLONS RECOVERED.
Release Secured: UNKNOWN
Release Rate:
Estimated Release Duration:

WEATHER

ADDITIONAL AGENCIES NOTIFIED

Federal:
State/Local:
State/Local On Scene:
State Agency Number:

NOTIFICATIONS BY NRC

NATIONAL RESPONSE CENTER HQ ME
15-OCT-03 18:07
MSO PORTLAND, OR
22-OCT-91 17:24

ADDITIONAL INFORMATION

MSIS MP91011012

xxx END INCIDENT REPORT 93331 xxx
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Incident Report # 544688
xxxxxxxxxxxxxx THIS IS A DRILL xxxxxxxxxxxxxx
INCIDENT DESCRIPTION

xReport taken by: CIV VAUSS at 09:39 on 10-OCT-00
Incident Type: PIPELINE
Incident Cause: EQUIPMENT FAILURE
Affected Area: WILLAMETTE RIVER
The incident occurred on 10-OCT-00 at 06:10 local time.
Affected Medium: WATER WILLIAMETTE RIVER

SUSPECTED RESPONSIBLE PARTY

Name: JOHN FERDIG
Organization: CHEVERON PRODUCTS CO
Address: 5924 N.W. FRONT AVE
PORTLAND, OR 97210
PRIMARY Phone: (503)2217890
Type of Organization: PRIVATE ENTERPRISE

INCIDENT LOCATION

5924 N.W. FRONT AVE County: MULTNOMAH
City: PORTLAND State: OR Zip: 97210

RELEASED MATERIAL(S)

CHRIS Code: NCC Official Material Name: NO CHRIS CODE
Also Known As: VACUUM GAS OIL
Qty Released: 300 BARREL(S) Qty in Water: 300 BARREL(S)

DESCRIPTION OF INCIDENT

THIS IS A DRILL///THE MATERIAL IS RELEASING FROM AN OUT OF SERVICE PIPELINE HOSE DUE TO HOSE FAILURE.

INCIDENT DETAILS

Pipeline Type: OTHER
DOT Regulated: UNKNOWN
Pipeline Above/Below Ground: ABOVE
Exposed or Under Water: NO
Pipeline Covered: UNKNOWN
---SHEEN INFORMATION---
Sheen Color: UNKNOWN
Sheen Odor Description:
Sheen Travel Direction:
Sheen Size Length: 100 YARDS
Sheen Size Width: 50 YARDS
---WATER INFORMATION---
Body of Water: WILLAMETTE RIVER
Tributary of: COLUMBIA RIVER
Nearest River Mile Marker:
Water Supply Contaminated: NO

DAMAGES

Fire Involved: NO Fire Extinguished: UNKNOWN

INJURIES: Hospitalized: Empl/Crew: Passenger:

FATALITIES: Empl/Crew: Passenger: Occupant:
EVACUATIONS: Who Evacuated: Radius/Area:
Damages:

Closure Type	Description of Closure	Hours Closed	Direction of Closure
Air: N			
Road: N			Major Artery: N
Waterway: N			
Track: N			

Media Interest: NONE Community Impact due to Material: NO

REMEDIAL ACTIONS

CLEAN RIVERS COOP CONTRACTOR HAS BEEN HIRED, TAKING STEPS TO CONTAIN THE SPILL
Release Secured: YES
Release Rate:
Estimated Release Duration: 50 MINUTE

WEATHER

Weather: RAINY, 60:F
Wave Condition: 0 CALM

ADDITIONAL AGENCIES NOTIFIED

Federal: MSO PORTLAND
State/Local: OERS, WA ERS
State/Local On Scene:
State Agency Number:

NOTIFICATIONS BY NRC

ATSDR OR ATTN: RICK LEIKER
10-OCT-00 09:51 (503)7314025
ATSDR WA ATTN: LUCY HARTER
10-OCT-00 09:51 (360)2363364
NOAA 1ST CLASS BB RPTS FOR OR
10-OCT-00 09:51 (206)5266344
NATIONAL RESPONSE CENTER HQ ME
15-OCT-03 18:02
OREGON EMERGENCY MANAGEMENT
10-OCT-00 09:51 (800)4520311
WA STATE EMERGENCY MANAGEMENT
10-OCT-00 09:51 (800)2585990

ADDITIONAL INFORMATION

THIS IS A DRILL///THE RELEASE WAS STOPPED AT 6:20AM.

xxx END INCIDENT REPORT 544688 xxx
Report any problems or Fax number changes by calling 1-800-424-8802
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Incident Report # 101034

INCIDENT DESCRIPTION

xReport taken by: ENS DECKER at 12:05 on 28-DEC-91
Incident Type: VESSEL
Incident Cause: OPERATOR ERROR
Affected Area:
The incident occurred on 28-DEC-91 at 02:15 local time.
Affected Medium: WATER WILLIAMETTE RIVER

SUSPECTED RESPONSIBLE PARTY

Name: UNKNOWN
Organization: M/V TAI CHUNG
Address: TAIWAN NAVIG. LTD >
7 FLOOR NO.17 >
HSU CHUNG ST
TAIPAI, TAIWAN ROC, XX

Type of Organization: PRIVATE ENTERPRISE

INCIDENT LOCATION

COLUMBIA ALUMINUM CO County: MULTNOMAH
MILE 10
WILLAMETTE RIVER
City: PORTLAND State: OR

RELEASED MATERIAL(S)

CHRIS Code: OTH Official Material Name: OTHER OIL
Also Known As: INTERMEDIATE FUEL OIL
Qty Released: 3000 GALLON(S) Qty in Water: 3000 GALLON(S)

DESCRIPTION OF INCIDENT

FUELING FROM BARGE / NO.4 TANK ON M/V TAI CHUNG BURPED

INCIDENT DETAILS

Platform Rig Name:
Platform Letter:
Location Area ID:
Location Block ID:
OCSG Number:
OCSP Number:
State Lease Number:
Pier Dock Number:
Berth Slip Number:

---VESSEL INFORMATION---
Name: UNKNOWN NAME1 Number: M/V TAI CHUNG Aground: NO
Flag:
Length: Breadth: Draught:
Type: UNKNOWN
Hull Construction:
Fuel Capacity:

Fuel on Board:
Cargo Capacity:
Cargo on Board:

DAMAGES

Fire Involved: NO Fire Extinguished: UNKNOWN
INJURIES: Hospitalized: Empl/Crew: Passenger:

FATALITIES: Empl/Crew: Passenger: Occupant:
EVACUATIONS: Who Evacuated: Radius/Area:
Damages:

Closure Type	Description of Closure	Hours Closed	Direction of Closure
Air: N			
Road: N			Major Artery: N
Waterway: N			
Track: N			

Media Interest: Community Impact due to Material: NO

REMEDIAL ACTIONS

CONTRACTORS ON SCENE; BOOMS DEPLOYEDMILE MARKER 11 AND 5 SHEEN PATCHES; SOME RECOVERABLE
Release Secured: UNKNOWN
Release Rate:
Estimated Release Duration:

WEATHER

ADDITIONAL AGENCIES NOTIFIED

Federal:
State/Local:
State/Local On Scene:
State Agency Number:

NOTIFICATIONS BY NRC

NATIONAL RESPONSE CENTER HQ ME
15-OCT-03 18:06
MSO PORTLAND, OR
28-DEC-91 12:11

ADDITIONAL INFORMATION

CG OVERFLIGHT IN PROGRESS

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xxx END INCIDENT REPORT 101034 xxx
Report any problems or Fax number changes by calling 1-800-424-8802
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Incident Report # 92484

INCIDENT DESCRIPTION

xReport taken by: MST3 WIKER at 16:14 on 16-OCT-91
Incident Type: VESSEL
Incident Cause: EQUIPMENT FAILURE
Affected Area:
The incident was discovered on 09-OCT-91 at 12:45 local time.
Affected Medium: WATER WILLIAMETTE RIVER

SUSPECTED RESPONSIBLE PARTY

Name: UNKNOWN
Organization: USNS HASSAYAMPA
XX

Type of Organization: FEDERAL GOVERNMENT

INCIDENT LOCATION

WILLAMETTE RIVER County: UNKNOWN
MILE MARKER 8.2
City: PORTLAND State: OR
Latitude: 45 Degrees 34' 1" N
Longitude: 122 Degrees 43' 1" W

RELEASED MATERIAL(S)

CHRIS Code: GAV Official Material Name: GASOLINE: AVIATION (4.86G PB/GAL
Also Known As:
Qty Released: 5 GALLON(S) Qty in Water: 5 GALLON(S)

DESCRIPTION OF INCIDENT

USNS HASSAYAMPA / LEAKING DUE TO STRUCTURAL FAILURE OF HULL DUE
TOCRACKS IN FUEL TANK

INCIDENT DETAILS

Platform Rig Name:
Platform Letter:
Location Area ID:
Location Block ID:
OCSG Number:
OCSP Number:
State Lease Number:
Pier Dock Number:
Berth Slip Number:

---VESSEL INFORMATION---
Name: UNKNOWN NAME1 Number: USNS HASSAYAMPA Aground: NO
Flag:
Length: Breadth: Draught:
Type: UNKNOWN
Hull Construction:
Fuel Capacity:
Fuel on Board:
Cargo Capacity:

Cargo on Board:

DAMAGES

Fire Involved: NO Fire Extinguished: UNKNOWN
INJURIES: Hospitalized: Empl/Crew: Passenger:

FATALITIES: Empl/Crew: Passenger: Occupant:
EVACUATIONS: Who Evacuated: Radius/Area:
Damages:

Closure Type	Description of Closure	Hours Closed	Direction of Closure
Air: N			
Road: N			Major Artery: N
Waterway: N			
Track: N			

Media Interest: Community Impact due to Material: NO

REMEDIAL ACTIONS

NONE, DISSIPATED.
Release Secured: UNKNOWN
Release Rate:
Estimated Release Duration:

WEATHER

ADDITIONAL AGENCIES NOTIFIED

Federal:
State/Local:
State/Local On Scene:
State Agency Number:

NOTIFICATIONS BY NRC

NATIONAL RESPONSE CENTER HQ ME
15-OCT-03 18:07
MSO PORTLAND, OR
16-OCT-91 16:19

ADDITIONAL INFORMATION

MSIS MP91010807

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xxx END INCIDENT REPORT 92484 xxx
Report any problems or Fax number changes by calling 1-800-424-8802
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Incident Report # 199227

INCIDENT DESCRIPTION

xReport taken by: MST3 LLOYD at 16:24 on 23-SEP-93
Incident Type: VESSEL
Incident Cause: EQUIPMENT FAILURE
Affected Area:
The incident occurred on 23-SEP-93 at 13:20 local time.
Affected Medium: WATER WILLIAMETTE RIVER

SUSPECTED RESPONSIBLE PARTY

Name: LINDA WELLS
Organization: BRIX MARITIME
Address: 9030 NW ST HELENS
PORTLAND, OR 97267
PRIMARY Phone: (503)2860631 SECONDARY Phone: (503)3256621
Type of Organization: PRIVATE ENTERPRISE

INCIDENT LOCATION

9030 NW ST HELENS County: MULTNOMAH
City: PORTLAND State: OR Zip: 97267

RELEASED MATERIAL(S)

CHRIS Code: OWA Official Material Name: WASTE OIL
Also Known As:
Qty Released: 1 GALLON(S) Qty in Water: 1 GALLON(S)

DESCRIPTION OF INCIDENT

TUG BOAT T. J. BRIX / HOSE LEAKED WHILE OFFLOADING WASTE OILSHEEN
SIZE: UNKNOWN / BLUE-GRAY

INCIDENT DETAILS

Platform Rig Name:
Platform Letter:
Location Area ID:
Location Block ID:
OCSG Number:
OCSP Number:
State Lease Number:
Pier Dock Number:
Berth Slip Number:

---VESSEL INFORMATION---
Name: UNKNOWN NAME1 Number: UNKNOWN Aground: NO
Flag:
Length: Breadth: Draught:
Type: UNKNOWN
Hull Construction:
Fuel Capacity:
Fuel on Board:
Cargo Capacity:
Cargo on Board:

DAMAGES

Fire Involved: NO Fire Extinguished: UNKNOWN

INJURIES: Hospitalized: Empl/Crew: Passenger:

FATALITIES: Empl/Crew: Passenger: Occupant:

EVACUATIONS: Who Evacuated: Radius/Area:

Damages:

Closure Type	Description of Closure	Hours Closed	Direction of Closure
Air: N			
Road: N			Major Artery: N
Waterway: N			
Track: N			

Media Interest: Community Impact due to Material: NO

REMEDIAL ACTIONS

RECOVERED MATERIAL WITH PADS

Release Secured: UNKNOWN

Release Rate:

Estimated Release Duration:

WEATHER

ADDITIONAL AGENCIES NOTIFIED

Federal:

State/Local:

State/Local On Scene:

State Agency Number:

NOTIFICATIONS BY NRC

NATIONAL RESPONSE CENTER HQ ME

15-OCT-03 18:04

MSO PORTLAND, OR PO STEVENSON

23-SEP-93 16:29

ADDITIONAL INFORMATION

WILL NOTIFY LOCAL CG AND STATE AUTHORITIES

xxx END INCIDENT REPORT 199227 xxx

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Incident Report # 644068

INCIDENT DESCRIPTION

xReport taken by: CIV THREATT at 14:22 on 05-MAY-03
Incident Type: VESSEL
Incident Cause: EQUIPMENT FAILURE
Affected Area: WILLIAMETTE RIVER
The incident was discovered on 25-APR-03 at 07:15 local time.
Affected Medium: WATER WILLIAMETTE RIVER

SUSPECTED RESPONSIBLE PARTY

Name: JOEL DERBYSHIRE
Address: JANTZEN BEACH MOORAGE
PORTLAND, OR

INCIDENT LOCATION

County: MULTNOMAH
City: PORTLAND State: OR
INCIDENT TOOK PLACE AT JANTZEN BEACH MOORAGE, MOORAGE #7

RELEASED MATERIAL(S)

CHRIS Code: GAS Official Material Name: GASOLINE: AUTOMOTIVE (UNLEADED)
Also Known As:
Qty Released: 1 GALLON(S) Qty in Water: 0 UNKNOWN AMOUNT
CHRIS Code: OLB Official Material Name: OIL, MISC: LUBRICATING
Also Known As:
Qty Released: 4 GALLON(S) Qty in Water: 0 UNKNOWN AMOUNT

DESCRIPTION OF INCIDENT

20 FT. BAYLINER CAPSIZED @ THE JANTZEN BEACH MOORAGE. THE SPILL CLEANED UP WAS BY THE RP AND THE VESSEL WAS REMOVED FROM THE WATER. APPROX 5 GALS OF MIXED OIL ENTERED THE WILLIAMETTE RIVER. AN LOW WAS ISSUED.

INCIDENT DETAILS

Platform Rig Name:
Platform Letter:
Location Area ID:
Location Block ID:
OCSG Number:
OCSP Number:
State Lease Number:
Pier Dock Number:
Berth Slip Number:
---SHEEN INFORMATION---
Sheen Color: SILVERY
Sheen Odor Description: STRONG GASOLINE SMELL
Sheen Travel Direction: E
Sheen Size Length: 5 FEET
Sheen Size Width: 10 FEET
---WATER INFORMATION---
Body of Water: WILLIAMETTE RIVER

Tributary of:
Nearest River Mile Marker:
Water Supply Contaminated: NO

---VESSEL INFORMATION---
Name: OR370AX Number: Aground: YES
Flag:
Length: Breadth: Draught:
Type: PLEASURE CRAFT
Hull Construction:
Fuel Capacity:
Fuel on Board:
Cargo Capacity:
Cargo on Board:

DAMAGES

Fire Involved: NO Fire Extinguished: UNKNOWN
INJURIES: Hospitalized: Empl/Crew: Passenger:

FATALITIES: Empl/Crew: Passenger: Occupant:
EVACUATIONS: Who Evacuated: Radius/Area:
Damages:

Closure Type	Description of Closure	Hours Closed	Direction of Closure
Air: N			
Road: N			Major Artery: N
Waterway: N			
Track: N			

Media Interest: NONE Community Impact due to Material: NO

REMEDIAL ACTIONS

OIL WAS CONTAINED, REMOVED AND VESSEL WAS TAKEN OUT OF THE WATER AS TO POSE NO FURTHER THREAT
Release Secured: UNKNOWN
Release Rate:
Estimated Release Duration:

WEATHER

Weather: SUNNY, 65:F Wind speed: 3 MPH

ADDITIONAL AGENCIES NOTIFIED

Federal: USCG
State/Local: DEQ
State/Local On Scene: FIRE DEPT
State Agency Number: NO REPORT #

NOTIFICATIONS BY NRC

ATSDR OR ATTN: THEODORA TSONGAS
05-MAY-03 14:33 (503)7314025
ATSDR WA ATTN: LINDA GUNNELLS
05-MAY-03 14:33 (360)2363387
NOAA 1ST CLASS BB RPTS FOR OR
05-MAY-03 14:33 (206)5266344

NATIONAL RESPONSE CENTER HQ	ME
15-OCT-03 17:59	
MSO PORTLAND, OR	SMITH
05-MAY-03 14:36	(503)2409379
OREGON EMERGENCY MANAGEMENT	
05-MAY-03 14:33	(800)4520311
WA STATE EMERGENCY MANAGEMENT	
05-MAY-03 14:33	(800)2585990

ADDITIONAL INFORMATION

THIS REPORT HAS BEEN SUBMITTED BY PORTLAND, OR. MSO. POC MST1 MACK.

xxx END INCIDENT REPORT 644068 xxx

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Incident Report # 633984

INCIDENT DESCRIPTION

xReport taken by: CIV HALL at 14:43 on 13-JAN-03
Incident Type: FIXED
Incident Cause: OTHER
Affected Area: WILLIAMETTE RIVER
The incident was discovered on 13-JAN-03 at 10:55 local time.
Affected Medium: WATER WILLIAMETTE RIVER

SUSPECTED RESPONSIBLE PARTY

Name: BRENDA DONOVAN
Organization: ARCO PRODUCTS
Address: 9930 NW ST HELEN ROAD
PORTLAND, OR 97231
PRIMARY Phone: (503)2868257
Type of Organization: PRIVATE ENTERPRISE

INCIDENT LOCATION

9930 NW ST HELEN ROAD County: MULTNOMAH
City: PORTLAND State: OR Zip: 97231

RELEASED MATERIAL(S)

CHRIS Code: ODS Official Material Name: OIL: DIESEL
Also Known As:
Qty Released: 5 GALLON(S) Qty in Water: 5 GALLON(S)

DESCRIPTION OF INCIDENT

THE MATERIAL RELEASED FROM A SEA WALL DUE TO NORMAL OPERATIONS.

INCIDENT DETAILS

Building ID:
Type of Fixed Object: OTHER
Power Generating Facility: NO
Generating Capacity:
Type of Fuel:
NPDES:
NPDES Compliance: UNKNOWN
---SHEEN INFORMATION---
Sheen Color: RAINBOW
Sheen Odor Description:
Sheen Travel Direction:
Sheen Size Length: 200 FEET
Sheen Size Width: 100 FEET
---WATER INFORMATION---
Body of Water: WILLIAMETTE RIVER
Tributary of: COLUMBIA RIVER
Nearest River Mile Marker:
Water Supply Contaminated: NO

DAMAGES

Fire Involved: NO Fire Extinguished: UNKNOWN
INJURIES: Hospitalized: Empl/Crew: Passenger:

FATALITIES: Empl/Crew: Passenger: Occupant:
EVACUATIONS: Who Evacuated: Radius/Area:
Damages:

Closure Type	Description of Closure	Hours Closed	Direction of Closure
Air: N			
Road: N			Major Artery: N
Waterway: N			
Track: N			

Media Interest: NONE Community Impact due to Material: NO

REMEDIAL ACTIONS

CLEAN UP UNDERWAY
Release Secured: YES
Release Rate:
Estimated Release Duration:

WEATHER

Weather: CLEAR, :F

ADDITIONAL AGENCIES NOTIFIED

Federal:
State/Local:
State/Local On Scene:
State Agency Number:

NOTIFICATIONS BY NRC

ATSDR OR ATTN: THEODORA TSONGAS
13-JAN-03 14:50 (503)7314025
ATSDR WA ATTN: LINDA GUNNELLS
13-JAN-03 14:50 (360)2363387
NOAA 1ST CLASS BB RPTS FOR OR
13-JAN-03 14:50 (206)5266344
MSO PORTLAND, OR TOWNSEN
13-JAN-03 16:21 (503)2409379
OREGON EMERGENCY MANAGEMENT
13-JAN-03 14:50 (800)4520311
WA STATE EMERGENCY MANAGEMENT
13-JAN-03 14:50 (800)2585990

ADDITIONAL INFORMATION

THE CALLER HAD ADDITIONAL INFORMATION.

xxx END INCIDENT REPORT 633984 xxx
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Incident Report # 549281

INCIDENT DESCRIPTION

xReport taken by: CIV JONES at 13:45 on 27-NOV-00
Incident Type: FIXED
Incident Cause: UNKNOWN
Affected Area: WILLAMETTE RIVER
The incident occurred on 27-NOV-00 at 10:15 local time.
Affected Medium: WATER WILLIAMETTE RIVER

SUSPECTED RESPONSIBLE PARTY

Name: MARVIN SMITH
Organization: FRED DIVINE DIVING & SAL
Address: 6211 NORTH ENGSIN
PORTLAND, OR 97217
PRIMARY Phone: (503)2835285
Type of Organization: PRIVATE ENTERPRISE

INCIDENT LOCATION

County: MULTNOMAH
City: PORTLAND State: OR
PORT OF PORTLAND SHIPYARD DRY DOCK 1

RELEASED MATERIAL(S)

CHRIS Code: OTH Official Material Name: OTHER OIL
Also Known As: OTHER OIL / MOBILE L EAL 224H
Qty Released: 3 GALLON(S) Qty in Water: 2 CUP(S)

DESCRIPTION OF INCIDENT

THE CALLER STATED THAT A HOSE BETWEEN A HYDRAULIC UNIT AND A PUMP BURST AND CAUSED OIL TO SPILL. THE CAUSE IS UNKNOWN.

INCIDENT DETAILS

Building ID:
Type of Fixed Object: OTHER
Power Generating Facility: NO
Generating Capacity:
Type of Fuel:
NPDES:
NPDES Compliance: UNKNOWN
---SHEEN INFORMATION---
Sheen Color: UNKNOWN
Sheen Odor Description:
Sheen Travel Direction:
Sheen Size Length: 30 FEET
Sheen Size Width: 30 FEET
---WATER INFORMATION---
Body of Water: WILLAMETTE RIVER
Tributary of: COLUMBIA RIVER
Nearest River Mile Marker:
Water Supply Contaminated: NO

DAMAGES

Fire Involved: NO Fire Extinguished: UNKNOWN
INJURIES: Hospitalized: Empl/Crew: Passenger:

FATALITIES: Empl/Crew: Passenger: Occupant:
EVACUATIONS: Who Evacuated: Radius/Area:
Damages:

Closure Type	Description of Closure	Hours Closed	Direction of Closure
Air: N			
Road: N			Major Artery: N
Waterway: N			
Track: N			

Media Interest: NONE Community Impact due to Material: NO

REMEDIAL ACTIONS

PORTION OF THE SPILL ON LAND HAS BEEN CONTAINED AND CLEANED UP. /
THE PORTION IN THE WATER HAS DISSIPATED.
Release Secured: YES
Release Rate:
Estimated Release Duration:

WEATHER

Weather: SUNNY, 48:F

ADDITIONAL AGENCIES NOTIFIED

Federal: MSO PORTLAND
State/Local:
State/Local On Scene:
State Agency Number:

NOTIFICATIONS BY NRC

ATSDR OR ATTN: RICK LEIKER
27-NOV-00 13:54 (503)7314025
ATSDR WA ATTN: LUCY HARTER
27-NOV-00 13:54 (360)2363364
U.S. EPA X SEATTLE MR. RODIN
27-NOV-00 13:56 (206)5531263
NOAA 1ST CLASS BB RPTS FOR OR
27-NOV-00 13:54 (206)5266344
MSO PORTLAND, OR MR. WESCHREK
27-NOV-00 13:55 (503)2409379
OREGON EMERGENCY MANAGEMENT
27-NOV-00 13:54 (800)4520311
WA STATE EMERGENCY MANAGEMENT
27-NOV-00 13:54 (800)2585990

ADDITIONAL INFORMATION

THE CALLER HAD NO ADDITIONAL INFORMATION

xxx END INCIDENT REPORT 549281 xxx
Report any problems or Fax number changes by calling 1-800-424-8802
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Incident Report # 508698

INCIDENT DESCRIPTION

xReport taken by: LT UTTING at 17:39 on 11-DEC-99
Incident Type: VESSEL
Incident Cause: UNKNOWN
Affected Area:
The incident was discovered on 11-DEC-99 at 14:20 local time.
Affected Medium: WATER WILLIAMETTE RIVER

SUSPECTED RESPONSIBLE PARTY

Name: RALPH SIEGRIST
Organization: FOSS MARITIME
Address: 9030 NW ST HELENS ROAD
PORTLAND, OR 97267
PRIMARY Phone: (503)2860631 ALTERNATE Phone: (503)3256621
Type of Organization: PRIVATE ENTERPRISE

INCIDENT LOCATION

TOSCO OIL DOCK County: MULTNOMAH
City: PORTLAND State: OR

RELEASED MATERIAL(S)

CHRIS Code: OTD Official Material Name: OIL, FUEL: NO. 2-D
Also Known As:
Qty Released: 17 GALLON(S) Qty in Water: 17 GALLONS

DESCRIPTION OF INCIDENT

REFUELING TUG AT DOCK / UNKNOWN

INCIDENT DETAILS

Platform Rig Name:
Platform Letter:
Location Area ID:
Location Block ID:
OCSG Number:
OCSP Number:
State Lease Number:
Pier Dock Number:
Berth Slip Number:

---VESSEL INFORMATION---
Name: UNKNOWN NAME1 Number: HOWARD OLSEN/566412 Aground: NO
Flag:
Length: Breadth: Draught:
Type: UNKNOWN
Hull Construction:
Fuel Capacity:
Fuel on Board:
Cargo Capacity:
Cargo on Board:

DAMAGES

Fire Involved: NO Fire Extinguished: UNKNOWN
INJURIES: Hospitalized: Empl/Crew: Passenger:

FATALITIES: Empl/Crew: Passenger: Occupant:
EVACUATIONS: Who Evacuated: Radius/Area:
Damages:

Closure Type	Description of Closure	Hours Closed	Direction of Closure
Air: N			
Road: N			Major Artery: N
Waterway: N			
Track: N			

Media Interest: Community Impact due to Material: NO

REMEDIAL ACTIONS

SECURED / BOOM IN PLACE / ABSORBENT PADS / FEIS CALLED ENR
Release Secured: UNKNOWN
Release Rate:
Estimated Release Duration:

WEATHER

ADDITIONAL AGENCIES NOTIFIED

Federal:
State/Local:
State/Local On Scene:
State Agency Number:

NOTIFICATIONS BY NRC

ATSDR OR ATTN: RICK LEIKER
11-DEC-99 00:00 (503)7314798
ATSDR WA ATTN: LUCY HARTER
11-DEC-99 00:00 (360)2362257
NOAA 1ST CLASS BB RPTS FOR OR
11-DEC-99 00:00 (202)5266329
MSO PORTLAND, OR PO BRATCHER
11-DEC-99 17:49
OREGON EMERGENCY MANAGEMENT
11-DEC-99 00:00 (503)5881378
WA STATE EMERGENCY MANAGEMENT
11-DEC-99 00:00 (253)5127287

ADDITIONAL INFORMATION

WX OVERCAST / 45F / WILL NOTIFY OREGON REPONSE

xxx END INCIDENT REPORT 508698 xxx
Report any problems or Fax number changes by calling 1-800-424-8802
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Incident Report # 470026

INCIDENT DESCRIPTION

xReport taken by: CIV REDDY at 14:11 on 08-JAN-99
Incident Type: VESSEL
Incident Cause: OPERATOR ERROR
Affected Area:
The incident occurred on 08-JAN-99 at 11:00 local time.
Affected Medium: WATER WILLIAMETTE RIVER

SUSPECTED RESPONSIBLE PARTY

Name: DENNIS FORSBERG
Organization: MARK MARINE
Address: UNKNOWN
VANCOUVER, WA
PRIMARY Phone: (360)6905753 SECONDARY Phone: (800)7746275
Type of Organization: PRIVATE ENTERPRISE

INCIDENT LOCATION

5480 NORTHWEST FRONT AVE County: MULTNOMAH
City: PORTLAND State: OR Zip: 97210

RELEASED MATERIAL(S)

CHRIS Code: OLB Official Material Name: OIL, MISC: LUBRICATING
Also Known As:
Qty Released: 1.5 GALLON(S) Qty in Water: 1.5 GALLON(S)

DESCRIPTION OF INCIDENT

TUG "UN-NAME" / DECKHAND CARRYING BUCKET TRIPPED / RELEASED BUCKET OFLUBE OIL INTO WILLAMETTE RIVER

INCIDENT DETAILS

Platform Rig Name:
Platform Letter:
Location Area ID:
Location Block ID:
OCSG Number:
OCSP Number:
State Lease Number:
Pier Dock Number:
Berth Slip Number:

---VESSEL INFORMATION---
Name: UNKNOWN NAME1 Number: UNK Aground: NO
Flag:
Length: Breadth: Draught:
Type: UNKNOWN
Hull Construction:
Fuel Capacity:
Fuel on Board:
Cargo Capacity:
Cargo on Board:

DAMAGES

Fire Involved: NO Fire Extinguished: UNKNOWN

INJURIES: Hospitalized: Empl/Crew: Passenger:

FATALITIES: Empl/Crew: Passenger: Occupant:

EVACUATIONS: Who Evacuated: Radius/Area:

Damages:

Closure Type	Description of Closure	Hours Closed	Direction of Closure
Air: N			
Road: N			Major Artery: N
Waterway: N			
Track: N			

Media Interest: Community Impact due to Material: NO

REMEDIAL ACTIONS

DECKHAND SCOOPED MOST OF OIL / SPILL CONTAINED WITH ABSORBENT PADS /

Release Secured: UNKNOWN

Release Rate:

Estimated Release Duration:

WEATHER

ADDITIONAL AGENCIES NOTIFIED

Federal:

State/Local:

State/Local On Scene:

State Agency Number:

NOTIFICATIONS BY NRC

ATSDR OR ATTN: ELIZABETH ESSEKS
08-JAN-99 00:00 (503)4944278

ATSDR WA ATTN: LUCY HARTER
08-JAN-99 00:00 (360)2362257

NOAA 1ST CLASS BB RPTS FOR OR
08-JAN-99 00:00 (202)5266329

MSO PORTLAND, OR PO BRATCHER
08-JAN-99 14:21

OREGON EMERGENCY MANAGEMENT
08-JAN-99 00:00 (503)5881378

WA STATE EMERGENCY MANAGEMENT
08-JAN-99 00:00 (253)5127287

ADDITIONAL INFORMATION

SIZE: 60 X 30 FEET / COLOR: RAINBOW / TEMP: 40F / CLOUD COVER: FOGWIND: CALM / CALLER WILL NOTIFY: OR RESPONSE CENTER / MSO PORLAND

xxx END INCIDENT REPORT 470026 xxx

Report any problems or Fax number changes by calling 1-800-424-8802
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Incident Report # 599501

INCIDENT DESCRIPTION

xReport taken by: CIV EDWARDS at 15:39 on 13-APR-02
Incident Type: VESSEL
Incident Cause: UNKNOWN
Affected Area: WILLIAMETTE RIVER
The incident was discovered on 13-APR-02 at 11:40 local time.
Affected Medium: WATER WILLIAMETTE RIVER

SUSPECTED RESPONSIBLE PARTY

Name: LENN BECICKA
Organization: TRANSOCEANIC CABLE SHIP COMPANY
Address: 1001 MCCOMAS STREET
BALTIMORE, MD 21230
PRIMARY Phone: (410)7832200
Type of Organization: PRIVATE ENTERPRISE

INCIDENT LOCATION

County: CLACKAMAS
City: PORTLAND State: OR
CASCADE GENERAL SHIPYARD

RELEASED MATERIAL(S)

CHRIS Code: OUN Official Material Name: UNKNOWN OIL
Also Known As:
Qty Released: 2 LITER(S) Qty in Water: 2 LITER(S)

DESCRIPTION OF INCIDENT

CALLER REPORTING A RELEASE OF MATERIAL FROM A VESSEL DUE TO UNKNOWN CAUSES.

INCIDENT DETAILS

Platform Rig Name:
Platform Letter:
Location Area ID:
Location Block ID:
OCSG Number:
OCSP Number:
State Lease Number:
Pier Dock Number: 304
Berth Slip Number:
---SHEEN INFORMATION---
Sheen Color: UNKNOWN
Sheen Odor Description:
Sheen Travel Direction:
Sheen Size Length:
Sheen Size Width:
---WATER INFORMATION---
Body of Water: WILLIAMETTE RIVER
Tributary of: COLUMBIA RIVER
Nearest River Mile Marker:
Water Supply Contaminated: NO

---VESSEL INFORMATION---
Name: TYCOM RELIANCE Number: V7CZ2 Aground: NO
Flag:
Length: 457 Breadth: 69 Draught: 28
Type: OTHER
Hull Construction: SINGLE HULL SINGLE LINING
Fuel Capacity: 25000 BARREL(S)
Fuel on Board: 0 UNKNOWN AMOUNT
Cargo Capacity:
Cargo on Board:

DAMAGES

Fire Involved: NO Fire Extinguished: UNKNOWN
INJURIES: Hospitalized: Empl/Crew: Passenger:

FATALITIES: Empl/Crew: Passenger: Occupant:
EVACUATIONS: Who Evacuated: Radius/Area:
Damages:

Closure Type	Description of Closure	Hours Closed	Direction of Closure
Air: N			
Road: N			Major Artery: N
Waterway: N			
Track: N			

Media Interest: NONE Community Impact due to Material: NO

REMEDIAL ACTIONS

BOOMS APPLIED,ABSORBENTS APPLIED,MATERIAL CONTAINED
Release Secured: YES
Release Rate:
Estimated Release Duration:

WEATHER

Weather: UNKNOWN, :F

ADDITIONAL AGENCIES NOTIFIED

Federal:
State/Local:
State/Local On Scene:
State Agency Number:

NOTIFICATIONS BY NRC

ATSDR OR ATTN: THEODORA TSONGAS
13-APR-02 15:51 (503)7314025
NOAA 1ST CLASS BB RPTS FOR OR
13-APR-02 15:51 (206)5266344
MSO PORTLAND, OR BURTLESON
13-APR-02 15:55 (503)2409379
OREGON EMERGENCY MANAGEMENT
13-APR-02 15:51 (800)4520311

ADDITIONAL INFORMATION

CALLER PLANS TO CALL THE STATE OF OREGON. CALLER HAD NO SHEEN INFORMATION.

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xxx END INCIDENT REPORT 599501 xxx
Report any problems or Fax number changes by calling 1-800-424-8802
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Incident Report # 113244

INCIDENT DESCRIPTION

xReport taken by: ENS DECKER at 06:06 on 07-APR-92
Incident Type: VESSEL
Incident Cause: UNKNOWN
Affected Area:
The incident occurred on 07-APR-92 at 02:35 local time.
Affected Medium: WATER WILLIAMETTE RIVER

SUSPECTED RESPONSIBLE PARTY

Name: UNKNOWN
Organization: VESSEL KEN SPANKER
XX

Type of Organization: UNKNOWN

INCIDENT LOCATION

PORT OF PORTLAND County: MULTNOMAH
TERMINAL 4
BERTH 411
City: PORTLAND State: OR Zip: 97223

RELEASED MATERIAL(S)

CHRIS Code: OTH Official Material Name: OTHER OIL
Also Known As: BLACK OIL
Qty Released: 300 GALLON(S) Qty in Water: 0 NONE

DESCRIPTION OF INCIDENT

TRANSFERRING BLACK OIL / SPILL OCCURRED

INCIDENT DETAILS

Platform Rig Name:
Platform Letter:
Location Area ID:
Location Block ID:
OCSG Number:
OCSP Number:
State Lease Number:
Pier Dock Number:
Berth Slip Number:

---VESSEL INFORMATION---
Name: UNKNOWN NAME1 Number: UNKNOWN Aground: NO
Flag:
Length: Breadth: Draught:
Type: UNKNOWN
Hull Construction:
Fuel Capacity:
Fuel on Board:
Cargo Capacity:
Cargo on Board:

DAMAGES

Fire Involved: NO Fire Extinguished:
INJURIES: Hospitalized: Empl/Crew: Passenger:

FATALITIES: Empl/Crew: Passenger: Occupant:
EVACUATIONS: Who Evacuated: Radius/Area:
Damages:

Closure Type	Description of Closure	Hours Closed	Direction of Closure
Air:			
Road:			Major Artery:
Waterway:			
Track:			

Media Interest: Community Impact due to Material:

REMEDIAL ACTIONS

SPILL CONTAINED ON VESSEL, CG ENROUTE
Release Secured:
Release Rate:
Estimated Release Duration:

WEATHER

ADDITIONAL AGENCIES NOTIFIED

Federal:
State/Local:
State/Local On Scene:
State Agency Number:

NOTIFICATIONS BY NRC

MSO PORTLAND, OR
07-APR-92 06:11

ADDITIONAL INFORMATION

xxx END INCIDENT REPORT 113244 xxx
Report any problems or Fax number changes by calling 1-800-424-8802
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Incident Report # 158614

INCIDENT DESCRIPTION

xReport taken by: MST3 WILKERSON at 11:18 on 18-FEB-93
Incident Type: UNKNOWN SHEEN
Incident Cause: UNKNOWN
Affected Area:
The incident occurred on 18-FEB-93 at 07:55 local time.
Affected Medium: WATER WILLIAMETTE RIVER

SUSPECTED RESPONSIBLE PARTY

Name: UNKNOWN

XX

Type of Organization: UNKNOWN

INCIDENT LOCATION

WILLAMETTE RIVER County: MULTNOMAH
City: PORTLAND State: OR

RELEASED MATERIAL(S)

CHRIS Code: OUN Official Material Name: UNKNOWN OIL
Also Known As:
Qty Released: 0 UNKNOWN AMOUNT Qty in Water: 0 UNKNOWN AMOUNT

DESCRIPTION OF INCIDENT

UNKNOWN / UNKNOWN SHEEN SIGHTING SHEEN SIZE: 300FT X 100FT

INCIDENT DETAILS

Platform Rig Name:
Platform Letter:
Location Area ID:
Location Block ID:
OCSG Number:
OCSP Number:
State Lease Number:
Pier Dock Number:
Berth Slip Number:

DAMAGES

Fire Involved: NO Fire Extinguished:
INJURIES: Hospitalized: Empl/Crew: Passenger:

FATALITIES: Empl/Crew: Passenger: Occupant:
EVACUATIONS: Who Evacuated: Radius/Area:
Damages:

Closure Type	Description of Closure	Hours Closed	Direction of Closure
Air:			

Road: Major Artery:

Waterway:

Track:

Media Interest: Community Impact due to Material:

REMEDIAL ACTIONS

NONE
Release Secured:
Release Rate:
Estimated Release Duration:

WEATHER

ADDITIONAL AGENCIES NOTIFIED

Federal:
State/Local:
State/Local On Scene:
State Agency Number:

NOTIFICATIONS BY NRC

MSO PORTLAND, OR
18-FEB-93 11:21

ADDITIONAL INFORMATION

xxx END INCIDENT REPORT 158614 xxx
Report any problems or Fax number changes by calling 1-800-424-8802
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Incident Report # 333560

INCIDENT DESCRIPTION

xReport taken by: MST3 RUTHERFORD at 17:40 on 27-MAR-96
Incident Type: VESSEL
Incident Cause: OTHER
Affected Area:
The incident occurred on 27-MAR-96 at 14:25 local time.
Affected Medium: WATER WILLIAMETTE RIVER

SUSPECTED RESPONSIBLE PARTY

Name: RON WORLEY
Organization: FOSS MARITIME
Address: 9030 NW ST HELENS
PORTLAND, OR 97267
PRIMARY Phone: (503)2860631 SECONDARY Phone: (503)3256621
Type of Organization: PRIVATE ENTERPRISE

INCIDENT LOCATION

TERMINAL 4 County: MULTNOMAH
BERTH 411
PORT OF PORTLAND
City: PORTLAND State: OR Zip: 97267

RELEASED MATERIAL(S)

CHRIS Code: OTD Official Material Name: OIL, FUEL: NO. 2-D
Also Known As:
Qty Released: 1 GALLON(S) Qty in Water: 1 GALLON(S)

DESCRIPTION OF INCIDENT

M/V ANSAC ASIA/DURING FUEL TRANSFER A FUEL TANK WAS OVER FILLED

INCIDENT DETAILS

Platform Rig Name:
Platform Letter:
Location Area ID:
Location Block ID:
OCSG Number:
OCSP Number:
State Lease Number:
Pier Dock Number:
Berth Slip Number:

---VESSEL INFORMATION---
Name: UNKNOWN NAME1 Number: UNKNOWN Aground: NO
Flag:
Length: Breadth: Draught:
Type: UNKNOWN
Hull Construction:
Fuel Capacity:
Fuel on Board:
Cargo Capacity:

Cargo on Board:

DAMAGES

Fire Involved: NO Fire Extinguished: UNKNOWN
INJURIES: Hospitalized: Empl/Crew: Passenger:

FATALITIES: Empl/Crew: Passenger: Occupant:
EVACUATIONS: Who Evacuated: Radius/Area:
Damages:

Closure Type	Description of Closure	Hours Closed	Direction of Closure
Air: N			
Road: N			Major Artery: N
Waterway: N			
Track: N			

Media Interest: Community Impact due to Material: NO

REMEDIAL ACTIONS

LEAK WAS SECURED/USED SORBENTS TO RECOVER
Release Secured: UNKNOWN
Release Rate:
Estimated Release Duration:

WEATHER

ADDITIONAL AGENCIES NOTIFIED

Federal:
State/Local:
State/Local On Scene:
State Agency Number:

NOTIFICATIONS BY NRC

ATSDR OR ATTN: LINDA SAMET ?????
27-MAR-96 00:00 (503)4944278
ATSDR WA ATTN: LUCY HARTER ?????
27-MAR-96 00:00 (360)5865529
MSO PORTLAND, OR PO KJELDGAARD
27-MAR-96 17:45
NOAA RPTS RGN X (1ST CLASS BB) ?????
27-MAR-96 00:00 (202)2672165

ADDITIONAL INFORMATION

SHEEN SIZE:UNKNOWN/COLOR:RAINBOWWILL NOTIFY:RESPONSE SYSTEM

---

xxx END INCIDENT REPORT 333560 xxx
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Incident Report # 304430

INCIDENT DESCRIPTION

xReport taken by: MST3 FINKBEINER at 13:51 on 18-AUG-95
Incident Type: VESSEL
Incident Cause: UNKNOWN
Affected Area:
The incident was discovered on 18-AUG-95 at 06:00 local time.
Affected Medium: WATER WILLIAMETTE RIVER

SUSPECTED RESPONSIBLE PARTY

Name: UNKNOWN
Organization: B/V OCEAN CROWN
XX

Type of Organization: PRIVATE ENTERPRISE

INCIDENT LOCATION

800 N RIVER ST County: MULTNOMAH
City: PORTLAND State: OR Zip: 97227

RELEASED MATERIAL(S)

CHRIS Code: OUN Official Material Name: UNKNOWN OIL
Also Known As:
Qty Released: 40 GALLON(S) Qty in Water: 40 GALLON(S)

DESCRIPTION OF INCIDENT

B/V OCEAN CROWN / UNKNOWN / SHEEN SIZE: 40 FT X 300 FT

INCIDENT DETAILS

Platform Rig Name:
Platform Letter:
Location Area ID:
Location Block ID:
OCSG Number:
OCSP Number:
State Lease Number:
Pier Dock Number:
Berth Slip Number:

---VESSEL INFORMATION---
Name: UNKNOWN NAME1 Number: UNKNOWN Aground: NO
Flag:
Length: Breadth: Draught:
Type: UNKNOWN
Hull Construction:
Fuel Capacity:
Fuel on Board:
Cargo Capacity:
Cargo on Board:

DAMAGES

Fire Involved: NO Fire Extinguished:
INJURIES: Hospitalized: Empl/Crew: Passenger:

FATALITIES: Empl/Crew: Passenger: Occupant:
EVACUATIONS: Who Evacuated: Radius/Area:
Damages:

Closure Type	Description of Closure	Hours Closed	Direction of Closure
Air: N			
Road: N			
Waterway:			
Track:			

Major Artery:

Media Interest: Community Impact due to Material:

REMEDIAL ACTIONS

CG ON SCENE/BOOMS PLACED AROUND SHIP
Release Secured:
Release Rate:
Estimated Release Duration:

WEATHER

ADDITIONAL AGENCIES NOTIFIED

Federal:
State/Local:
State/Local On Scene:
State Agency Number:

NOTIFICATIONS BY NRC

ATSDR OR ATTN: LINDA SAMET	18-AUG-95 00:00	????? (503)4944278
ATSDR WA ATTN: LUCY HARTER	18-AUG-95 00:00	????? (206)5865529
MSO PORTLAND, OR	18-AUG-95 13:58	PO CALLISTER
NOAA RPTS RGN X (1ST CLASS BB)	18-AUG-95 00:00	????? (202)2672165

ADDITIONAL INFORMATION

xxx END INCIDENT REPORT 304430 xxx
Report any problems or Fax number changes by calling 1-800-424-8802
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Incident Report # 113280

INCIDENT DESCRIPTION

xReport taken by: MST2 BESHOAR at 10:27 on 07-APR-92
Incident Type: PIPELINE
Incident Cause: EQUIPMENT FAILURE
Affected Area:
The incident occurred on 07-APR-92 at 07:05 local time.
Affected Medium: WATER WILLIAMETTE RIVER

SUSPECTED RESPONSIBLE PARTY

Name: KURT BOESCH
Organization: CHEVRON
Address: 5460 NORTHWEST DONNE
PORTLAND, OR 97232
PRIMARY Phone: (503)2217866
Type of Organization: PRIVATE ENTERPRISE

INCIDENT LOCATION

5460 NORTHWEST DONNE County: MULTNOMAH
City: PORTLAND State: OR Zip: 97232

RELEASED MATERIAL(S)

CHRIS Code: GAT Official Material Name: GASOLINE: AUTOMOTIVE (4.23G PB/G
Also Known As:
Qty Released: 4.99 GALLON(S) Qty in Water: 4.99 GALLON(S)

DESCRIPTION OF INCIDENT

10" PIPELINE/RUPTURED DUE TO CORROSION

INCIDENT DETAILS

Pipeline Type: UNKNOWN
DOT Regulated: UNKNOWN
Pipeline Above/Below Ground: ABOVE
Exposed or Under Water: UNKNOWN
Pipeline Covered: UNKNOWN

DAMAGES

Fire Involved: NO Fire Extinguished: UNKNOWN
INJURIES: Hospitalized: Empl/Crew: Passenger:

FATALITIES: Empl/Crew: Passenger: Occupant:
EVACUATIONS: Who Evacuated: Radius/Area:
Damages:

Closure Type	Description of Closure	Hours Closed	Direction of Closure
Air: N			
Road: N			Major Artery: N

Waterway: N

Track: N

Media Interest: Community Impact due to Material: NO

REMEDIAL ACTIONS

NONE
Release Secured: UNKNOWN
Release Rate:
Estimated Release Duration:

WEATHER

ADDITIONAL AGENCIES NOTIFIED

Federal:
State/Local:
State/Local On Scene:
State Agency Number:

NOTIFICATIONS BY NRC

MSO PORTLAND, OR
07-APR-92 10:30

ADDITIONAL INFORMATION

SHEEN SIZE=30 YDS X 30 YDS, RAINBOW, WILL CALL DEQ

xxx END INCIDENT REPORT 113280 xxx
Report any problems or Fax number changes by calling 1-800-424-8802
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Incident Report # 585866

INCIDENT DESCRIPTION

xReport taken by: CIV JONES at 13:38 on 13-NOV-01
Incident Type: VESSEL
Incident Cause: EQUIPMENT FAILURE
Affected Area: WILLAMETTE RIVER
The incident occurred on 13-NOV-01 at 09:00 local time.
Affected Medium: WATER WILLIAMETTE RIVER

SUSPECTED RESPONSIBLE PARTY

Name: CARL GRUELUNE
Organization: CHEVRON USA
Address: POB 6027
SAN RAMONE, CA 94583
PRIMARY Phone: (503)2217864
Type of Organization: PRIVATE ENTERPRISE

INCIDENT LOCATION

County: MULTNOMAH
City: PORTLAND State: OR
Latitude: 45 Degrees 34' " N
Longitude: 122 Degrees 44' " W
WILLBRIDGE TERMINAL / UPPER BERTH

RELEASED MATERIAL(S)

CHRIS Code: OTH Official Material Name: OTHER OIL
Also Known As: GAS TURBINE OIL
Qty Released: 1 CUP(S) Qty in Water: 1 CUP(S)

DESCRIPTION OF INCIDENT

THE CALLER STATED THAT A CONTROLLABLE PITCH PROPELLER'S BLADE IS LEAKING.

INCIDENT DETAILS

Platform Rig Name:
Platform Letter:
Location Area ID:
Location Block ID:
OCSG Number:
OCSP Number:
State Lease Number:
Pier Dock Number:
Berth Slip Number:
---SHEEN INFORMATION---
Sheen Color: OTHER
Sheen Odor Description:
Sheen Travel Direction:
Sheen Size Length: 15 FEET
Sheen Size Width: 1 FEET
---WATER INFORMATION---
Body of Water: WILLAMETTE RIVER
Tributary of: COLUMBIA RIVER

Nearest River Mile Marker:
Water Supply Contaminated: NO

---VESSEL INFORMATION---
Name: CHEVRON COLORADO Number: 577358 Aground: NO
Flag: UNITED STATES OF AMERICA
Length: 651 Breadth: 96 Draught: 26
Type: TANKER
Hull Construction: STEEL HULL
Fuel Capacity: 1500 TON(S)
Fuel on Board: 0 UNKNOWN AMOUNT
Cargo Capacity: 265000 BARREL(S)
Cargo on Board:

DAMAGES

Fire Involved: NO Fire Extinguished: UNKNOWN
INJURIES: Hospitalized: Empl/Crew: Passenger:

FATALITIES: Empl/Crew: Passenger: Occupant:
EVACUATIONS: Who Evacuated: Radius/Area:
Damages:

Closure Type	Description of Closure	Hours Closed	Direction of Closure
Air: N			
Road: N			Major Artery: N
Waterway: N			
Track: N			

Media Interest: NONE Community Impact due to Material: NO

REMEDIAL ACTIONS

INVESTIGATING THE INCIDENT
Release Secured: NO
Release Rate:
Estimated Release Duration:

WEATHER

Weather: OVERCAST, :F

ADDITIONAL AGENCIES NOTIFIED

Federal: MSO PORTLAND
State/Local:
State/Local On Scene:
State Agency Number:

NOTIFICATIONS BY NRC

ATSDR OR ATTN: THEODORA TSONGAS
13-NOV-01 13:47 (503)7314025
ATSDR WA ATTN: LUCY HARTER
13-NOV-01 13:47 (360)2363364
FBI PORTLAND FIELD OFC
13-NOV-01 13:47 (503)2244181
NOAA 1ST CLASS BB RPTS FOR OR
13-NOV-01 13:47 (206)5266344

NATIONAL RESPONSE CENTER HQ 21-NOV-01 13:02	VANTRAN
MSO PORTLAND, OR 13-NOV-01 13:49	PO HUMPHRIES (503)2409379
OREGON EMERGENCY MANAGEMENT 13-NOV-01 13:47	(800)4520311
WA STATE EMERGENCY MANAGEMENT 13-NOV-01 13:47	(800)2585990

ADDITIONAL INFORMATION

THE CALLER HAD NO ADDITIONAL INFORMATION

xxx END INCIDENT REPORT 585866 xxx

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Incident Report # 94105

INCIDENT DESCRIPTION

xReport taken by: MST3 WIKER at 12:50 on 28-OCT-91
Incident Type: VESSEL
Incident Cause: OTHER
Affected Area:
The incident was discovered on 24-OCT-91 at 11:30 local time.
Affected Medium: WATER WILLIAMETTE RIVER

SUSPECTED RESPONSIBLE PARTY

Name: UNKNOWN
Organization: USN-USN TITAN
XX

Type of Organization: PRIVATE ENTERPRISE

INCIDENT LOCATION

WILLIAMETTE RIVER County: UNKNOWN
MILE MARKER 8
City: PORTLAND State: OR

RELEASED MATERIAL(S)

CHRIS Code: WTO Official Material Name: WASTE OIL/LUBRICANTS - POSS. CON
Also Known As:
Qty Released: .99 OTHER Qty in Water: .99 OTHER

DESCRIPTION OF INCIDENT

USNS TITAN / WHILE SHIFTING BERTHS, RAIN RUN-OFF WASHED OIL OFF OF THEDECK

INCIDENT DETAILS

Platform Rig Name:
Platform Letter:
Location Area ID:
Location Block ID:
OCSG Number:
OCSP Number:
State Lease Number:
Pier Dock Number:
Berth Slip Number:

---VESSEL INFORMATION---
Name: UNKNOWN NAME1 Number: UNKNOWN Aground: NO
Flag:
Length: Breadth: Draught:
Type: UNKNOWN
Hull Construction:
Fuel Capacity:
Fuel on Board:
Cargo Capacity:
Cargo on Board:

DAMAGES

Fire Involved: NO Fire Extinguished: UNKNOWN
INJURIES: Hospitalized: Empl/Crew: Passenger:

FATALITIES: Empl/Crew: Passenger: Occupant:
EVACUATIONS: Who Evacuated: Radius/Area:
Damages:

Closure Type	Description of Closure	Hours Closed	Direction of Closure
Air: N			
Road: N			Major Artery: N
Waterway: N			
Track: N			

Media Interest: Community Impact due to Material: NO

REMEDIAL ACTIONS

NONE
Release Secured: UNKNOWN
Release Rate:
Estimated Release Duration:

WEATHER

ADDITIONAL AGENCIES NOTIFIED

Federal:
State/Local:
State/Local On Scene:
State Agency Number:

NOTIFICATIONS BY NRC

MSO PORTLAND, OR
28-OCT-91 12:57

ADDITIONAL INFORMATION

MSIS MP91011329

xxx END INCIDENT REPORT 94105 xxx
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Appendix F

LWG
LOWER WILLAMETTE GROUP

PORTLAND HARBOR RI/FS PROGRAMMATIC WORK PLAN

APPENDIX F: DATA SOURCES AND QA/QC REVIEWS

REVISED DRAFT FINAL
November 13, 2003

Prepared for:
The Lower Willamette Group

Prepared by:
Striplin Environmental Associates, Inc.
Kennedy/Jenks Consultants

TABLE OF CONTENTS

1.0 INTRODUCTION 1

2.0 PHYSICAL STUDIES 3

3.0 STUDIES CONTAINING CHEMICAL DATA 4
- 3.1 Chemical Data Quality Reevaluation 4
- 3.2 Methods for QA/QC Review of HISTORICAL Chemical Data 5
- 3.3 Chemistry QA/QC Results 8
  - 3.3.1 Sediment Chemistry 8
  - 3.3.2 Water Chemistry 9
  - 3.3.3 Tissue Chemistry 10

4.0 BIOLOGICAL STUDIES 13
- 4.1 Methods for Data Quality Review of Biological Data 13
- 4.2 Biological Data QA/QC Results 13
  - 4.2.1 Sediment Toxicity Bioassays 13
  - 4.2.2 Benthic Infauna 14
- 4.3 Biomarker Studies 15

5.0 NATURAL RESOURCES INFORMATION 16
- 5.1 Habitat Types 16
- 5.2 Macroinvertebrates 17
- 5.3 Resident and Seasonally Resident Fish 18
- 5.4 Migratory Fish Species 19
  - 5.4.1 Historical Studies 19
  - 5.4.2 Recent LWG Studies 24
- 5.5 Special Aquatic Sites 24
- 5.6 Threatened and Endangered Species 25
  - 5.6.1 Fish 25
  - 5.6.2 Upland Plants and Animals 32

6.0 CULTURAL AND HUMAN RESOURCE STUDIES 34

7.0 REFERENCES 54

Attachments 58

LIST OF TABLES

Table 1. Existing Lower Willamette River Physical Studies.
Table 2. Existing Lower Willamette River Sediment Chemistry Data.
Table 3. Existing Lower Willamette River Surface Water Data.
Table 4. Existing Lower Willamette River Tissue Residue Studies.
Table 5. Existing Lower Willamette River Bioassay Data.
Table 6. Existing Lower Willamette River Macroinvertebrate Studies.
Table 7. Existing Lower Willamette River Biomarker and Histopathology Studies.

1.0 INTRODUCTION

This appendix presents existing data and information for the Portland Harbor Superfund Site (Site), Portland, Oregon. The compilation of existing information herein is necessary for initial planning of site remediation. Nearly 700 documents have been compiled into the Portland Harbor Remedial Investigation/Feasibility Study (RI/FS) project library to date. These documents include analytical data, ecological studies, facility investigations, regional studies, and other non-specific documents about the Portland Harbor area. The purpose of this appendix is to identify those documents and data sets that are being used by the Lower Willamette Group (LWG) in the development of the Portland Harbor Work Plan and subsequent RI/FS. This appendix is organized into the following sections:

- **Section 2.** Physical Studies
- **Section 3.** Chemical Data (e.g., sediments, water column, tissue)
- **Section 4.** Biological Data (e.g., bioassays, benthic infauna)
- **Section 5.** Natural Resources Information (e.g., habitat types, macroinvertebrates, resident and seasonally resident fish, migratory fish, special aquatic sites, threatened and endangered fish, upland plant, and animal species
- **Section 6.** Cultural and Human Resource Studies

Producing a database containing historical Portland Harbor chemical and biological data was a key step in the development of the Portland Harbor Work Plan. The data sets discussed in Sections 2 (chemical data) and 3 (biological data) have undergone a quality assurance/quality control (QA/QC) evaluation to ensure that the data are appropriate for use in the RI/FS. Data passing the QA/QC review were used to initially understand the patterns of chemical distributions in Portland Harbor sediments, tissues, and surface water. In addition to their role in developing the Work Plan, these data sets were used to formulate the Field Sampling Plans, including the placement of sampling stations and development of the list of analytes. Results of the QA/QC evaluation for these data sets are also provided in this appendix.

A detailed review of the quality of each chemical and biological data set was performed prior to entering the historical data into the project database. The purpose of this review was to fully evaluate each data set and categorize the quality of the data in the database. The two categories of data are as follows:

Category 1. Category 1 data are of known quality and are considered to be acceptable for use in decision-making for the Portland Harbor Superfund Site. There is sufficient information on these data sets to confidently verify that the data, along with associated data qualifiers, accurately represent chemical concentrations present at the site at the time of sampling.

Category 2. Data in Category 2 are of generally unknown or suspect quality. The QA/QC information shows that data quality is poor or suspect or essential QA/QC data (e.g., surrogate recoveries, matrix spike/matrix spike duplicates) are either incomplete or lacking.

Analyses on which project decisions will be based will utilize Category 1 data. As examples, the ecological and human health risk assessments will use Category 1 data in the risk calculations, and the definition of sediment management areas will rely on Category 1 sediment data. Category 2 data will be used during project scoping. For example, Category 2 tissue data were used to help identify chemicals of interest and Category 2 sediment data were used in the initial assessment of trends in chemical concentrations which was useful for defining the nature and extent sampling program.

2.0 PHYSICAL STUDIES

Studies describing the physical setting of the lower Willamette River (LWR), including regional geology, hydrology, topography, river morphology, sediment transport, dredging projects, ownership, land use, and human development (residential, commercial, industrial) were compiled. This information is described in Section 2 of the Work Plan and forms the basis of the physical conceptual site model (Section 5.1 of the Work Plan). A summary of the available physical data and information is provided in Table 1.

3.0 STUDIES CONTAINING CHEMICAL DATA

A significant number of studies were identified that contained chemical data. These studies addressed sediment chemistry, surface water chemistry, and tissue chemistry. The chemical data have undergone a QA/QC review to determine if they are appropriate for use in the RI/FS. The approach for the review and results, including a reevaluation, of the QA reviews are provided below. Data will be used in the development of the Portland Harbor Work Plan and subsequent RI/FS.

3.1 CHEMICAL DATA QUALITY REEVALUATION

During the review of the Round 1 Work Plan (SEA et al. 2002), the agencies emphasized the need to identify as many suitable chemical data points as possible for various components of the RI. In response, the LWG reevaluated historical Category 2 chemical data, and some data were reclassified as Category 1. The results of the reevaluation are presented in a technical memorandum entitled, Historical Chemistry Data Category Reclassification (SEA 2003). This section briefly describes the reevaluation process and its outcome.

The reevaluation focused on three distinct questions with regard to initial classification of the data:

1. Was all information necessary to assess data quality available initially?
2. Were chemical data quality criteria too restrictive?
3. Were criteria applied to data consistently?

The first step in the reevaluation process was to assess the outcome of the initial data quality review provided in Appendix F of the Round 1 Work Plan. It was noted that many surveys with Category 2 classification were lacking appropriate quality assurance/quality control (QA/QC) documentation necessary for data validation. It was also noted (as mentioned by agency representatives in meetings) that the lack of chain-of-custody forms was responsible for Category 2 classification of otherwise high-quality data. The next step in the process was to obtain source documents for all Category 2 data from the project library. Investigators of those source documents lacking laboratory documentation were contacted and asked to obtain and transmit the necessary backup. The project chemist then performed the following tasks:

- Evaluate the adequacy of the chemical quality criteria
- Ensure that data quality criteria were consistently applied to all data, including those classified as Category 1

- Identify any QA/QC information that was either not initially available or that may have been originally overlooked
- Classify data based on newly acquired back-up documentation.

The reevaluation resulted in the amendment of only one chemical quality review criterion. A data set is not rejected as Category 1 data based solely on the absence of chain-of-custody documentation as it was during the initial data quality evaluation. The revised process used to assess "traceability" is described in the next section. Additional QA/QC information was obtained for several studies, and chemical review criteria were consistently applied to all QA/QC results, both newly acquired and existing.

Based on the reevaluation of data quality, the number of Category 1 surface sediment samples by chemical group between RM 0 and RM 11 increased by 10 to 314 percent for an average of 46 percent. The number of Category 1 subsurface sediment samples by chemical group between RM 0 and RM 11 increased by 0 to 47 percent for an average of 16 percent. Data sets for three water quality studies were upgraded from Category 2 to Category 1. For tissue data, one study was upgraded to Category 1 for all chemical groups, and one study became a mixture of Category 1 and Category 2 data. Results of the reevaluation effort and reasons for Category 2 designation are provided in Table 4-1 and Appendix F.

3.2 METHODS FOR QA/QC REVIEW OF HISTORICAL CHEMICAL DATA

Data quality and potential usability were established by satisfying various quality assessment criteria. These criteria were developed following a preliminary review of a cross section of the historical data. Two categories of data were identified: Category 1, which are data of known quality; and Category 2, which are data of unknown or suspect quality. Criteria for placing data sets into these categories were developed to identify basic data qualities and not to limit data to specific program uses. Data quality was assessed by evaluating the following factors:

1. Traceability
2. Comparability
3. Sample integrity
4. Potential measurement bias
   - Accuracy
   - Precision.

All of these factors were known or supported by existing QA/QC information for Category 1 data. If supporting documentation for each factor were not available

or were not reinforced by the availability of other high quality QA/QC information, data were assigned a Category 2 designation. If the acceptance criteria for any of the above factors were not satisfied for either the entire data set or a specific analyte group, data for that data set or group were generally qualified and were determined to have limited usefulness. The chemical data review was conducted by analyte group (e.g., metals, semivolatile organic compounds). As a result, a data set may contain all Category 1 data, all Category 2 data, or both Category 1 and Category 2.

The four data quality factors were evaluated based on the following information, when available:

- Analytical method
- Chain-of-custody
- Sample holding time
- Method blanks
- Matrix spike/matrix spike duplicates
- Laboratory control samples
- Replicates
- Surrogates.

Performance criteria for establishing acceptable data quality for each of the factors are as follows:

- **Traceability.** Based on the reevaluation of the chemical data, chain-of-custody is preferably documented and complete, and attached to the report or supporting documentation package. However, a data set is not rejected as Category 1 data based solely on the absence of chain-of-custody documentation. If a high-quality data set satisfies all criteria except chain-of-custody documentation, there may either be references to chain-of-custody forms in the text of a report or appendix or there may be other documentation consistent with state or federal guidelines that demonstrate investigators are typically compliant with industry standard field collection and documentation requirements and imply chain-of-custody forms were used. In that instance, an assumption is made that the investigator and contracted laboratories used appropriate sample tracking methods, and the data set is assessed as Category 1.
- **Comparability.** Analytical procedures or methods are identified and are accepted in the industry as "standard" or "universal."
- **Sample Integrity.** Sample holding times and conditions between collection and analysis meet established criteria, which are generally identified by the U.S. Environmental Protection Agency (EPA),

Puget Sound Estuary Program (PSEP 1986, 1997a, 1997b, 1997c) or other pertinent and published guidance.

- **Potential Measurement Bias.** Procedural and/or analytical method blanks are available to evaluate potential for introduction of positive bias in reported results, and bias is within acceptable limits. Lower reporting or quantitation levels may be limited by the presence of background or laboratory contamination. Potential measurement bias includes an evaluation of both accuracy and precision:

  - **Accuracy**—Matrix spikes (MS), laboratory control samples, (which may be spiked blanks or other pertinent reference materials), and/or organic surrogate compounds are available for review, and accuracy falls within an acceptable range. Recoveries fall within ranges typically established by major national monitoring programs, regional guidance, or other accepted "standards". Acceptable analyte recoveries tend to be in the range of 50 to 150%. Recoveries measured outside specified acceptance ranges generally result in the qualification of associated analytical results as estimates or unusable/rejected.

  - **Precision**—Replicate samples are generally available to evaluate analytical variability, and variability falls with an acceptable range. However, the lack of replicate data does not preclude Category 1 status as long as other laboratory quality control data to evaluate bias (e.g., blanks and accuracy quality control samples) are available for review to bolster the evaluation. When available, duplicate or triplicate analyses are normally performed at frequencies of 5% or once for every 20 samples analyzed (of the same matrix). Measurement of analytical variability for organic compounds is performed by analyses of MS and matrix spike duplicate (MSD) samples. (Occasionally, MS/MSD analyses are unable to provide desired measurements due to spike levels that were significantly less than native concentrations. This occurs mostly for highly contaminated solids where *in situ* levels can be extreme compared to spiking levels). Acceptable replicate analyses in most monitoring programs are less than or equal to 25% to 50% relative standard deviation or relative percent difference. Variability outside acceptance ranges results in the qualification of associated results as estimates.

3.3 CHEMISTRY QA/QC RESULTS

3.3.1 Sediment Chemistry

Historical Studies

The primary sources of sediment chemical data in the LWR were LWG members (i.e., facility reports), Oregon Department of Environmental Quality (DEQ), the Portland District U.S. Army Corps of Engineers (Corps), and the U.S. Geological Survey (USGS). Most studies characterized sediments immediately adjacent to facilities, either as part of a dredged material characterization or a remedial investigation. Consequently, most of their sampling locations were located close to shore. The exception to this trend is EPA's Site Investigation (SI) and the Corps' dredged material characterizations. The EPA SI largely characterized the nearshore areas within the ISA (Weston 1998). Samples (top 10 cm or top 90 cm) were collected approximately every 400 feet. The Corps collected both subsurface cores and some surface grab samples within the navigation channel from river mile (RM) 0 to RM 11. The locations of all Category 1 and 2 surface and subsurface sediment samples are shown in Section 4 of the Work Plan. The sediment chemistry data from these studies were evaluated for data quality. Results of the evaluation are provided in Attachment F1 and are summarized in Table 2. Both Category 1 and Category 2 data, including station coordinates, are provided in the project database. Of the 76 data sets that were reviewed by analytical group, 36 were classified as Category 1 and 15 were classified as Category 2. Twenty-five surveys contained a mixture of Category 1 and Category 2 data. Surveys completed prior to 1990 are summarized in Section 4.2.1 of the main text. For surveys completed in 1990 or after (over 60), detailed descriptions of each sediment investigation are provided in Attachment F4. Information included in Attachment F4 descriptions includes project objectives, sampling dates, sampling methods, sample types, analyses for each survey, and concentration ranges for indicator chemicals.

Recent LWG Studies

To support the human health risk assessment, LWG consultants collected composite surface beach sediment samples at twenty recreational and industrial beaches in Portland Harbor. At each beach, samples for analysis were generated by combining randomly-selected individual 0-15 cm surface samples into a single composite. All sediments were collected using stainless-steel hand corers.

Surface sediments (0-15 cm) were also collected for chemical analyses to support the ecological risk assessment at two types of stations. First, co-located sediments were collected at all nearshore sculpin and/or crayfish tissue sampling stations. Second, surface sediments for chemical analysis were also collected at ten benthic infauna stations to provide additional information on the distribution of benthic infauna in Portland Harbor. These stations were situated both nearshore and in the navigation channel to supplement the distribution of the 27 sculpin/crayfish co-located stations.

All surface sediments were collected using either a 0.10-m^2 van Veen grab sampler or a 0.3-m^2 hydraulic power grab sampler. Sediment chemistry results and data quality category designation will be presented in the Round 1 Data Report.

3.3.2 Water Chemistry

The primary sources of surface water data were DEQ and USGS monitoring programs, including DEQ's ambient monitoring program, the USGS National Water Quality Assessment (NAWQA) program, and the Willamette River Basin Water Quality Study cooperative program between USGS and DEQ (Table 3). The data were obtained through the U.S. EPA Data Storage and Retrieval System (STORET) and DEQ's Laboratory Analytical Storage and Retrieval (LASAR) database.

Nearly all data were collected at four DEQ or USGS monitoring stations in the lower Willamette main stem. These stations had the greatest amount of data, most frequent sampling (including all months and flow conditions), and were determined overall to be most representative of general water quality in the lower river. Although there are data for other stations, they were sampled only on a single occasion. Other site-specific water quality data, representative of source characteristics, are also available.

Monitoring data sets were composed primarily of conventional parameters. The ambient monitoring programs established by DEQ in the Willamette River also routinely monitor metals, but do not monitor any organic pollutants. Recent organic data in the lower Willamette main channel reported by USGS are limited to herbicide and pesticide analyses.

In addition, surface water quality data from three sites (McCormick & Baxter, Ross Island, and Rhône-Poulenc—St. Helens Road Facility) were collected with the intention of monitoring potential releases from sources. Surface water quality data was gathered in conjunction with dredged sediment elutriate in a study performed by Rinella and McKensie (1977). Gleeson (1972) and Fuhrer et al. (1996) provide an overview of historical water quality trends prior to 1980. Table 3 lists the historical data sets or studies that were compiled.

The water chemistry data from the studies listed in Table 3 were evaluated for data quality. Results of the evaluation are provided in Attachment F2 and are summarized in Table 3. Data from STORET and LASAR were classified as Category 2. The remaining data sets were classified as Category 1.

The Category 2 designation for the monitoring data was primarily due to the lack of QA/QC documentation. The databases and available reports did not contain adequate information to allow complete independent verification of data quality.

However, most of the data compiled in this review received some level of QA/QC review by the agency responsible for collecting the data. Data collected by DEQ monitoring programs are reviewed for quality assurance and data in the LASER database are provided with a quality ranking. All data from the LASAR database had been classified by DEQ as Level "A " or better, indicating that there was a QAPP approved by DEQ, QA criteria were met, and that the data are suitable for evaluating compliance with water quality standards. The quality of data included in the STORET database cannot be easily determined. However, data collected by USGS generally undergo QA/QC review. Data quality reviews of some of the USGS data compiled in this report are reported by Fuhrer et al. (1996) and Anderson et al. (1996). In general, these reports determined that data quality is adequate for use with the following exceptions:

- Some USGS metals data collected prior to 1992 may be biased high due to contamination of the samples by the field sampling apparatus (Tetra Tech et al. 1993). Therefore, metals data collected prior to this date were not included in this compilation.
- Caution must also be used in comparing metals data as several different methods were used. Therefore, in this report the applicable method has been noted wherever appropriate.

3.3.3 Tissue Chemistry

Historical Studies

Table 4 lists available data from various toxicological studies of chemical residues in fish and piscivorous birds and mammals of the Willamette Basin, with particular emphasis on studies or portions of studies that have occurred in the Portland Harbor area between Willamette Falls and the confluence with the Columbia River.

There are uncertainties associated with QA/QC in all the tissue residue studies. Most data are considered useful for screening purposes only and are thus considered Category 2 data. *The Oregonian* newspaper "River of Risk" data (*Oregonian* 2000) and the mercury data provided by the DEQ (2000) Water Quality Division are of unknown quality and are assumed to be useful for screening purposes only. The data from DEQ are primarily limited to fish fillets and may be useful for a human health screening assessment. DEQ reported that the Willamette River Toxics Study (WRTS) report (DEQ 1994) does not present laboratory QA/QC information, and the original laboratory data obtained from DEQ files do not provide sufficient QA/QC information to be useable (DEQ 2000). Moreover, sample collection procedures for fish and fish tissues were not

performed consistently at each station or in each year during the study (DEQ 1994). Consequently, the extensive tissue data set from the WRTS is characterized as screening-level data only. There are also QA/QC issues associated with the OSU/DEQ fish tissue data (Curtis et al. 1993). According to Dr. Curtis, the original data and QA/QC information are no longer available (DEQ personal communication). Therefore, the data from Curtis et al. (1993) are of unknown quality and are assumed to be useful for screening purposes only. The bioaccumulation data from the Port of Portland (NAS 1989) are of poor quality based on the relatively high degree of uncertainty associated with the test design. It is also unclear which tissue types were analyzed, and data were not reported here.

Data quality reviews were completed for eight surveys and results are provided in Attachment F3. All but two surveys were assigned to Category 2 (Table 4). The remaining two data sets were classified as Category 1 and a mixture of Category 1 and 2. In general, insufficient QA/QC documentation was available for the tissue chemistry data sets.

Recent LWG Studies

Based on the lack of existing high quality tissue data, a concerted effort to collect analytical tissue data was made by the LWG in Round 1A. For the ecological and human health risk assessments, eleven fish species and one crayfish species were targeted for tissue analyses. The target species for the ecological risk assessment (ERA) were northern pikeminnow, smallmouth bass, sculpin, subyearling chinook salmon, peamouth, largescale sucker, lamprey ammocoetes, and crayfish. For the human health risk assessment (HHRA), carp, black crappie, and bullhead, as well as the ERA species smallmouth bass and crayfish, were the target species. In addition, walleye and largescale sucker were collected as alternative species for bullhead and carp, respectively. These alternate species were not used for tissue analyses because adequate numbers of bullhead and carp were collected.

Tissue collections occurred from July 22 through November 10, 2002, and a total of six fishing techniques were used. These included beach seining, boat electrofishing, backpack electrofishing, trot line, angling, and crayfish traps. A total of 1870 fish were collected including 863 sculpin, 419 crayfish, 128 largescale sucker, 90 smallmouth bass, 78 carp, 92 subyearling chinook salmon, 64 brown bullhead, 35 northern pikeminnow, 48 black crappie, 30 peamouth, 18 yellow bullhead, 3 lamprey ammocoetes, and 2 walleye. Analytical testing was performed according to methods described in the LWG's QAPP. Results are will be provided in the Round 1 Data Report.

During the LWG's Round 1A juvenile lamprey/benthic infauna reconnaissance survey conducted in September 2002, it was determined that the non-native, bivalve species, *Corbicula fluminea,* was likely the only soft-bottom organism that could be found in sufficient abundance and size for benthos tissue chemical

analyses in Portland Harbor. Clams were collected using repeated drops of a 0.10 m^2 van Veen grab sampler at each target location. Also, at one location, an unsuccessful attempt was made to rake clams from a shallow, subtidal beach. Clam collection was attempted at five stations over multiple sampling days. After considerable total effort (over 500 van Veen casts), two locations near the center of the ISA yielded more than 150 grams of tissue, the minimum biomass required to conduct tissue analyses for a full suite of target analytes. Fifty-three grams were collected a third station, while the remaining two stations yielded only nominal amounts. Chemical testing results will be presented in the Round 1 Data Report.

4.0 BIOLOGICAL STUDIES

4.1 METHODS FOR DATA QUALITY REVIEW OF BIOLOGICAL DATA

Bioassay and benthic community data quality were evaluated based on validation guidelines and performance criteria from the PSEP (PTI 1989).

Bioassay validation guidelines include checks of completeness, holding conditions, standard reporting methods, and QA/QC results for negative control, reference sediment, positive control (reference toxicant), and measured water quality parameters according to standard testing methods. Reference and control performance requirements were as follows:

- **Amphipod:** Control absolute mortality does not exceed 20%; reference absolute mortality does not exceed 30%.
- **Midge:** Control absolute mortality does not exceed 30%; reference absolute mortality does not exceed 35%.
- ***Daphnia spp.*:** Control absolute mortality does not exceed 10%.
- ***Lumbriculus*:** On Day 4, numbers of organisms should not be significantly reduced in test relative to control sediment. Organisms should burrow into sediment.

Reference sediment has similar grain size as test stations.

Data comparability among benthic data sets was used as an additional QA/QC criterion and was based on sampling methodology and sampler size, sample processing, and endpoints measured.

4.2 BIOLOGICAL DATA QA/QC RESULTS

4.2.1 Sediment Toxicity Bioassays

The sources of bioassay data were generally from dredged material characterizations, remedial investigations, and site investigations for which sediment chemical data were collected at the same time. The majority of surveys were conducted at Portland Harbor facilities, and most samples were collected within the ISA. Samples were also collected from upriver locations (RMs 16, 18, and 25) during DEQ's Willamette River Toxics Study between 1988 and 1991. Table 5 lists the available data sets.

In general, existing freshwater bioassay data were collected using standard testing methods (ASTM 1992, ASTM 1998, EPA 1994, EPA 2000, EPA/Corps 1998,

PSQWA 1995). However, these methods have evolved over the past 10 years. For example, tests performed just five years ago were set up with five replicate samples. ASTM now recommends the use of eight replicate samples, although the Dredged Material Evaluation Framework for the Lower Columbia River Management Area (LCRMA) requires only five. As another example, the method for measuring biomass in sublethal effects tests has changed. Growth measurements using *Chironomus spp.* are now calculated ash-free (dry weight), while those prior to recent guideline updates were reported as total biomass. Despite the changes in test methods, surveys conducted since 1990 are considered comparable for purposes of inter-survey screening.

Data quality reviews were completed on seven types of bioassays [amphipod survival, midge survival and growth, oligochaete 28-day bioaccumulation (*Lumbriculus*), Microtox bacterial luminescence, Daphnia 48-hr and 96-hr mortality, and rainbow trout mortality] for surface, subsurface and sediment pore water spread over 18 surveys (see Table 5). Eleven bioassay data sets were assigned Category 1 status, four bioassay data sets were Category 2, and the remaining three data sets were a mixture of Category 1 and Category 2.

4.2.2 Benthic Infauna

Historical Studies

A literature search for information documenting the condition of benthic invertebrate communities in the LWR found very little peer-reviewed data. Since 1993, only three studies, each having both shallow and deep-water benthic data, were obtained. Table 6 lists the sources of benthic community structure data.

A review of the methods used in obtaining, processing and analyzing the samples found that, with minor variations, internal quality assurance and quality control procedures were followed and that the data were suitable for the objectives of each study. However, a comparison of major benthic ecological indices among the three surveys is not possible because of differences in sampling gear, surface areas sampled, splitting methods and sieve sizes.

The samples from Dames & Moore and Tetra Tech were both sieved through a 0.5-mm mesh sieve screen; however, the samples were handled differently in the laboratory with the Tetra Tech samples being randomly divided using a sample splitter. This procedure involved the continued splitting and counting of individuals until a minimum of 300 individuals per composite sample was counted (or the entire sample), at which time the abundance per 0.06 m^2 was obtained. The deep-water Ross Island Ecological Survey samples were sieved through a 1.0-mm mesh sieve, resulting in many fewer species and individuals in the Ross Island samples than in the other two studies. Hence, these surveys are not comparable.

Data quality reviews were completed on three surveys, which were assigned to Category 1 (Table 6). Sediment was collected with six different types of equipment (0.09-m^2 Surber, 3-in. PVC pipe, 1 ft^2 clamshell dredge, 0.06-m^2 modified van Veen grab, 0.3-m^2 power grab and a 6-in. PVC core).

Recent LWG Studies

In the fall of 2002, soft-bottom benthos samples were collected from a total of 22 stations in the LWR by LWG consultants. Benthos were collected at 12 sediment stations where sculpin and crayfish were also collected for tissue analysis. Benthos were also collected at 10 nearshore and channel sediment stations. Infauna were collected with a 0.10-m^2 van Veen grab sampler and sieved through a 0.5-mm sieve box. A single replicate was collected at each location to provide a qualitative indication of the benthic infaunal assemblages throughout the harbor for the ecological risk food web modeling.

In order to characterize the epibenthic macroinvertebrate community on solid substrates, LWG consultants deployed Hester-Dendy samplers (i.e., multiplates) at 12 locations adjacent to or within areas characterized by solid substrates. Each deployment consisted of an array of seven replicate samplers. Samplers were retrieved in August 2002.

The enumeration and identification of all macroinvertebrate species are complete. Results will be reported in the Round 1 Data Report.

4.3 BIOMARKER STUDIES

Biomarker assays can be useful in evaluating potential exposure to contaminants. It has been suggested that fish exposed to PAHs and organochlorine compounds exhibit elevated levels of hepatic DNA adducts. In addition, some fish exhibited induction of hepatic cytochrome P450-1A1 monooxygeneases, a biochemical response to chemical stressors. Only three studies (Table 7) of biomarker responses have been performed in the LWR. Studies of histopathology in fish, birds, and mammals have also been completed. These studies were not assigned data quality categories.

5.0 NATURAL RESOURCES INFORMATION

This section presents a list of existing references that describe natural resources in the LWR. Portland Harbor is a highly developed industrial and commercial area, and the river, shoreline, and surrounding areas have been substantially modified and developed. Areas outside Portland Harbor in the LWR offer a variety of habitat types and natural resources. In this section, references that describe the general types of habitat present in the lower Willamette River Valley are described first, followed by references that describe macroinvertebrate species, fish species, special aquatic sites, endangered or threatened species, and cultural and human resources.

5.1 HABITAT TYPES

Data types, such as sediment-profile imaging (SPI), bathymetry, Light Detection and Ranging (LIDAR), and sediment trend analysis (STA) data presented in Section 2 (Physical Studies), describe open-water and, to a certain degree, bank and riparian habitat. A literature search for habitat studies of the LWR revealed several additional sources:

Adolfson Associates, Inc., Walker Macy, Esther Lev Environmental Consulting, Winterowd Planning Services and Ecotrust. 2000. Draft Willamette River Inventory: Natural Resources. Prepared for City of Portland Bureau of Planning, August, 2000.

Beak Consultants, Inc. 2000. Ross Island and Lower Willamette River Fish Monitoring Study – 1999. Prepared for Ross Island Sand & Gravel, Landau Associates, and Perkins Coie, LLP. 31 pp. + Appendices.

Fishman Environmental Services. 1988. Columbia Slough Master Plan. Task Report: Fish and Biological Studies, Fish and Fish Habitat. Submitted to Brown and Caldwell Consulting Engineers. Sponsored by City of Portland, Bureau of Environmental Services.

Greenworks, PC Landscape Architecture, ClearWater West, Fishman Environmental Services, Inter-Fluve, Inc., and KPFF Consulting Engineers. 2001. Willamette River Design Notebook: Portland, Oregon. Sponsored by City of Portland, Bureau of Environmental Services. 105 p.

Greenworks, PC Landscape Architecture, ClearWater West, Fishman Environmental Services, Inter-Fluve, Inc., KPFF Consulting Engineers. 1999. Riverbank Conditions Geographic Information Systems Database. Sponsored by City of Portland, Bureau of Environmental Services.

North, J.A., L.C. Burner, B.S. Cunningham, R.A. Farr, T.A. Friesen, J.C. Harrington, H.K. Takata, and D.L. Ward. 2001. Relationship Between Bank Treatment/Nearshore Development and Anadromous/Resident Fish in the Lower Willamette River. Draft annual progress report. Project sponsored by City of Portland and the Lower Willamette Group.

Finally, CH2M Hill prepared the Willamette River Atlas (2000) for the City of Portland and the Port of Portland. Spatial habitat (i.e., bank condition) GIS data from this atlas have been projected to the project basemap.

5.2 MACROINVERTEBRATES

In addition to Beak (2000), Dames & Moore (1998), DEQ (1994), Tetra Tech et al. (1993), and Tetra Tech (1995), references for macroinvertebrate distribution and abundance, status, habitat preferences, and life cycle from the LWR and lower Columbia River basins include the following:

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Emmett, R.L., S.A. Hinton, D.J. Logan, and G.T. McCabe, Jr. In Press. Introduction of the Siberian Prawn, *Exopalaemon modestus* (Heller, 1862), into the Lower Columbia River. Northwest Fisheries Science Center, Seattle, WA.

Frest, T.J., and E.J. Johannes. 1995. Interior Columbia Basin Mollusk Species of Special Concern. Final Report. Prepared for Interior Columbia Basin Ecosystem Management Project, Walla Walla, WA. Contract #43-0E00-4-9112.

Ingram, W.M. 1948. The larger freshwater clams of California, Oregon and Washington. *J. of Entom. and Zoo*. 40(4):72-92.

Logan, D.J., E.L. Bibles, and D.F. Markle. 1996. Recent Collections of Exotic Aquarium Fishes in the Freshwaters of Oregon and Thermal Tolerance of Oriental Weatherfish and Pirapatinga. California Fish and Game 82: 66-80.

Miller, G.C., and J.M. VanHyning. 1970. The Commercial Fishery for Freshwater Crawfish *Pacifastacus leniusculus* (Astacidae) in Oregon 1893-1956. Research reports of the Fish Comm. of Oregon. Vol. 2, No. 1, pp. 77-89.

ONHP. 2001. Rare, Threatened and Endangered Plants and Animals of Oregon. February 2001. Oregon Natural Heritage Program, Portland, OR.

ONHP. 2001. Letter from ONHP, dated November 20, 2001, listing threatened, endangered, candidate species and species of concern within two-mile radius of Lower Willamette River.

Salmon, J.J. 1972. Polychlronated Biphenyls: Uptake by *Daphnia* and Residues in Crayfish from the Willamette River. Masters Thesis, Oregon State University, Eugene, OR.

Snyder, G.R., R.J. McConnell, J.T. Durkin, D.A. Misitano, and H.R. Sanborn. 1973. Checklist of Aquatic Organisms in the Lower Columbia and Willamette Rivers. Northwest Fisheries Science Center, National Marine Fisheries Service, NOAA Environmental Conservation Division and Marine Fish and Shellfish Division, Seattle, WA.

5.3 RESIDENT AND SEASONALLY RESIDENT FISH

Resident and seasonally resident fish are described in North et al. (2001), Barbour et al. (1999), Tetra Tech (1995), and the references that follow. Note that references for specific information about home range, distribution and status, life history, and food habits are also provided.

Altman, B., C.M. Henson, and I.R. Waite. 1997. Summary of Information on Aquatic Biota and their Habitats in the Willamette Basin, Oregon, through 1995. U. S. Geological Survey Water-Resources Investigations Report 97-4023. 85 pp. + Appendices.

Dimick, R.E., and F. Merryfield. 1945. The Fishes of the Willamette River System in Relation to Pollution. Oregon State University Engineering Experiment Station Bulletin No. 20, June 1945. 58 pp.

Ellis Ecological Services (EES). 2000. A Review and Compilation of Available Information on Fish Use of the Portland Harbor, Portland, Oregon. Prepared for the Port of Portland, Portland, OR (September 15, 2000).

Farr, RA., and D.L. Ward. 1992. Fishes of the Lower Willamette River Near Portland, Oregon. *In:* D. L. Ward (editor), Effects of Waterway Development on Anadromous and Resident Fish in Portland Harbor, pages 49-59. Oregon Department of Fish and Wildlife.

Foster, C.A. 2001. 1999 Willamette River Spring Chinook Salmon Run, Fisheries, and Passage at Willamette Falls. Prepared by the Oregon Department of Fish and Wildlife, Portland, OR.

Hughes, R.M., and J.R. Gammon. 1987. Longitudinal Changes in Fish Assemblages and Water Quality in the Willamette River. Transactions of the American Fisheries Society 116:196-209.

Hutchinson, J.M. and W.W. Aney. 1964. The Fish and Wildlife Resources of the Lower Willamette Basin, Oregon, and their Water Use Requirements. Federal Aid to Fish Restoration Progress Report. Fisheries Stream Flow Requirements Project F-69-R-1, Job Number 2. 10 pp.

Scott, W.B., and E.J. Crossman. 1973. Freshwater Fishes of Canada. Bulletin 184. Fisheries Research Board of Canada, Ottawa, Canada.

Ward, D. L., C. J. Knutsen, and R. A. Farr. 1992. Status and Biology of Black Crappie and White Crappie in the Lower Willamette River Near Portland, Oregon. *In*: D. L. Ward (editor), Effects of Waterway Development on Anadromous and Resident Fish in Portland Harbor, pages 60-77. Oregon Department of Fish and Wildlife.

Wydoski R.S., and R.R. Whitney. 1979. Inland Fishes of Washington. University of Washington Press, Seattle, WA.

5.4 MIGRATORY FISH SPECIES

5.4.1 Historical Studies

Migratory fish species are described in Farr and Ward (1993), Beak (2000), North et al. (2001), and the following citations:

Beamish, R.J. 1980. Adult biology of the river lamprey (*Lampetra ayersi*) and the Pacific lamprey (*Lampetra tridentata*) from the Pacific Coast of Canada. *Can. J. of Fish. and Aquat. Sci.* 37:1906-1923

Beamish, R.J., and T.G. Northcote. 1989. Extinction of a population of anadromous parasitic lamprey, *Lampetra tridentata*, upstream of an impassable dam. *Can. J. of Fish. and Aquat. Sci.* 46:420-425.

Beamish, R.J., and C. D. Levings. 1991. Abundance and freshwater migrations of the anadromous parasitic lamprey, *Lampetra tridentata*, in a tributary of the Fraser River, British Columbia. *Can. J. of Fish. and Aquat. Sci.* 48:1250-1263.

Beamsderfer, R.C. 1997. Management and Trade of Pacific Strugeon. Oregon Department of Fish and Wildlife, Clackamas, OR.

California Department of Fish and Game (CDFG). 1992. Sturgeon in Relation to Water Development in the Sacramento-San Joaquin Estuary. Entered by the

California Dept. of Fish and Game for the State Water Resources Control Board 1992 Water Rights Phase of the Bay-Delta Estuary Proceedings.

Chadwick, H.K. 1959. California Sturgeon Tagging Studies. California Department of Fish and Game 45 (4): 297-301.

CH2M Hill. 1985. Klamath River Basin Fisheries Resource Plan. Prepared for U. S. Department of the Interior. CH2M Hill, Bellevue, WA.

Cheek, R.P. 1968. The American Shad. U. S. Fish and Wildlife Service Fishery Leaflet 614, Bureau of Commercial Fisheries Biological Laboratory, Beaufort, NC.

Close, D.A., M. Fitzpatrick, and H. Li. 1995. Status Report of the Pacific Lamprey (*Lampetra Tridentata*) in the Columbia River Basin. Oregon Cooperative Fishery Research Unit, Department of Fisheries and Wildlife, Oregon State University, B. Parker , D. Hatch, Columbia River Inter-Tribal Fish Commission, G. James, Department of Natural Resources, Fisheries Program, Confederated Tribes of the Umatilla Indian Reservation, U.S. Department of Energy, BPA, Division of Fish and Wildlife, Project Number 94-026, BPA Report DOE/BP-39067-1.

Conley, R.L. 1977. Distribution, Relative Abundance, and Feeding Habits of Marine and Anadromous Juvenile Fishes of Everett Bay, Washington. M.S. Thesis. University of Washington, Seattle, WA. 64 p.

Devore, J.D., and J.T. Grimes. 1993. Migration and distribution of white sturgeon in the Columbia River downstream from Bonneville Dam and in adjacent marine areas. R.C. Beamesderfer and A.A. Nigro (editors). *In:* Status and Habitat Requirements of the White Sturgeon Populations in the Columbia River Downstream from McNary Dam. Volume 1, pp. 83-100. Final Report to Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife.

Devore, J.D., B. James, and R. Beamesderfer. 1999. Lower Columbia River White Sturgeon Current Stock Status and Management Implications. Draft Report of the WDFW/ODFW. 26 pp.

Emmett, R.L., S.A. Hinton, S.L. Stone and M.E. Monaco. 1991. Distribution and Abundance of Fishes and Invertebrates in West Coast Estuaries, Volume II: Species Life Histories Summaries. ELMR Report No. 8., NOS/NOAA Strategic Environmental Assessment Division, Rockville, MD. 329 pp.

Environmental Protection Information Center (EPIC) with the Center for Biological Diversity and Waterkeepers Northern California. 2001. Petition to List the North American Green Sturgeon (*Acipenser medirostris*) as an

Endangered or Threatened Species Under the Endangered Species Act. Contact: Cynthia Elkins, Garberville, CA.

Fitch, J.E., and R.J. Lavenberg. 1971. Marine Food and Game Fishes of California. University of California Press, Berkeley, CA. 179 pp.

Ganssle, D. 1966. Fishes and decapods of San Pablo and Suisun Bays. *In*: Ecological Studies of the Sacramento-San Joaquin Estuary, Part I (compiled by D. W. Kelley), California Department of Fish and Game Fish Bulletin 133. pp. 64-94.

Garrison, K.J., and B.S. Miller. 1982. Review of the Early Life History of Puget Sound Fishes. University of Washington Fish Res. Inst. Seattle, WA. UW 8216: 729pp.

Hammann, M.G. 1981. Utilization of the Columbia River Estuary by American Shad, (*Alosa sapidissima*), M.S. Thesis, Oregon State University, Corvallis, OR.

Hart, J.L. 1973. Pacific Fishes of Canada. Bulletin 180. Fisheries Research Board of Canada, Ottawa, Canada.

Kan, T.T. 1975. Systematics, Variation, Distribution, and Biology of Lampreys of the Genus Lampetra in Oregon. Doctoral Dissertation, Oregon State University, Corvallis, OR. 194 pp.

King, S.D., and G. Norman. 1991. Status Report: Columbia River Fish Runs and Fisheries 1960-1990. Oregon Department of Fish and Wildlife and Washington Department of Fisheries.

Mattson, C.R. 1949. The lamprey fishery at Willamette Falls, Oregon. *In:* Fish Commission of Oregon Research Briefs. 2(2):23-27.

McCabe G.T. Jr., and C.A. Tracy. 1993. Spawning Characteristics and Early Life History of White Sturgeon (*Acipenser transmontanus*) in the Lower Columbia River. R.C. Beamesderfer and A.A. Nigro (editors). *In:* Status and Habitat Requirements of the White Sturgeon Populations in the Columbia River Downstream from McNary Dam. Volume 1, pages 19-46. Final Report to Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife.

McCabe, G.T. Jr., R.L. Emmett, and S.A. Hinton. 1993. Feeding ecology of juvenile white sturgeon (*Acipenser transmontanus*) in the Lower Columbia River. R.C. Beamesderfer and A.A. Nigro (editors). *In:* Status and Habitat Requirements of the White Sturgeon Populations in the Columbia River Downstream from McNary Dam, Volume II, pages 245-263. Bonneville Power Administration, Contract DE-AI79-86BP63584.

Miller, L.W. 1972. Migrations of Sturgeon Tagged in the Sacramento-San Joaquin Estuary. California Department of Fish and Game 58(2):102-106.

Moore, J.W., and J.M. Mallatt. 1980. Feeding of larval lamprey. *Can. J. of Fish. and Aquat. Sci.*37:1658-1664.

Moyle, P.B., P.J. Foley, and R.M. Yoshiyama. 1992. Status of Green Sturgeon, *Acipenser medirostris*, in California. Final Report submitted to National Marine Fisheries Service, Terminal Island, CA.

Moyle, P.B., P.J. Foley, and R.M. Yoshiyama. 1994. Status and Biology of the Green Sturgeon, *Acipenser medirostris*. Sturgeon Quarterly 2.

Moyle, P.B., R.M. Yoshiyama, J.E. Williams, and E.D. Wikramanayake. 1995. Fish Species of Special Concern in California, 2nd Edition. California Department of Fish and Game, Inland Fisheries Division, Rancho Cordova, CA.

Mulligan, H., T. Mulligan, and D. Hillemeier. 1996. Genetic Analysis of Klamath River Green Sturgeon (interim report). Yurok Tribal Fisheries Program.

Musick, J.A. and 17 additional authors. 2000. Marine Extinction, and Diadromous Fish Stocks at Risk of Extinction in North America (Exclusive of Pacific Salmonids). *Fisheries* 25(11):6-29.

Nakamoto, R.J., T.T. Kisanuki, and G.H. Goldsmith. 1995. Age and Growth of Klamath River Green Sturgeon (*Acipenser medirostris*). U. S. Fish and Wildlife Service Project #93-FP-13, Klamath River Fishery Resource Office, Yreka, CA.

Ocker, P.A., L.C. Stuehrenberg, M.L. Moser, A L. Matter, J.J. Vella and B.P. Sandford. 2001. Fish Ecology Division, Northwest Fisheries Science Center, NMFS, NOAA, Seattle WA and T. C. Bjornn, K. R. Tolotti, USGS, Biological Resource Division, Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow, Idaho. Report of Research to U.S. Army Corps of Engineers, Portland District, Portland, OR.

ODFW. 2000. ODFW Green sturgeon files. Produced by Steve King in response to an Oregon Public Records Act request. *In:* Environmental Protection Information Center (EPIC) with the Center for Biological Diversity and Waterkeepers Northern California. 2001. Petition to List the North American Green Sturgeon (*Acipenser medirostris*) as an Endangered or Threatened Species Under the Endangered Species Act. Contact: Cynthia Elkins, Garberville, CA

Orcutt, H.G. 1950. The Life History of the Starry Flounder (*Platichthys stellatus*). California Department of Fish and Game, Bureau of Marine Fisheries, Fish Bulletin No. 78.

Pletcher, T.F. 1963. The Life History and Distribution of Lampreys in the Salmon and Certain other Rivers in British Columbia, Canada. M.S. Thesis. University of British Columbia, Vancouver, B.C. 195 pp.

Radtke, L.D. 1966. Distribution of Smelt, Juvenile Sturgeon and Starry Flounder in the Sacramento-San Joaquin Delta with Observations on Food of Sturgeons. *In:* Turner, J. L. and D.W. Keley (ed.). Ecological Studies of the Sacramento-San Joaquin Estuary, Part II; California Department of Fish Game Fish Bulletin 136, pp 115-119.

Richards, J.E. 1980. Freshwater Life History of the Anadromous Pacific Lamprey *Lampetra tridentata.* M.S. Thesis. University of Guelph. Guelph, Ontario, Canada. 99 pp.

Rieman, B.E., and R.C. Beamesderfer. 1990. White sturgeon in the lower Columbia River: Is the stock overexploited? *N. Amer. J. of Fish. Manage.* 10 (4):388-396.

Russell, J.E., F.W.H. Beamish, and R.J. Beamish. 1987. Lentic spawning by the Pacific lamprey *Lampetra tridentata. Can. J. of Fish. and Aquat. Sci.*44: 476-478.

Skinner, J.E. 1962. An Historical Review of the Fish and Wildlife Resources of the San Francisco Bay Area. California Department of Fish and Game,Water Projects Branch Report No. 1. 226 pp.

Turner, J.L. 1966. Introduction to Fisheries Studies in the Sacramento-San Joaquin Delta. *In*: Turner, J. L. and D. W. Kelley, (editors), Ecological Studies of the Sacramento-San Joaquin Estuary, Part II; California Department of Fish and Game Fish Bulletin 136, pp 9-14.

USFWS. 1961. Sturgeons. Fishery Leaflet 526. U. S. Department of the Interior, Fish and Wildlife Service, Bureau of Commercial Fisheries, Washington, DC.

USFWS. 1982. Klamath River Fisheries Investigation Program. Annual Report 1981.

USFWS. 1993. Klamath River Fisheries Investigations 1980-1993. Annual Reports. Arcata, CA.

USFWS. 1995. Sacramento-San Joaquin Delta Native Fishes Recovery Plan. USFWS, Portland, OR.

USFWS. 1999. Trinity River Mainstem Fishery Restoration Environmental Impact Statement/Report. *In:* Environmental Protection Information Center (EPIC) with the Center for Biological Diversity and Waterkeepers Northern

California. 2001. Petition to List the North American Green Sturgeon (*Acipenser medirostris*) as an Endangered or Threatened Species Under the Endangered Species Act. Contact: Cynthia Elkins, Garberville, CA.

USFWS. 2000. USFWS Green Sturgeon Files. Produced by USFWS in response to a Center for Biological Diversity Freedom of Information Act request. *In:* Environmental Protection Information Center (EPIC) with the Center for Biological Diversity and Waterkeepers Northern California. 2001. Petition to List the North American Green Sturgeon (*Acipenser medirostris*) as an Endangered or Threatened Species Under the Endangered Species Act. Contact: Cynthia Elkins, Garberville, CA.

Warren, J.J., and LG. Beckman. 1993. Fishway use by white sturgeon to bypass mainstem Columbia River dams. *In:* R. C. Beamesderfer and A. A. Nigro (editors), Status and Habitat Requirements of the White Sturgeon Populations in the Columbia River Downstream from McNary Dam. Volume 1, pages 119-136. Final Report to Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife.

Washington Department of Fish and Wildlife/Oregon Department of Fish and Wildlife (WDFW/ODFW). 2001. Joint Staff Report Concerning Commercial Seasons For Sturgeon and Smelt in 2002. Joint Columbia River Management Staff. 34 pp.

5.4.2 Recent LWG Studies

Reconnaissance surveys of lamprey species were also completed in 2002. The first survey took place during the lamprey harvest at the Willamette Falls. The objective of the survey was to observe the harvest and to identify the lamprey species harvested. The second survey was completed in the fall of 2002 to locate juvenile lamprey for potential tissue testing. The results of these surveys were reported in a technical memorandum submitted to EPA in 2003.

5.5 SPECIAL AQUATIC SITES

Special habitat areas are those that are sensitive to disturbance and are known to provide shelter or forage for species listed or proposed for listing under the Endangered Species Act of 1973. The data used to describe sensitive and special habitats were compiled from a variety of sources. Although there may be several sensitive and special habitat areas between Willamette Falls and the City of Portland boundary, much of the data compiled was provided through habitat inventories funded by the City that do not extend upriver beyond RM 17.0. Other sources of existing information and data were from Metro, USACE, NMFS,

ODFW, Isaacs et al (2001), and Houck and Cody (2000) and the following citations:

City of Portland, Bureau of Planning. 2000. Willamette River Inventory: Natural Resources. Public review draft. 112 pp.

Greenworks, PC Landscape Architecture, ClearWater West, Fishman Environmental Services, Inter-Fluve, Inc., KPFF Consulting Engineers. 2001. Willamette River Design Notebook: Portland, Oregon. Project sponsored by City of Portland, Bureau of Environmental Services. 105 pp.

Greenworks, PC Landscape Architecture, ClearWater West, Fishman Environmental Services, Inter-Fluve, Inc., KPFF Consulting Engineers. 1999. Riverbank Conditions Geographic Information Systems Database. Sponsored by City of Portland, Bureau of Environmental Services, Portland, OR.

Houck, M.C., and M.J. Cody. 2000. Wild in the City, A Guide to Portland's Natural Areas. Oregon Historical Society Press, Portland, OR. 433 pp.

Isaacs, F.B., and R.G. Anthony. 1995. Bald Eagle Nest Locations and History of Use in Oregon, 1971 through 1995. Oregon Cooperative Wildlife Research Unit, Oregon State University, Corvallis, OR. 17 pp.

Isaacs, F.B., R.G. Anthony and D.P. Anderson. 2001. Bald Eagle Nest Locations and History of Use in Oregon and the Washington Portion of the Columbia River Recovery Zone, 1972 through 2001. Oregon Cooperative Wildlife Research Unit, Oregon State University, Corvallis, OR. 34 pp.

North, J.A., L.C. Burner, B.S. Cunningham, R.A. Farr, T.A. Friesen, J.C. Harrington, H.K. Takata, and D.L. Ward. 2001. Relationship Between Bank Treatment/Nearshore Development and Anadromous/Resident Fish in the Lower Willamette River. Draft annual progress report. Project sponsored by City of Portland and the Lower Willamette Group.

5.6 THREATENED AND ENDANGERED SPECIES

5.6.1 Fish

Information on fish species that have been listed or are proposed for listing under the Endangered Species Act of 1973, as amended, are provided in the Oregon Natural Heritage Program, NMFS, USFWS, North et al. (2001), Farr and Ward (1992), Beak (2000), and the citations that follow. Note that references for specific information about home range, distribution and status, life history, and food habits are also provided.

Birtwell, I.K. 1978. Studies on the relationship between juvenile Chinook salmon and water quality in the industrialized estuary of the Somass River, p. 58-78. *In*: B. G. Shepherd and R. M. J. Ginetz (rapps.). Proceedings of the 1977 Northeast Pacific Chinook and Coho Salmon Workshop. Fish. Mar. Serv. (Can.) Tech. Rep. 759. 164pp.

Bjorn, T., D. Craddock, and D. Corley. 1968. Migration and survival of Redfish Lake, Idaho, sockeye salmon, *Oncorhynchus nerka*. *Trans. Am. Fish. Soc.* 97:360-373.

Busby, P., T. Wainwright, G. Bryant, L. Lierheimer, R. Waples, F. Waknitz, and I. Lagomarsino. 1996. Status Review of West Coast Steelhead from Washington, Idaho, Oregon, and California. NOAA Tech. Memorandum NMFS-NWFSC-27.

Chapman, W.M., and E. Quistdorff. 1938. The Food of Certain Fishes of North Central Columbia River Drainage, in Particular, Young Chinook Salmon and Steelhead Trout. Washington Department of Fish, Biological Report. 37-A:1-14.

Cramer, D.P., and S.P. Cramer. 1994. Status and Population Dynamics of Coho Salmon in the Clackamas River. Technical Report Prepared for Portland General Electric Company, March 1994.

Cramer, D., and S. Bullock. 1995. Evaluation of the Downstream Migrant Bypass System-T.W. Sullivan Plant, Willamette Falls. Portland General Electric Progress Report.

Cramer, F.K. 1940. Notes on the natural spawning of cutthroat trout *Salmo clarkii clarkii* in Oregon. Proceedings of the Sixth Pacific Science Conference of the Pacific Science Association 3:335-339.

Dawley, E. and eight other authors. 1986. Migrational Characteristics, Biological Observations, and Relative Survival of Juvenile Salmonids Entering the Columbia River Estuary, 1966-1983. Bonneville Power Administration Report BPA DOE IBP-39652-1.

Domina, D.J. 1997. Evaluation of the Downstream Migrant Bypass System, T.W. Sullivan Plant, Willamette Falls, Oregon. Portland General Electric Progress Report for 1996.

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Everest, F. H. and five co-authors. 1986. Abundance, Behavior, and Habitat Utilization by Coho Salmon and Steelhead Trout in Fish Creek, Oregon, as

Influenced by Habitat Enhancement. U. S. Forest Service annual report to Bonneville Power Administration, Contract DE-A1-BP-16726. Portland, OR.

Foster, C.A. 2001. 1999 Willamette River Spring Chinook Salmon Run, Fisheries, and Passage at Willamette Falls. Prepared by the Oregon Department of Fish and Wildlife, Portland, OR.

Fish Passage Center (FPC). 1991. 1990 Annual Report. Fish Passage Center of the Columbia Basin Fish and Wildlife Authority.

Fish Passage Center (FPC). 1992. 1991 Annual Report. Fish Passage Center of the Columbia Basin Fish and Wildlife Authority.

Fish Passage Center (FPC). 1993. 1992 Annual Report. Fish Passage Center of the Columbia Basin Fish and Wildlife Authority.

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Fish Passage Center (FPC). 1995. 1994 Annual Report. Fish Passage Center of the Columbia Basin Fish and Wildlife Authority.

Fish Passage Center (FPC). 1997. 1996 Annual Report. Fish Passage Center of the Columbia Basin Fish and Wildlife Authority.

Fulton, L.A. 1968. Spawning Areas and Abundance of Chinook Salmon, *Oncorhynchus tshawytscha*, in the Columbia River Basin-Past and Present. U.S. Fish and Wildl. Serv. Spec. Sci. Rep. Fish. 571:26.

Giger, R.D. 1972. Ecology and Management of Coastal Cutthroat Trout in Oregon. Oregon State Game Commission, Fishery Research Report 6, Corvallis, OR.

Glova, G.J., and J.C. Mason. 1976. Interactive Ecology of Juvenile Salmon and Trout in Streams. Fisheries Research Board of Canada Manuscript Report 1391.

Glova, G.J. and J.C. Mason. 1977. Interactions for Food and Space Between Sympatric Populations of Underyearling Coho salmon and Coastal Cutthroat Trout in a Stream Simulator During Summer. Fish. Mar. Serv. Rep. No. 1428.

Hartman, G.F. and C.A. Gill. 1968. Distributions of juvenile steelhead and cutthroat trout (*Salmo gairdneri* and *S. clarki clarki*) within streams in southwestern British Columbia. *J. of the Fish. Res. Board of Canada* 25:33-48.

Healey M. C. 1991. Life History of Chinook Salmon. pp. 311-394. *In:* C. Groot and L. Margolis (editors). Pacific Salmon Life Histories. UBC Press, Vancouver, Canada.

Herrman, R.B. 1970. Food of juvenile chinook and chum salmon in the lower Chehalis River and upper Grays Harbor, p. 59-82. *In*: Grays Harbor Cooperative Water Quality Study 1964-1966. Wash. Dep. Fish. Tech. Rep. 7.

Hooton, R.H. 1997. Status of coastal cutthroat trout in Oregon. pp. 57-67. *In:* J. D. Hall, P. A. Bisson and R. E. Gresswell, (editors). Sea-Run Cutthroat Trout: Biology, Management and Future Conservation, Oregon Chapter, American Fisheries Society, Corvallis, OR.

Hunter, J.W. 1973. A discussion of Gamefish in the State of Washington as Related to Water Requirements. Washington State Game Department, Olympia, WA.

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5.6.2 Upland Plants and Animals

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Recent LWG Studies

In 2002, a reconnaissance survey was completed in the LWR to characterize aquatic plants and amphibians. There were two objectives of the reconnaissance survey:

- Determine the presence or absence of amphibians and/or reptiles in the ISA by surveying potential amphibian and reptile habitat for evidence of amphibians or reptiles (e.g. egg masses, tadpoles, mature frogs or reptiles)
- Determine the presence or absence of aquatic plants throughout the ISA by locating potential areas of aquatic plant establishment and surveying these areas for submersed and emergent macrophytes.

A technical memorandum describing the results of the survey was submitted to EPA in 2003 (see Attachment B2 in Appendix B).

6.0 CULTURAL AND HUMAN RESOURCE STUDIES

Age and ethnic population data in Multnomah and Clackamas counties are provided in the 2000 Census conducted by the U.S. Census Bureau. Population distributions by ethnicity, age, and gender for the counties were extracted by Smartgirl Technologies (2000). Information on cultural, residential, recreational, and occupational uses of the LWR is described in:

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Table 1. Existing Lower Willamette River Physical Studies.

Data Type/*Format*	**Source**	**Date**	**Area**	**Physical Study Summary**
Aerial Photography Georeferenced TIF images	Spencer B. Gross	10/01	RM 0 to RM 15.6	Survey area: RM 0 to RM 15.6. Aerial photography was conducted on six flight lines along the Willamette, encompassing the river, the shoreline, and an additional 500' into the upland area. The scale was 1 inch = 500 feet. Photographs were scanned at 1800 dpi for a nominal pixel resolution of 0.3-foot to generate digital orthophotos.
Aerial Photography Georeferenced TIF images	Walker and Associates	1997	Willamette River Valley	Aerial photography was conducted over Willamette Valley at a scale of 1 inch = 2640 feet. Photographs were scanned at 668 dpi to generate digital orthophotos. These photographs may be used for areas (i.e., upriver) not recently surveyed by Spencer B. Gross.
Bathymetry x,y,z text files, ArcInfo DEM and grid files, hillshade TIF files, and ArcView contour shape files	David Evans and Associates	12/01-01/02, 07/02, 05/03	RM 0 to RM 15.6	Water depth measurements were collected using a Reson SeaBat 8101 multibeam bathymetric sonar system (240 kHz frequency) integrated with an Applanix POS/MV differential global positioning system (DGPS) with Real-Time-Kinematic positioning capabilities and motion reference system. Water depths are referenced to the North American Vertical Datum of 1988 (NAVD88). The vertical accuracy of collected water depths was 0.5 ft, and the horizontal accuracy was 1 meter. The resulting data were processed using a grid size of 3 ft by 3 ft to generate a digital terrain model (DTM). Survey methods, contour maps, and hillshade maps are presented in a Striplin Letter Report (Portland Harbor RI/FS Phase 1 – Precision Bathymetric Survey) dated April 24, 2002.
Bathymetry x,y,z text files and contour shape files	U.S. Army Corps of Engineers, Portland	1992-2001	RM 0 to RM 11.5	Water depth measurements were collected primarily within the Willamette River navigation channel for the purpose of maintenance dredging. All data were collected by the Corps, Portland District. Parsons Brinckerhoff compared water depth data over months to years to document changes in sediment volume (Parsons Brinckerhoff 2001).
Light Detection and Ranging (LIDAR): Contour shape files of bathymetry and LIDAR gridded together	Spencer B. Gross	10/01	RM 0 to RM 15.6	Twelve flight lines with three cross-flights for validation were completed from 6000 ft altitude over the same area as the aerial photography. The survey had a 25-degree field of view, and pulse data were collected at 2/3-meter point spacing. The raw data were pre-processed for differential corrections, noise removal, geodetic orientations, formatting by return, and conversion to the project coordinate system. The data were post-processed to a bare earth digital elevation model (DEM) and converted to a gridded data set (10-ft grid) for GIS applications. 2001 bathymetric data were resampled to 10-foot cell size and both LIDAR and bathymetry were compiled into one grid.

Table 1. Existing Lower Willamette River Physical Studies.

Data Type/*Format*	**Source**	**Date**	**Area**	**Physical Study Summary**
Sediment Trend Analysis® (STA) ArcView shape files	GeoSea	9/00	RM 0 to RM 26.5	Sediment grab samples were obtained from the upper 10 to 15 cm of the sediment using a van Veen type grab sampler at 836 locations. Samples were collected on a hexagonal grid of 150-m spacing from RM 3 to RM 9.6. Elsewhere in the study area samples were collected on a grid spacing of 200 m or greater. Samples were analyzed for grain size distributions using a laser particle sizer instrument. The size distributions were analyzed using proprietary software to establish sediment trends and transport functions. The methodology statistically examines the relative changes in grain size distributions that occur along transport paths. Maps were produced that indicate the patterns of sediment transport and areas of erosion, equilibrium, and accretion. The analysis concluded that sediments in transport or those injected from outfalls into the system from Willamette Falls downstream to below the Fremont Bridge are either erosional or are in dynamic equilibrium. Below the Fremont Bridge, sediments are finer and transport becomes depositional. The analysis concluded the industrial and Port facilities area is the only part of the Lower Willamette that is a sink for sediments. Downstream of this reach, sediments in transport enter another transport regime in which they are moved downstream and enter the Columbia River system. The final region is the extreme downstream end of the Willamette and a portion of the Columbia near the confluence where erosion dominates the sedimentary environment.
Water Velocity Data	USGS	7/62 to 1/65	RM 11.7 and 14	Velocities were measured with a Price current meter suspended from the Broadway Bridge and the Ross Island Bridge. Mean cross-sectional velocities ranged from 8 feet/second downstream during the 1964 flood to a low upstream velocity of almost 1 feet/second in 1963.
Water Stage and Velocity Data	USGS	10/72 to 9/94	RM 12.8	An acoustic velocity meter with water stage and velocity index recorder was installed at the Morrison Bridge. Since 10/94, the gauge measures unverified stage only.
ADCP Flow data	USGS	1/14/00	RM 12.8 and 4.1	The estimated discharge for January 14th, 2000 was 99,000 cubic feet/sec.
ADCP Flow Data	LWG Round 1 - ongoing	4/19/02, 05/02	2002: RM 1, 2, 2.5, 3.1, 4, 4.6, 5.8, 6.3, 6.8, 7.8, 8.6, 9.6, 10, 11 2003: mouth of Multnomah Channel	ADCP mounted to 30-ft vessel and transects were made at the river miles indicated. Water velocities ranged from almost 1 feet/second to 2 feet/second. Flow across transects were computed at approximately 70,000 cfs above Multnomah Channel and at approximately 35,000 cfs below Multnomah Channel.

Table 1. Existing Lower Willamette River Physical Studies.

Data Type/*Format*	**Source**	**Date**	**Area**	**Physical Study Summary**
Suspended Sediment Concentration	USGS	ongoing	RM 12.8	USGS measures suspended sediment concentrations at the Morrison Bridge gauge approximately once/month in addition to synoptic surveys at various locations in Portland Harbor. Increased sediment concentrations occur in the water column during high flow events.
Corps HEC-2 Model	Corps Hydrologic Engineering Center (HEC)	1978	RM 0 to RM 22.3	HEC developed a one-dimensional standard step backwater model using HEC-2 (Water Surface Profiles computer program) to prepare FEMA floodplain and floodway maps. The model input data consists of cross-section and geometry data, downstream water surface elevation, discharge, and various friction factors. Cross-section spacing varied from a few hundred feet to thousands of feet. Model output consists of cross-section averages of hydraulic parameters. The model is a steady-state model, the boundary conditions do not vary with time. Peak flood events were modeled.
QUAL2EU Model	Tetra Tech	1995	RM 0 to RM 187	Tetra Tech, Inc. (1995a) developed a water quality model of the Willamette River mainstem for the DEQ using QUAL2EU. QUAL2EU (Brown and Barnwell 1987) is a one-dimensional, steady-state, hydraulic and water quality model. Because of the tidal dynamics in the Lower Willamette River (downstream from Willamette Falls), the model's use is limited.
DYNHYD Model	Limno-Tech, Inc.	1997	Portland Harbor and Multnomah Channel	DYNHYD (Ambrose et al. 1988) is a one-dimensional, unsteady hydraulic model. Limno-Tech, Inc. (1997) conducted an investigation of the Lower Willamette and the tidal influence on the CSO area using the DYNHYD model for the City of Portland, Bureau of Environmental Services. The magnitude of flows through Multnomah Channel was also investigated.
Corps UNET Model	Corps	1996	RM 0 to RM 26.5 and Columbia River to Bonneville Dam (RM 144)	UNET is a one-dimensional, unsteady flow model. Input data are similar to HEC-2; however, boundary conditions such as downstream water surface elevation and discharges can vary with time. Geometry is in cross-section form and was constructed from hydrographic surveys conducted in 1995. Similar to HEC-2, the model output is cross- section averages for various hydraulic parameters. The model was originally constructed to examine water levels for various flow regimes and has been used for both low and high flow conditions. Flows from 1995 through 1998 have been applied (Corps 2001).
PSU CE-QUAL-W2 Water Quality Model	Portland State University	2001	RM 0 to RM 35 and Columbia River (RM 54 to RM 144)	CE-QUAL-W2 was developed by the Corps and is a two-dimensional (vertical/longitudinal), laterally averaged, hydrodynamic and water quality model. It is highly applicable in areas where stratification is a concern. The model has been calibrated for low flow conditions from May 1to October 1 for 1993, 1994, 1997, 1998, and 1999. Parameters calibrated include flow, stage, and temperature. Portland State University constructed a CE-QUAL-W2 model for Clackamas County to examine low flow water quality impacts associated with proposed improvements to their sewage treatment plants (Portland State University 2001a,b).

Table 1. Existing Lower Willamette River Physical Studies.

Data Type/*Format*	Source	Date	Area	Physical Study Summary
FESWMS 2-D Model	Parsons Brinckerhoff	2001-2002	RM 5 to RM 8	Parsons Brinckerhoff developed a two-dimensional model of the Willamette River from approximately RM5 to RM8 as part of a sediment cap design effort for DEQ. FESWMS was selected to effectively model the complex hydraulics in the vicinity of the railroad bridge crossing. FESWMS is a two-dimensional, finite element, depth-averaged model that was developed by the USGS for the Federal Highway Administration. The model is capable of unsteady or steady-state calculations. For the purposes of the cap design, a 500-year flood event was modeled. Since tidal effects are drowned out with floods of that magnitude, a steady-state calculation was performed. Output of the model includes depth-average velocity (magnitude and direction) and water depth at each node within the finite element grid.
Sediment-Profiling Imagery (SPI) ArcView shape files	Germano & Associates, Inc.	11/01-12/01	RM 0 to RM 15	SPI is a remote method for mapping conditions in the near-surface sediments (0-20 cm) of the seafloor or lake and river bottoms. SPI data are used to help assess patterns of physical disturbance and sediment characteristics in the study area, complimenting the STA® survey results and providing additional support in the development of RI/FS sediment sampling plans. SPI produces 35-mm color slides of sediment profiles, which are analyzed using a computer image analysis system. The software allows rapid measurement and storage of a wide variety of imaged features from each photograph, including: (1) grain-size major mode and range; (2) small scale surface boundary roughness; (3) evidence of erosional or depositional environments, allowing identification of high and low kinetic energy areas; (4) subsurface methane gas pockets (evidence of high sediment oxygen demand); (5) depth of the apparent redox discontinuity; (6) evidence of excess organic loading; and (7) presence and general type (e.g., subsurface deposit feeders vs. suspension feeders) of benthic infauna. SPI photos were collected from over 500 stations. Station locations were stratified between relatively deep federal channel locations (assumed to have minimal strong gradients) and the shallower nearshore and backwater areas that likely show more heterogeneity. Five hundred twenty-three (523) photos were analyzed. The images revealed areas that were depositional, erosional, and mixed case, which supported the findings of the STA. Overlays of the major SPI parameters point to seven major "benthic zones" in the deeper portions of the Willamette River from Ross Island to the Columbia River. Within each zone, gross benthic conditions are relatively uniform throughout the area mapped. The nearshore zone, all surveyed river bed areas less than 20 feet depth CRD along both margins of the river, represents an eighth benthic zone. Detailed results and discussion are provided in *Sediment Profile Image Survey of the Lower Willamette River* (SEA 2002).
Monitoring of Deposition and Erosion using Sediment Stake	LWG	2002-ongoing	RM 3 - 9	Nine sediment stakes (PVC tubes) were installed at beaches within the ISA in 2002. Sediment levels are recorded each month. Data from each stake will be compared over time to determine whether accretion, erosion, or no net change is occurring at each location. Any trends will be compared to existing flow and water level data for the river.

Table 1. Existing Lower Willamette River Physical Studies.

Data Type/*Format*	**Source**	**Date**	**Area**	**Physical Study Summary**
Additional Spatial Files	METRO RLIS	2001 with quarterly updates	Tri-County	Transportation, Property (taxlots), Zoning, Water (shoreline rivers, streams, lakes and 100-year flood), and Miscellaneous (city and county boundary) themes with associated annotation.
ArcView shape files	USGS	1991	State of OR	Natural theme – geological faults and lithology
	Corps	2000-01	LWR	Water theme – river miles, channel boundary, and Portland District bathymetric contours
	DEQ	4/01	Portland Harbor	DEQ Cleanup Sites
	City of Portland	11/01 with updates	Portland Harbor	Outfalls – city and non-city
	Parsons Brinckerhoff	01/02	Portland Harbor	Dredged Areas – Federal and Port of Portland dredged area polygons since 1980. Note that 3rd party dredged areas are not included in this shape file. A FOIA request for 3rd party dredge permits is currently being processed by the Portland District.

Table 2. Existing Lower Willamette River Sediment Chemistry Data.

Survey	Source	Field Start Date	Data QA Category	Survey Name	Program Type	Sediment Sample Summary
CRBC8494*	EPA On-line database	1984 to 1994	2	Columbia River Basin Contaminant Study	Sediment, Biota Investigation	DEQ (1994) - 6 surface below RM 27 and only 1 (RM12) since 1990; Curtis et al. (1993) - 1 surface at RM 11
COLWIL90	Corps-Portland District	05/03/90	2	Columbia and Willamette Rivers Channel Deepening Reconnaissance Study	Dredge	13 subsurface sediment
MBCREOS1	DEQ/ PTI 1992	09/21/90	1 & 2	McCormick & Baxter RI Phase 1	Remedial Investigation	16 subsurface sediment, 62 surface sediment, 1 upriver reference surface
MBCREOS2	DEQ/ PTI 1992	09/01/91	1 & 2	McCormick & Baxter RI Phase 2	Remedial Investigation	18 subsurface sediment, 6 surface sediment, 1 upriver reference surface
MCAL0986	Corps-Portland District	09/18/86	1 & 2	McCall Oil Dock 9/1986	Dredge	7 surface sediment
MCAL1286	Corps-Portland District	12/15/86	1 & 2	McCall Oil Dock 12/1986	Dredge	9 subsurface sediment, 2 elutriate
MOOR0595	Corps-Portland District	05/16/95	1 & 2	US Moorings May 1995	Dredge	43 subsurface sediment, 1 surface sediment
MOOR0694	Corps-Portland District	06/14/94	1 & 2	US Moorings June 1994	Dredge	31 surface sediment
MOOR1089	Corps-Portland District	10/12/89	1 & 2	US Moorings Sediment Quality Evaluation	Dredge	7 subsurface sediment
MOOR1294	Corps-Portland District	12/20/94	1	US Moorings Preliminary Assessment Sampling	Site Assessment	9 surface sediment, 9 nearshore soil
PPTLDT24	Port of Portland	09/15/98	1	Sediment Study Marine Terminals 2 and 4	Dredge	3 subsurface porewater, 3 subsurface sediment
PSBTH311	Port of Portland	09/09/90	1 & 2	Port of Portland Berth 311 Dredge Data	Dredge	8 subsurface sediment, 14 surface sediment

Table 2. Existing Lower Willamette River Sediment Chemistry Data.

Survey	Source	Field Start Date	Data QA Category	Survey Name	Program Type	Sediment Sample Summary
PSYD&M97	DEQ/Dames & Moore 1997	11/26/97	1	Portland Shipyard Environmental Audit	Sediment Investigation	4 subsurface sediment, 8 surface
PSYDD3	Port of Portland	12/15/94	1	Portland Shipyard DD-3 Post-Dredge Data	Dredge	3 subsurface sediment, 8 surface sediment
PSYDD4	Port of Portland	12/15/92	1 & 2	Portland Shipyard DD-4 Post-Dredge Data	Dredge	9 surface sediment
PSYSEA98	Port of Portland/ SEA 1999	03/31/98	1	Portland Shipyard Sediment Investigation	Sediment Investigation	65 subsurface sediment, 60 surface sediment, 61 surface porewater, 3 surface reference
RIEDEL96	Triangle Park, L.L.C./MFA 1996	09/03/96	2	Focused ESA Riedel	Site Assessment	7 subsurface sediment
RIEDEL97	Triangle Park, L.L.C./MFA 1997	08/12/97	1	Baseline Sediment Assessment Riedel	Baseline Assessment	19 subsurface sediment, 8 surface sediment
TOSCO99	DEQ/Exponent 1999	01/20/99	1	TOSCO Sediment Sampling Results 1999	Dredge	4 subsurface sediment, 1 surface reference
WBWRIR98	USGS/Bonn 1998	01/01/92	2	Dioxins and Furans in Bed Sediment and Fish Tissue of the Willamette Basin	Sediment Investigation	2 surface sediment
WLCAYH00	DEQ/Jacobs Engineering 2000	08/09/00	1	Union Pacific Railroad Albina Yard Expanded Preliminary Assessment Data Report	Site Assessment	3 subsurface sediment, 6 surface sediment
WLCARI99	ARCO/SECOR 2002	09/01/99	2 pending	Forensic Assessment of Nearshore Sediments, ARCO/BP Terminal 22T	Remedial Investigation	17 surface sediment
WLCCIF01	Cargill Irving Elevator Terminal/Harding ESE 2001	06/29/01	1,2	Results of Sediment Sampling and Analysis, Cargill Irving Elevator	Dredge	5 subsurface, 1 subsurface porewater
WLCCPF01	Chevron Products	06/01/01	1	Chevron Dredging Permit Application	Dredge	15 surface sediment

Table 2. Existing Lower Willamette River Sediment Chemistry Data.

Survey	Source	Field Start Date	Data QA Category	Survey Name	Program Type	Sediment Sample Summary
	Company/PNG Environmental 2001					
WLCDRE87	Corps-Portland District	01/01/82	2	Organic Compounds in Willamette sediments	Dredge	12 surface sediment
WLCGAF00	DEQ/CH_2M Hill 2001	06/12/00	1	Goldendale Aluminum Dredge Phase 1	Dredge	5 surface sediment, 1 reference surface sediment
WLCGAL00	DEQ/CH_2M Hill 2001	12/21/00	1	Goldendale Aluminum Dredge Phase 2	Dredge	4 surface sediment
WLCGPE00	Georgia-Pacific West, Inc./ CH_2M Hill 2000	05/16/00	2	G-P Linnton Site Preliminary Assessment	Site Assessment	13 surface sediment
WLCGSA96	Northwest Natural/Hahn & Assoc. 1998	01/23/96	1	Gasco Phase I Remedial Investigation	Remedial Investigation	10 subsurface sediment, 12 surface sediment
WLCGSD01	DEQ/Anchor Environmental 2001	04/10/01	1	Gasco Source Control Evaluation	Source Control Investigation	18 subsurface sediment, 9 surface sediment
WLCGXV99	KHM Environmental Management 1999	10/08/99	1	Environmental Site Assessment GATX Terminals Corp.	Site Assessment	4 surface sediment, 4 subsurface sediment
WLCMBA01	DEQ/Ecology and Environment 2001	01/05/01	1	McCormick & Baxter Creosoting Company Sediment RD Phase 2	Remedial Investigation	32 subsurface sediment, 1 upriver reference surface sediment
WLCMBJ99	DEQ/Ecology and Environment 2001	10/01/99	1	McCormick & Baxter Creosoting Company Sediment RD Phase 1	Remedial Investigation	44 site and 4 upriver reference surface sediment
WLCMCB02	DEQ/Parametrix 2002	02/08/02	1	MarCom Expanded Preliminary Assessment	Site Assessment	3 surface sediment
WLCMFH00	DEQ/Jacob Engineering 2000	08/08/00	1	Marine Finance Expanded Preliminary Assessment Data Report	Site Assessment	3 subsurface sediment, 6 surface sediment

Table 2. Existing Lower Willamette River Sediment Chemistry Data.

Survey	Source	Field Start Date	Data QA Category	Survey Name	Program Type	Sediment Sample Summary
WLCOFH02	City of Portland/ CH_2M Hill	08/21/02	1 & 2	City of Portland Outfall Pilot Project, Outfall 18 and M-1	Outfall Study	18 surface sediment
WLCOSJ00	Oregon Steel Mills/Exponent 2001	10/10/00	1	Pre-Remedial Investigation Field Activities Data Report for Oregon Steel Mills	Remedial Investigation	1 subsurface sediment, 15 surface sediment
WLCRFE95	City of Portland/AGI 1995	05/11/95	1 & 2	Rose Festival Fleet Moorage	Dredge	5 surface sediment
WLCRIJ99	DEQ/Landau 1999	10/26/99	1	Ross Island Lagoon Baseline Sediment Characterization	Baseline	4 surface porewater, 12 surface sediment
WLCRIL99	Port of Portland/Hart Crowser 2000	11/02/99	1	Site Investigation Report, Port of Portland Confined Dredged Disposal, Ross Island Facility	Baseline	6 subsurface porewater, 20 subsurface sediment, 38 surface porewater, 41 surface sediment, 4 surface reference sediment
WLCRIV99	Ross Island Sand & Gravel/Landau 2000	10/07/99	1	Phase I Remedial Investigation, Ross Island Sand & Gravel Co.	Remedial Investigation	4 surface sediment, 41 subsurface sediment
WLCRPB95	Aventis/Woodward-Clyde Consultants 1995	02/01/95	1	Rhône-Poulenc St Helens Road Facility Q1,95	Remedial Investigation	5 surface sediment
WLCT0F01	Port of Portland/Hart Crowser 2001	06/27/01	1	Terminal 2 and Terminal 5 2001 Dredge Characterization Study	Dredge	4 subsurface porewater, 7 subsurface sediment
WLCT0I98	Corps-Portland District	09/14/98	1	Sediment Characterization Local Sponsors Berths and Columbia/Willamette Channel Deepening	Dredge	7 subsurface porewater, 7 subsurface sediment, 12 surface porewater, 12 surface sediment
WLCT0K96	Port of Portland/Hart Crowser 1997	11/12/96	1	Port of Portland T1, T2, and T5 Sediment Characterization Study	Dredge	7 subsurface sediment, 1 surface sediment
WLCT1F00	Port of Portland/SEA	06/22/00	1	T1 South Sediment Study		9 surface porewater, 9 surface sediment

Table 2. Existing Lower Willamette River Sediment Chemistry Data.

Survey	Source	Field Start Date	Data QA Category	Survey Name	Program Type	Sediment Sample Summary
	2000					
WLCT1L91	Port of Portland	12/17/91	1 & 2	Port of Portland 1992 Terminal 1 Sediment Characterization Results	Dredge	2 subsurface sediment
WLCT4J97	Port of Portland/Hart Crowser 1997	10/23/97	1 & 2	Port of Portland Terminal 4 Berth 416 1997 Sediment Characterization Study	Dredge	4 subsurface sediment and 4 subsurface porewater
WLCT4J98	Port of Portland/Hart Crowser 1999	10/12/98	1	Remedial Investigation Report, Terminal 4, Slip 3 Sediments, Port of Portland	Remedial Investigation	18 subsurface sediment, 44 surface sediment, 2 surface reference sediment
WLCT4K99	Port of Portland	11/18/99	2	Port of Portland T4 - Slip 1 & Berth 401 Sediment Characterization	Dredge	19 surface sediment
WLCT4L93	Port of Portland	12/07/93	1 & 2	T4 Berth 408 Maintenance Dredging	Dredge	3 subsurface sediment
WLCT5K99	Port of Portland	11/22/99	1 & 2	1999, T5, Berths 501, 503 Sediment Characterization Study	Dredge	5 subsurface sediment and 5 subsurface porewater
WLCWCJ95	DEQ	10/19/95	1	Willamette Cove SA	Site Assessment	3 surface sediment samples
WLCWTI00	KHM Environmental Management/TOSCO	09/21/00	1	Revised 60-Inch Storm Sewer Interim Remedial Actions Report, TOSCO	Remedial Action	13 subsurface sediment
WLFL0496	Corps-Portland District	04/18/96	2	Willamette Falls Locks 1996 Flood Deposits Sediment Quality Evaluation	Dredge	4 subsurface sediment
WLLRSH01	Corps-Portland District/Hart Crowser 2001	08/29/01	1 & 2	Willamette River Reference Area Study (Phase I)	Sediment Investigation	9 surface sediment
WLLRSI01	Corps-Portland District/Hart Crowser	09/17/01	1	Willamette River Reference Area Study (Phase II)	Sediment Investigation	3 surface sediment samples for potential reference sites, 5 surface sediment samples for

Table 2. Existing Lower Willamette River Sediment Chemistry Data.

Survey	Source	Field Start Date	Data QA Category	Survey Name	Program Type	Sediment Sample Summary
	2002					grain size and conventionals
WLRPT294	Port of Portland	05/94	1	Terminal 2, Berth 203 Sediment Investigation	Sediment Investigation	1 surface sediment; 2 subsurface
WLR0277	Corps-Portland District/USGS	02/01/77	2	Analyses of Bottom Materials from the Willamette River Portland Harbor	Dredge	8 surface sediment
WLR0388	Corps-Portland District	03/22/88	2	Broadway Bridge Evaluation of Sediment Lead Levels	Dredge	5 surface sediment
WLR0488	Corps-Portland District	03/30/88	1 & 2	Lower Willamette River March & April 1988	Dredge	5 surface sediment, 24 subsurface sediment, and 4 elutriate samples
WLR0499	Corps-Portland District	04/29/99	1 & 2	Willamette River Sediment Quality Evaluation – April	Dredge	11 subsurface sediment and 3 porewater
WLR0577	Corps-Portland District	05/17/77	2	Elutriate Study of Willamette River Bottom Material and Willamette/Columbia River Water	Dredge	1 surface sediment and 4 elutriate samples
WLR0692	Corps-Portland District	06/03/92	1 & 2	Lower Willamette River Portland Harbor 1992	Dredge	6 subsurface sediment
WLR0789	Corps-Portland District	07/19/89	2	Willamette River Burlington Northern RR Bridge Sediment Quality Evaluation	Dredge	5 subsurface sediment
WLR0797	Corps-Portland District	07/22/97	1 & 2	CRCD – Willamette River Channel Deepening	Dredge	18 surface sediment, 17 surface porewater, 50 subsurface sediment, and 1 subsurface porewater
WLR0988	Corps-Portland District	09/07/88	1 & 2	Lower Willamette River Sept 1988	Dredge	8 subsurface sediment

Table 2. Existing Lower Willamette River Sediment Chemistry Data.

Survey	Source	Field Start Date	Data QA Category	Survey Name	Program Type	Sediment Sample Summary
WLR1083	Corps-Portland District	10/01/83	2	Quality of Bottom Materials & Elutriates in the Lower Willamette River Portland Or	Dredge	2 surface sediment, 1 surface elutriate sample, 13 subsurface sediment, and 4 subsurface elutriate samples
WLR1196	Corps-Portland District	11/13/96	1 & 2	Lower Willamette Portland Harbor 1996	Dredge	2 surface sediment, 4 subsurface sediment
WLR1199	Corps-Portland District	11/29/99	1 & 2	Willamette River Sediment Quality Evaluation – November	Dredge	9 subsurface sediment, 7 subsurface porewater, 1 surface sediment
WLRELF99	DEQ	11/23/98	1	ATOFINA Willamette River 1999	Remedial Investigation	15 subsurface sediment, 13 surface sediment
WLRWTF98	DEQ	12/17/98	1	Willbridge Terminal Facility 1998	Remedial Investigation	15 surface sediment
WRD&M98	DEQ/Dames & Moore 1998	01/19/98	1	Willamette River 1998 Data	Sediment Investigation	12 surface sediment
WRSTRM94	U.S. EPA, Region 10/Hartman 1994	07/15/94	1	Characterization of Stormwater Outfalls	Source Control Investigation	25 surface sediment, 4 subsurface sediment
WR-WSI98	EPA/DEQ/Roy F. Weston 1998	09/17/97	1 & 2	Portland Harbor Sediment Investigation	Site Investigation	158 surface sediment, 28 surface porewater, 39 subsurface sediment

* Includes Curtis et al. 1993, Willamette River Toxics Study (DEQ 1994)

Table 3. Existing Lower Willamette River Surface Water Data.

Survey	Source	Begin Date	Data QA Category	Survey Name	Program Type	Water Sample Summary
DEQ – ongoing	DEQ – downloaded from LASAR: www.deq.state.or.us/wq/lasar/lasarhome.htm	Pre-1990	2	Ambient Water Quality Monitoring Program – Laboratory Analytical Storage and Retrieval Database	Monitoring	3 DEQ surface water stations with frequent sampling, including all months and flow conditions.
Anderson et al. 1996	USGS/EPA – downloaded from STORET: www.epa.gov/storet	1992	2	Occurrence of Selected Trace Elements and Organic Compounds and Their Relation to Land Use in The Willamette River Basin, Oregon, 1992-94	Monitoring	1 USGS surface water station in Portland Harbor. Primarily pesticides and herbicides.
Tetra Tech 1992	Tetra Tech/DEQ/EPA – downloaded from STORET: www.epa.gov/storet	1987	2	Willamette River Basin Water Quality Study. Component 2: Review & Summary of Toxic Pollutants in the Willamette River and Major Tributaries	Monitoring	3 DEQ surface water stations in Portland Harbor, metals and conventionals.
USGS ongoing	USGS/EPA – downloaded from STORET and National Water Information System (NWIS): www.waterdata.usgs.gov/nwis	Pre-1990	2	Water Quality Monitoring	Monitoring	1 USGS surface water station in Portland Harbor, sampled 4-12 times per year.
Fuhrer et al. 1996	USGS/EPA – downloaded from STORET: www.epa.gov/storet	1949-1994	2	Water Quality of the Lower Columbia River Basin: Analysis of Current and Historical Water-Quality Data through 1994	Monitoring	1 USGS and 1 DEQ surface water station in Portland Harbor.
WLCMBJ99	DEQ/ Ecology and Environment	10/01/99	1 & 2	McCormick & Baxter Creosoting Company Sediment RD Phase 3	Remedial Investigation	6 site surface water samples
WLCMBI02	DEQ/EPA	09/05/02	1 & 2	Surface Water, Sediment, and Groundwater Sampling Report	Remedial Investigation	20 SPMD, 41 surface water grabs at 20 SPMD locations
WLCRIL99	Port of Portland/Hart Crowser	11/02/99	2	Site Investigation Report, Port of Portland Confined Dredged Disposal, Ross Island Facility	Baseline	8 surface water
WLR0577	Corps-Portland District	05/17/77	2	Elutriate Study of Willamette River Bottom Material and	Dredge	4 surface water

Survey	Source	Begin Date	Data QA Category	Survey Name	Program Type	Water Sample Summary
				Willamette/Columbia River Water		
WLCRPB95	Aventis/Woodward-Clyde Consultants	02/01/95	2	Rhône-Poulenc St Helens Road Facility Q1,95	Remedial Investigation	5 surface water

Table 4. Existing Lower Willamette River Tissue Residue Studies.

Survey	Source	Begin Date	Data QA Category	Survey Name	Program Type	Sample Summary
CRBC8494	EPA, Region 10	Biota:1987-1993, Curtis et al. 1993, DEQ Toxics Study (1988-1991)	2	Columbia River Basin Contaminant Aquatic Biota and Sediment Data (1988-1991)	Monitoring	Various fish species (carp, squawfish, sucker, largemouth bass, cutthroat trout, crayfish, whitefish), whole body, edible tissues, liver) at 4 stations – RM 7, RM 18, Portland Harbor
DEQWQP97	DEQ 1997, Eugene Foster	1997	2	DEQ Mercury in Tissue Study	Monitoring	Various fish species (smallmouth bass, largemouth bass, largescale sucker, carp, squawfish) at 3 stations – RM 7, RM 19, RM 23.8
MBCREOS2	DEQ/PTI 1992	9/91	1 & 2	McCormick & Baxter Cresosoting Company Remedial Investigation	Remedial Investigation	Sucker and crayfish from 6 stations (1 reference)
CLWLTC94	Thomas and Anthony 1997	1994	2	Environmental Contaminants and Breeding Biology of Great Blue Herons in the Columbia River Basin	Monitoring	Great Blue Heron eggs in Lower Willamette River – 2 samples, one in 1994 and one in 1995
ORRORS00	The Oregonian 2000	7/00	2	Oregonian's "River of Risk"	Monitoring	Various fish species at 40 stations
--	Henny et al. 1996	1996	2	A Field Evaluation of Mink and Otter on the Lower Columbia River and the Influence of Environmental Contaminants	Monitoring	River Otter liver samples in Portland-Vancouver area
PGERAP88	Multnomah Co. Library/Hart Crowser 1988	2/88	2	Remedial Action Plan, Station "L" Site, Willamette River Sediments	Remedial Investigation	Sculpin and crayfish at 7 stations
WBWRIR98	USGS	1992	2	Dioxins and Furans in Bed Sediments and Fish Tissue of the Willamette Basin, 1992-1995	Monitoring	3 stations at RM 5, RM 7, RM 13
WLLRSI01	Corps – Portland District/Hart Crowser 2001	09/17/01	1	Willamette River Reference Area Study Phase 2	Monitoring	Bioaccumulation testing

Table 5. Existing Lower Willamette River Bioassay Data.

Survey	Source	Test Date	Data QA Category	Survey Name	Program Type	Bioassay Sample Summary
WLCZDI00	Maul, Foster & Alongi	11/00, 12/00, 01/01	1 & 2	Zidell Waterfront Remedial Investigation		6 surface + 1 ref – amphipod and midge
WLCCIF01	DEQ/Harding ESE 2001	08/01	1	Results of Sediment Sampling and Analysis, Cargill Irving Terminal	Dredge	3 subsurface – amphipod and midge. No reference sediment.
WLCMA01	DEQ/Ecology and Environment 2001	01/01	1	McCormick & Baxter Creosoting Company Sediment RD Phase II	Remedial Investigation	17 subsurface + 1 ref – amphipod and midge
WLCRIL99	Port of Portland/Hart Crowser 2000	12/99	1	Site Investigation Report, Port of Portland Confined Dredged Disposal, Ross Island Facility	Baseline	11 surface +3 ref – amphipod and midge
WLR1199	Corps Portland District 2000	11/99	1	Willamette River Sediment Quality Evaluation – November	Dredge	4 subsurface + 1 ref – amphipod, midge, 28-day bioaccumulation (*Lumbriculus*)
WLCRIV99	RIS&G/Landau 2000	11/99	1	Phase I Remedial Investigation, Ross Island Sand & Gravel Co.	Remedial Investigation	1 surface + 4 ref – amphipod and midge
WLCMBJ99	DEQ/Ecology and Environment 2001	10/99	1	McCormick & Baxter Creosoting Company Sediment RD Phase I	Remedial Investigation	39 surface + 4 ref – amphipod and midge
TOSCO99	DEQ/Exponent 1999	01/99	1	January 1999 Sediment Sampling Results for TOSCO Terminal	Dredge	2 subsurface +1 ref – amphipod and midge
WLCT4J98	Port of Portland/Hart Crowser 1999	10/98, 12/98	1	Remedial Investigation Report, Terminal 4, Slip 3 Sediments, Port of Portland	Remedial Investigation	16 surface + 2 ref in 2 phases – amphipod and midge
PPTLDT24	Port of Portland/Hart Crowser 1999	10/98	1	Sediment Study Marine Terminals 2 and 4	Dredge	3 subsurface +1 ref – amphipod and midge
PSYSEA98	Striplin Environmental Assoc. 1999	10/98	1	Portland Shipyard Sediment Investigation	Sediment Investigation	36 surface + 3 ref – amphipod, midge, Microtox
WRD&M98	DEQ/Dames & Moore 1998	04/98	1	Willamette River 1998 Data	Sediment Investigation	2 surface – amphipod. No reference sediment.

Table 5. Existing Lower Willamette River Bioassay Data.

Survey	Source	Test Date	Data QA Category	Survey Name	Program Type	Bioassay Sample Summary
PSYD&M97	DEQ/Dames & Moore 1997	01/98	1	Portland Shipyard Environmental Audit	Sediment Investigation	5 surface – amphipod. No reference sediment.
WLRPT294	Port of Portland 1994	05/94	1	Sediment Study Terminal 2	Dredge	1 subsurface – amphipod and *Daphnia*. No reference sediment.
MBCREOS1	DEQ/PTI 1992	09/90	1	McCormick & Baxter Creosoting Company RI Phase 1	Remedial Investigation	46 surface + 4 ref – amphipod and Microtox
MBCREOS2	DEQ/PTI 1992	01/92	1	McCormick & Baxter Creosoting Company RI Phase 2	Remedial Investigation	6 surface + 1 ref – amphipod and Microtox
PSYDD4	Port of Portland 1991	12/91	2	Sediment Study Portland Shipyard Dry Dock #4	Dredge	1 subsurface – amphipod, *Daphnia* 48-hr, *Daphnia* 96-hr, rainbow trout. No reference sediment.
WLRWQH92	DEQ 1994	08/88, 01/88	2	Willamette River Toxic Pollutants Summary	Sediment Investigation	6 surface – amphipod, midge, 48-hr *Daphnia* and 14 surface - Microtox (porewater). Lake reference.
NA	Corps Portland District 1988	03/88	2	Willamette River Data	Dredge	4 subsurface – midge, 48-hr *Daphnia* and elutriate using *Daphnia*. No reference sediment.

Notes: Category 2 data were not entered into the project database.

NA – Not Available

Table 6. Existing Lower Willamette River Macroinvertebrate Studies.

Survey	Source	Begin Date	Data QA Category	Survey Name	Program Type	Benthic Sample Summary
WLCRIV99	RIS&G/Landau/Beak	Fall 1999, Spring 2000	1	Ecological Survey: Fall & Spring 2000 Ross Island Sand & Gravel	Remedial Investigation	• 8 shallow nearshore stations, 5 reps each using 0.09 m^2 Surber sampler and sieved through 0.5 mm mesh. • 2 shallow nearshore stations, 3 reps each using 3-in. PVC pipe. 20 cores collected for each rep to duplicate methods used with the Surber sampler. 0.5 mm mesh. • 8 deepwater samples using a 0.3 m^2 power grab. 3, 6-in. PVC cores taken from each side of grab resulting in 2 replicate samples, (i.e., 3 cores = 1 rep). Sample was washed through 1.0 mm mesh.
WRD&M98	DEQ/Dames & Moore	01/98	1	Willamette River 1998 Data	Sediment Investigation	16 stations, 5 reps each using 1 ft^2 clamshell dredge and sieved through 0.5 mm mesh screen.
WLRWQH92	DEQ/Tetra Tech	08/92, 10/93	1	Willamette River Basin Water Quality Study	Sediment Investigation	12 stations sampled in 1992 and again in 1993, 3 reps (pooled into one) using a 0.06 m^2 modified van Veen grab. Samples were washed through a 0.5 mm mesh.

Table 7. Existing Lower Willamette River Biomarker and Histopathology Studies.

Source	Data QA Category	Survey Name	Program Type	Sample Summary
Anderson et al. 1999, Corps 1999	Not Assessed	Integrated Feasibility Report for Channel Improvements and Environmental Impact Statement: Columbia & Lower Willamette River Federal Navigation Channel.	EIS and FS	Cytochrome (CYP1A1) P450 Human Reporter Gene System (HRGS). This study used Benzo(a)pyrene equivalents which are a measure of the CYP1A1-inducing PAHs in river sediment samples.
Curtis et al. 1993	Not Assessed	Sensitivity of Cytochrome P450-1A1 Induction in Fish as a Biomarker for Distribution of TCDD and TCDF in the Willamette River, Oregon	Monitoring	Cytochrome P450-1A1 induction in fish as a biomarker for TCDD and TCDF. Also conducted microscopic examination of carp, cutthroat trout, and northern pikeminnow liver, gills, kidneys, spleen, stomach, and gonads.
Thomas and Anthony 1997	Not Assessed	Environmental Contaminants and Breeding Biology of Great Blue Herons in the Columbia River Basin	Monitoring	Cytochrome P450-1A1 induction in great blue heron embryos as a biomarker for 2,3,7,8-TCDD. Also reported eggshell thinning at the Ross Island heronry.
DEQ Toxics Study 1994 and Tetra Tech 1993, 1995	Not Assessed	Willamette River Toxics Study 1988/1991, Willamette Basin Water Quality Study, Component 9—Willamette River Ecological Systems Investigation Component Report, and Phase II - Ecological Monitoring Component: Assessment of Aquatic Communities and Biological Indices	Monitoring	Pikeminnow and largescale suckers at RM 1, RM 6.5, RM 7. Both studies qualitatively evaluated external and internal features and measured blood parameters using assessment methods developed for salmonids.
PTI 1992	Not Assessed	McCormick & Baxter Creosoting Company RI	Remedial Investigation	249 largescale sucker livers collected from four stations and inspected for abnormalities.
EVS Consultants 2000	Not Assessed	Characterization of Skeletal Deformities in Three Species of Juvenile Fish from the Willamette River Basin	Monitoring	Investigated skeletal abnormalities in 71 chiselmouth at RM 15.
Henny et al. 1996	Not Assessed	A Field Evaluation of Mink and Otter on the Lower Columbia River and the Influence of Environmental Contaminants	Monitoring	In association with tissue residue studies in river otter, external and internal abnormalities were noted in river otters.

7.0 REFERENCES

The references listed below include only those cited in the narrative text in Sections 1 through 6 of this Appendix. The reports/data sources cited in Tables 1 through 7, as well as the additional references listed within Section 5 (Natural Resources) and Section 6 (Cultural and Human Resources), are not repeated here.

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ATTACHMENTS

Attachment F1: Historical Sediment Chemical Data Quality Review
Attachment F2: Historical Water Chemical Data Quality Review
Attachment F3: Historical Tissue Residue Data Quality Review
Attachment F4: Sediment Chemistry Survey Descriptions

Notes: Definition of headings in Attachments F1, F2, and F3 - "Survey CD" is the survey code as assigned in the LWG database. "SedQual Survey Code" is data taken from SEDQUAL database. The "Comments" column contains the recommended QC assignment of data based on fulfillment or nonfulfillment of the data quality performance factors. "Analytical Method" is as noted. "Parameter Group" lists the reported analytes using the specified method(s). "QA Review" - either QA1, QA2 or NA (not available). "DV Survey Code" identifies the document or source for the data review - it may be published or could be (in the case of DMD QA1) as presented/summarized in this "decision matrix". "Matrix" is as specified. "Laboratory" is the analytical lab that performed the analyses. "C-O-C" indicates whether or not a means of determining sample accountability/integrity between the lab and the field is available. "HT's" indicates that sample holding times are able to be determined - they could have been exceeded with consequent assignment of pertinent data qualifier codes, as indicated in the "decision matrix". "Method Blanks", "MS/MSD", "LCS", "Replicates and Surrogate(s)" are evaluated as indicated - blanks indicates that the factor was not evaluated and may not be necessary to establish data quality for the samples/analytes of concern. ?? means that the info is required to establish data quality and is unavailable.

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Comments	Recommend Category Revision (Y/N-comment)	Reason for Category 2 Designation	Analytical Method(s)	Parameter group	QA Review	DV Survey Code
EPA Region 10, Columbia River Basin Contaminant Aquatic Biota and Sediment Data - On-line Database (biota 1987-1993; sediment 1984-1994). Sources include USFWS	CLBC8494		Cat2; no QC data	No	Methods unknown, no COC, no laboratory QC data	??	butyltins, dioxins/furans, metals, PCBs, pesticies, and SVOCs	NA	*(none)*
Sediment Quality (Dioxin/Furan) Evaluation - Lower Columbia & Willamette Rivers (5/90)	COLWIL90	COLWIL90	Cat2	No	No COC or reference to COC procedures; holding conditions unknown	SW846 M.8290	chlorinated dioxins & furans	QA1	*(Lab report - DMD review, 3/02)*
Sediment Quality (Dioxin/Furan) Evaluation - Lower Columbia & Willamette Rivers (5/90)	COLWIL90	COLWIL90	Cat2	No	No COC or reference to COC procedures	Walkley-Black in Methods for Soil Analysis (1965)	TOC	QA1	*(Lab report - DMD review, 3/02)*
Sediment Quality (Dioxin/Furan) Evaluation - Lower Columbia & Willamette Rivers (5/90)	COLWIL90	COLWIL90	Cat2	No	No COC or reference to COC procedures	ASTM EM 1110-2-1906	Grain size & volatile solids	QA1	*(Lab report - DMD review, 3/02)*
McCormick & Baxter Creosoting Company, Remedial Investigation Report, Vol. II of IV (Appendices A-D) by PTI Environmental Services (9/92)	MBCREOS1, MBCREOS2	MBCREOS1, MBCREOS2	Cat 1	Yes - COCs referenced multiple times in DV reports; Labs identified in Volume 1 of RI report		PSEP (1986) & SW846 M.9060	Grain size & TOC	QA1	*PTI (9/92)*
McCormick & Baxter Creosoting Company, Remedial Investigation Report, Vol. II of IV (Appendices A-D) by PTI Environmental Services (9/92)	MBCREOS1, MBCREOS2	MBCREOS1, MBCREOS2	Cat 1	Yes - COCs referenced multiple times in DV reports; Labs identified in Volume 1 of RI report		Barrick et al. 1980 (extraction/gravimetric)	total aliphatic hydrocarbons	QA1	*PTI (9/92)*
McCormick & Baxter Creosoting Company, Remedial Investigation Report, Vol. II of IV (Appendices A-D) by PTI Environmental Services (9/92)	MBCREOS1, MBCREOS2	MBCREOS1, MBCREOS2	Cat 1	Yes - COCs referenced multiple times in DV reports; Labs identified in Volume 1 of RI report		U.S. EPA ??	chlorinated dioxins & furans	QA1	*PTI (9/92)*
McCormick & Baxter Creosoting Company, Remedial Investigation Report, Vol. II of IV (Appendices A-D) by PTI Environmental Services (9/92)	MBCREOS1, MBCREOS2	MBCREOS1, MBCREOS2	Cat 1	Yes - COCs referenced multiple times in DV reports; Labs identified in Volume 1 of RI report		U.S. EPA ??	Chlorin. pesticides & total PCBs	QA1	*PTI (9/92)*
McCormick & Baxter Creosoting Company, Remedial Investigation Report, Vol. II of IV (Appendices A-D) by PTI Environmental Services (9/92)	MBCREOS1, MBCREOS2	MBCREOS1, MBCREOS2	Cat 1	Yes - COCs referenced multiple times in DV reports; Labs identified in Volume 1 of RI report		U.S. EPA ??	Metals	QA1	*PTI (9/92)*
McCormick & Baxter Creosoting Company, Remedial Investigation Report, Vol. II of IV (Appendices A-D) by PTI Environmental Services (9/92)	MBCREOS1, MBCREOS2	MBCREOS1, MBCREOS2	Cat2 (or unusable due to extended holding times and v. low recoveries)	No	Extended holding times and low recovories of MS/MSD and LCS	SW846 M.3060 / 7195 / CLP (ICP)	Cr (VI)	QA1	*PTI (9/92)*
U.S. Moorings 1995 Data	MOOR0595	COEUSM95	Cat2	No	Method unknown	(unreferenced)	Grain size & volatile solids	QA1	USM1995_Convs
U.S. Moorings 1995 Data	MOOR0595	COEUSM95	Cat1	No		EPA 160.3	total solids	QA1	USM1995_Convs
U.S. Moorings 1995 Data	MOOR0595	COEUSM95	Cat1	No		SW846 M.7420; digestion by M.3050	Metals; Pb only	QA1	USM1995_Metals
U.S. Moorings 1995 Data	MOOR0595	COEUSM95	Cat1 (all analytes do not appear to be reported in SedQual)	No		SW846 M.8290	chlorinated dioxins & furans	QA1	USM1995_PCDD_PCDF
U.S. Moorings 1995 Data	MOOR0595	COEUSM95	Cat1	No		SW846 M.8080; extraction by M.3540 (soxhlet)	Chlorinated pesticides only	QA1	USM1995_PestPCB
U.S. Moorings 1995 Data	MOOR0595	COEUSM95	Cat1	No		SW846 M.8270 (SIM); extraction by M.3540 (soxhlet)	PAHs only	QA1	USM1995_SVOCs

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Comments	Recommend Category Revision (Y/N-comment)	Reason for Category 2 Designation	Analytical Method(s)	Parameter group	QA Review	DV Survey Code
U.S. Moorings 1995 Data	MOOR0595	COEUSM95	Cat1; qual. as estimates due to HT exceedances	No		GC/FPD (Krone et al., 1989)	TBT	QA1	USM1995_TBT
U.S. Moorings 1994 Data	MOOR0694	COEUSM94	Cat2	No	Method unknown	(unreferenced)	Grain size & volatile solids	QA1	USM94_Convs
U.S. Moorings 1994 Data	MOOR0694	COEUSM94	Cat 1	Yes - COC found in data package		EPA 160.3 (solids), SW846 M.9030 (t. sulfides), EPA draft 1991 (AVS) & ASTM D4129-82 (TOC)	Conventionals (t. solids, t. sulfides, acid volatile sulfides & TOC)	QA1	USM94_Convs
U.S. Moorings 1994 Data	MOOR0694	COEUSM94	Cat 1	Yes - COC found in data package		EPA 200.8 (As, Cd, Cr, Cu, Pb, Ni, Ag & Zn) & SW846 M.7471 (Hg)	Metals	QA1	USM94_Metals
U.S. Moorings 1994 Data	MOOR0694	COEUSM94	Cat 1	Yes - COC found in data package		SW846 M.8080; extraction by M.3550 (sonication)	Chlorin. pesticides & PCBs (Aroclors)	QA1	USM94_PestPCB
U.S. Moorings 1994 Data	MOOR0694	COEUSM94	Cat 1	Yes - COC found in data package		SW846 M.8270 (SIM); extraction by M.3550 (sonication)	SVOCs	QA1	USM94_SVOCs
U.S. Moorings 1994 Data	MOOR0694	COEUSM94	Cat 1	Yes - COC found in data package		GC/FPD (Krone et al., 1989)	TBT	QA1	USM94_TBT
U.S. Moorings 1994 Data	MOOR0694	COEUSM94	Cat1	No		SW846 M.8290	chlorinated dioxins & furans	QA1	USM94_PCDD_PCDF
Results of 1989 U.S. Moorings Sediment Quality Evaluation	MOOR1089	COEUSM89	Cat 1	Yes - no explicit reference to COC - replicates acceptable		SW846 M.3050 & "atomic absorption"	Metals (Ag, As, Cd, Cr, Cu, Pb, Hg, Ni & Zn)	QA1	*(Lab report - DMD review, 1/02)*
Results of 1989 U.S. Moorings Sediment Quality Evaluation	MOOR1089	COEUSM89	Cat 1	Yes - no explicit reference to COC		(unreferenced)	total sulfides	QA1	*(Lab report - DMD review, 1/02)*
Results of 1989 U.S. Moorings Sediment Quality Evaluation	MOOR1089	COEUSM89	Cat 1	Yes - no explicit reference to COC		SW846 M.8270	SVOCs	QA1	*(Lab report - DMD review, 1/02)*
Results of 1989 U.S. Moorings Sediment Quality Evaluation	MOOR1089	COEUSM89	Cat 1	Yes - no explicit reference to COC		SM 502	TOC	QA1	*(Lab report - DMD review, 1/02)*
Results of 1989 U.S. Moorings Sediment Quality Evaluation	MOOR1089	COEUSM89	Cat 1	Yes - no explicit reference to COC		SW846 M.8080	Chlorin. pesticides & PCBs (Aroclors)	QA1	*(Lab report - DMD review, 1/02)*
Results of 1989 U.S. Moorings Sediment Quality Evaluation	MOOR1089	COEUSM89	Cat 1	Yes - no explicit reference to COC		SW846 M.8290	chlorinated dioxins & furans	QA1	*(Lab report - DMD review, 1/02)*
Results of 1989 U.S. Moorings Sediment Quality Evaluation	MOOR1089	COEUSM89	Cat2	No	No COC; No replicates	ASTM EM1110-2-1906 (sieve/hydrometer)	Grain size & volatile solids	QA1	*(Lab report - DMD review, 1/02)*
U.S. Moorings 12/20/94 Data	MOOR1294	MOOR1294	Cat1 (J qual. As estimates Pb & Zn data)	No		SW846 M. 6010; M.7xxx (As, Pb, Hg, Se)	Metals (Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Tl, Zn)	QA1	*(Lab report - DMD review, 3/02)*
Sediment Characterization Study Marine Terminal 2, Berths 203-206 (3/17/99) AND Terminal 4, Berth 416 (4/20/99) by Hart Crowser	PPTLDT24	PPTLDT24	Cat 1	Yes - Revised to Cat 1		ASTM D4129-82M (TOC), EPA 350.1 (NH3), PSEP 1986 (t.sulfides) & EPA 160.4 (TVS)	conventionals (TOC, NH_3, total sulfides & total volatile solids)	QA1	PTLDBRTH_Convs

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Comments	Recommend Category Revision (Y/N-comment)	Reason for Category 2 Designation	Analytical Method(s)	Parameter group	QA Review	DV Survey Code
Sediment Characterization Study Marine Terminal 2, Berths 203-206 (3/17/99) AND Terminal 4, Berth 416 (4/20/99) by Hart Crowser	PPTLDT24	PPTLDT24	Cat1	No		EPA 200.8 (Sb, As, Cd, Cr, Cu, Pb, Ni, Ag & Zn) & SW846 M.7471 (Hg); digestion: M.3050 & M.7471A	Metals	QA1	PTLDBRTH_Metals
Sediment Characterization Study Marine Terminal 2, Berths 203-206 (3/17/99) AND Terminal 4, Berth 416 (4/20/99) by Hart Crowser	PPTLDT24	PPTLDT24	Cat1	No		SW846 M.8080 (pesticides) & M.8082 (PCBs [Aroclors]); extraction: M.3550	Chlorin. pesticides & PCBs (Aroclors)	QA1	PTLDBRTH_PestPCB
Sediment Characterization Study Marine Terminal 2, Berths 203-206 (3/17/99) AND Terminal 4, Berth 416 (4/20/99) by Hart Crowser	PPTLDT24	PPTLDT24	Cat1; use results from initial analyses.	No		SW846 M.8270 (SIM); extraction by M.3550 (sonication) & M.3540 (soxhlet)	SVOCs	QA1	PTLDBRTH_SVOCs
Sediment Characterization Study Marine Terminal 2, Berths 203-206 (3/17/99) AND Terminal 4, Berth 416 (4/20/99) by Hart Crowser	PPTLDT24	PPTLDT24	Cat1 - require qual. as estimates when any surrogate <50%.	No		GC/FPD (Krone et al., 1989)	TBT	QA1	PTLDBRTH_TBT
Sediment Characterization Study Marine Terminal 2, Berths 203-206 (3/17/99) AND Terminal 4, Berth 416 (4/20/99) by Hart Crowser	PPTLDT24	PPTLDT24	Cat1	No		SW846 M.8260	dichlorobenzenes	QA1	PTLDBRTH_VOCs
Sediment Testing at PSY Berth 311	PSBTH311	PSBTH311	Cat2, no QC data	No	Method unknown, no COC, no replicates, holding time unknown	(unreferenced)	Grain size & volatile solids	QA1	PSY_Berth311_Convs
Sediment Testing at PSY Berth 311	PSBTH311	PSBTH311	Cat1	No		U.S.EPA 160.3, 160.4 & ASTM D422	total & volatile solids, grain size	QA1	PSY_Berth311_Convs
Sediment Testing at PSY Berth 311	PSBTH311	PSBTH311	Cat1	No		SW846 M.8080 / 3540 (soxhlet)	Chlorin. pesticides & PCBs	QA1	PSY_Berth311_Convs
Sediment Testing at PSY Berth 311	PSBTH311	PSBTH311	Cat1	No		SW846 M.8240	VOCs (7 analytes only)	QA1	PSY_Berth311_Convs
Sediment Testing at PSY Berth 311	PSBTH311	PSBTH311	Cat2	No	No COC, holding time unknown, no precision or accuracy documentation from laboratory QC data	SW846 M.8270	SVOCs	QA1	PSY_Berth311_Convs
Sediment Testing at PSY Berth 311	PSBTH311	PSBTH311	Cat2, lack of QC data	No	Method unknown, no COC, holding time unknown, no precision or accuracy documentation from laboratory QC data	(unreferenced)	Metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Ag & Zn)	QA1	PSY_Berth311_Convs
Sediment Testing at PSY Berth 311	PSBTH311	PSBTH311	Cat2, lack of QC data	No	Method unknown, no COC, holding time unknown, no precision or accuracy documentation from laboratory QC data	(unreferenced)	Chlorin. pesticides & PCBs (Aroclors)	QA1	PSY_Berth311_Convs
Sediment Testing at PSY Berth 311	PSBTH311	PSBTH311	Cat2	No	No precision or accuracy documentation from laboratory QC data	SW846 M.8270 (SIM)	PAHs & phenols	QA1	PSY_Berth311_Convs
Sediment Testing at PSY Berth 311	PSBTH311	PSBTH311	Cat2, lack of QC data	No	No COC, holding time unknown, no precision or accuracy documentation from laboratory QC data	SW846 M.8240	VOCs	QA1	PSY_Berth311_Convs

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Comments	Recommend Category Revision (Y/N-comment)	Reason for Category 2 Designation	Analytical Method(s)	Parameter group	QA Review	DV Survey Code
Appendix D: Dames & Moore Data	PSYD&M97, WRD&M98	PSYD&M97, WRD&M98	Cat1	No		PSEP 1986 (AVS), SW846 M.9060 (TOC), ASTM D422 (GS)	acid volatile sulfides, TOC & grain size	QA2	DM_Convs
Appendix D: Dames & Moore Data	PSYD&M97, WRD&M98	PSYD&M97, WRD&M98	Cat1	No		SW846 M.6010A (Cd, Cr, Cu, Fe, Mn, Ni, Ag, Zn, Ti), M.6020 (As, Pb, Sn), M.7471 (Hg)	Metals	QA2	DM_Metals
Appendix D: Dames & Moore Data	PSYD&M97, WRD&M98	PSYD&M97, WRD&M98	Cat1	No		SW846 M.8081; extraction by M.3550 (sonication)	PCBs (Aroclors)	QA2	DM_PestPCB
Appendix D: Dames & Moore Data	PSYD&M97, WRD&M98	PSYD&M97, WRD&M98	Cat1; bis(2-ethylhexyl) & dioctyl phthalates reported in MB and "B" qualified - "U" code.	No		SW846 M.8270 (SIM); extraction by M.3550 (sonication)	6 phthalates & 16 PAHs	QA2	DM_SVOCs
Appendix D: Dames & Moore Data	PSYD&M97, WRD&M98	PSYD&M97, WRD&M98	Cat1	No		GC/FPD after Krone et al. 1989	TBT	QA2	DM_TBT
Appendix D: Dames & Moore Data	PSYD&M97, WRD&M98	PSYD&M97, WRD&M98	Cat1	No		SW846 M.8260	VOCs	QA2	DM_VOCs
Sediment Testing at PSY Dry Dock #3, Post Dredging (Port of Portland) and Sediment Testing at PSY Dry Dock #4, Post Dredging (Port of Portland)	PSYDD3	PSYDD3	Cat1	No		ASTM D422-63 & U.S.EPA 160.3	Grain size & total solids	QA1	PSY_Dry_Dock_Convs
Sediment Testing at PSY Dry Dock #3, Post Dredging (Port of Portland) and Sediment Testing at PSY Dry Dock #4, Post Dredging (Port of Portland)	PSYDD3	PSYDD3	Cat1	No		SW846 M.6010, 7041 (Sb), 7060 (As), 7131 (Cd), 7760 (Ag & 7471 (Hg)	Metals (Sb, As, Cd, Cr, Cu, Pb, Hg, Ni, Ag & Zn)	QA1	PSY_Dry_Dock_Metals
Sediment Testing at PSY Dry Dock #3, Post Dredging (Port of Portland) and Sediment Testing at PSY Dry Dock #4, Post Dredging (Port of Portland)	PSYDD3	PSYDD3	Cat1	No		SW846 M.8080	Chlorin. pesticides & PCBs (Aroclors)	QA1	PSY_Dry_Dock_PestPCB
Sediment Testing at PSY Dry Dock #3, Post Dredging (Port of Portland) and Sediment Testing at PSY Dry Dock #4, Post Dredging (Port of Portland)	PSYDD3	PSYDD3	Cat1	No		SW846 M.8270	SVOCs	QA1	PSY_Dry_Dock_SVOCs
Sediment Testing at PSY Dry Dock #3, Post Dredging (Port of Portland) and Sediment Testing at PSY Dry Dock #4, Post Dredging (Port of Portland)	PSYDD3	PSYDD3	Cat1	No		GC/FPD (Krone et al. 1989)	TBT	QA1	PSY_Dry_Dock_TBT
Sediment Testing at PSY Dry Dock #3, Post Dredging (Port of Portland) and Sediment Testing at PSY Dry Dock #4, Post Dredging (Port of Portland)	PSYDD3	PSYDD3	Cat1	No		SW846 M.8240	VOCs	QA1	PSY_Dry_Dock_VOCs
Sediment Testing at PSY Dry Dock #3, Post Dredging (Port of Portland) and Sediment Testing at PSY Dry Dock #4, Post Dredging (Port of Portland)	PSYDD4	PSYDD4	Cat1	No		ASTM D422-63 & U.S.EPA 160.3	Grain size & total solids	QA1	PSY_Dry_Dock_Convs

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Comments	Recommend Category Revision (Y/N-comment)	Reason for Category 2 Designation	Analytical Method(s)	Parameter group	QA Review	DV Survey Code
Sediment Testing at PSY Dry Dock #3, Post Dredging (Port of Portland) and Sediment Testing at PSY Dry Dock #4, Post Dredging (Port of Portland)	PSYDD4	PSYDD4	Cat1	No		SW846 M.8080 / 3550 (sonication)	Chlorin. pesticides & PCBs (Aroclors)	QA1	PSY_Dry_Dock_PestPCB
Sediment Testing at PSY Dry Dock #3, Post Dredging (Port of Portland) and Sediment Testing at PSY Dry Dock #4, Post Dredging (Port of Portland)	PSYDD4	PSYDD4	Cat1	No		SW846 M.8270 (SIM)	phthalate esters, PAHs & phenols	QA1	PSY_Dry_Dock_SVOCs
Sediment Testing at PSY Dry Dock #3, Post Dredging (Port of Portland) and Sediment Testing at PSY Dry Dock #4, Post Dredging (Port of Portland)	PSYDD4	PSYDD4	Cat1	No		GC/FPD (Krone et al. 1989)	TBT	QA1	PSY_Dry_Dock_TBT
Sediment Testing at PSY Dry Dock #3, Post Dredging (Port of Portland) and Sediment Testing at PSY Dry Dock #4, Post Dredging (Port of Portland)	PSYDD4	PSYDD4	Cat1	No		SW846 M.8240	VOCs (7 analytes only)	QA1	PSY_Dry_Dock_VOCs
Sediment Testing at PSY Dry Dock #3, Post Dredging (Port of Portland) and Sediment Testing at PSY Dry Dock #4, Post Dredging (Port of Portland)	PSYDD4	PSYDD4	Cat2	No	No documentation of accuracy (MS, LCS, Surrogates)	U.S.EPA 200.8 & SW846 M.7471 (Hg)	Metals (Sb, As, Cr, Cu, Pb, Hg, Ni, Ag & Zn)	QA1	PSY_Dry_Dock_Metals
Portland Shipyard Sediment Investigation, Port of Portland and Cascade General, Inc. October 1, 1998.	PSYSEA98	PSYSEA98	Cat1; some results qual. as estimates due to low MS recoveries and high rep. variabilities.	No		EPA 200.8 (Sb, As, Cd, Cr, Cu, Pb, Ni, Ag & Zn), SW846 M.7471A (Hg) & EPA 1991 (AVS [M.6010 & 7470A])	Metals	QA2	PSYSEA_Metals
Portland Shipyard Sediment Investigation, Port of Portland and Cascade General, Inc. October 1, 1998.	PSYSEA98	PSYSEA98	Cat1	No		SW846 M.8081 (chlor. Pest. & PCBs [Aroclors]) & M.8082 (PCBs [Aroclors])	Chlorin. pesticides & PCBs (Aroclors)	QA2	PSYSEA_PestPCB
Portland Shipyard Sediment Investigation, Port of Portland and Cascade General, Inc. October 1, 1998.	PSYSEA98	PSYSEA98	Cat1; some results qual. as estimates due to out of range MS, LCS and surrogate recoveries.	No		SW846 M.8270C (SIM) & M.3550 (sonication)	SVOCs	QA2	PSYSEA_SVOCs
Portland Shipyard Sediment Investigation, Port of Portland and Cascade General, Inc. October 1, 1998.	PSYSEA98	PSYSEA98	Cat1; qual. as estimates when one surrogate shows <50% recovery.	No		GC/FPD (Krone et al., 1989)	TBT	QA2	PSYSEA_TBT
Portland Shipyard Sediment Investigation, Port of Portland and Cascade General, Inc. October 1, 1998.	PSYSEA98	PSYSEA98	Cat1	No		SW846 M.8260	VOCs	QA2	PSYSEA_VOCs
Portland Shipyard Sediment Investigation, Port of Portland and Cascade General, Inc. October 1, 1998.	PSYSEA98	PSYSEA98	Cat1	No		ASTM D4129-82M (TOC), EPA 350.1 (NH_3) & EPA 1991 (AVS)	conventionals (TOC, NH_3 & acid volatile sulfides)	QA1	PSYSEA_Convs
Reidel/Triangle Park 1997 Data	RIEDEL97	RIEDEL97	Cat1	No		ASTM M.4129-82, EPA M.160.3, ASTM M.D-422	Conventionals (TOC, total solids & grain size)	QA1	Reidel_Convs-rev
Reidel/Triangle Park 1997 Data	RIEDEL97	RIEDEL97	Cat1	No		SW846 M.6010A & 7060A (As)	Metals (Cr, Cu, Pb & As)	QA1	Reidel_Metals

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Project Description	SURVEY_CD	SedQual Survey Code	Comments	Recommend Category Revision (Y/N-comment)	Reason for Category 2 Designation	Analytical Method(s)	Parameter group	QA Review	DV Survey Code
Reidel/Triangle Park 1997 Data	RIEDEL97	RIEDEL97	Cat1	No		SW846 M.8270 (SIM) / M.3545 (ASE) & M.3550 (sonication)	PAHs	QA1	Reidel_SVOCs
Reidel/Triangle Park 1997 Data	RIEDEL97	RIEDEL97	Cat1	No		GC/FPD (Krone et al. 1989)	TBT	QA1	Reidel_TBT
TOSCO Willamette TPT Sediment Investigation	TOSCO99	TOSCO99	Cat1	No		SW846 M.9030 (sulfides), EPA 350.1/350.3 (NH_3) & ASTM D422 (GS)	conventionals (total sulfides, NH_3 & grain size)	QA2	TOSCO_Convs1
TOSCO Willamette TPT Sediment Investigation	TOSCO99	TOSCO99	Cat1	No		SW846 M.6010B (Sb, Be, Cd, Cr, Cu, Pb, Ni, Ag & Zn); M.7060A (As); M.7740 (Se); M.7841 (Tl); M.7471A (Hg)	Metals	QA2	TOSCO_Metals1
TOSCO Willamette TPT Sediment Investigation	TOSCO99	TOSCO99	Cat1	No		SW846 M.8082	PCBs (Aroclors)	QA2	TOSCO_PCBs1
TOSCO Willamette TPT Sediment Investigation	TOSCO99	TOSCO99	Cat1	No		SW846 M.8081; extraction by M.3550B (sonication)	Chlorinated pesticides	QA2	TOSCO_Pest1
TOSCO Willamette TPT Sediment Investigation	TOSCO99	TOSCO99	Cat1	No		SW846 M.8270C (SIM); extraction by M.3550B (sonication)	SVOCs	QA2	TOSCO_SVOCs1
USGS Water-Resources Investigations Report 97-4082-D - Dioxins and Furans in Bed Sediment and Fish Tissue of the Willamette Basin, 1992-95	WBWRIR98		Cat2; lack of QC data	No	Method unknown, no COC, holding time unknown, no precision or accuracy documentation from laboratory QC data	SW846 M.8290	chlorinated dioxins & furans	NA	*(none)*
Expanded Preliminary Assessment Data Report - Union Pacific Railroad Albina Yard (11/00) by Jacobs Engineering	WLCAYH00		Cat 1	Yes - Data packages received		NWTPH-Dx	TPH	QA1	*(Lab Report - Integral review)*
Expanded Preliminary Assessment Data Report - Union Pacific Railroad Albina Yard (11/00) by Jacobs Engineering	WLCAYH00		Cat 1	Yes - Data packages received		SW846 M.6010B & 7471A (Hg)	Metals (Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, K, Se, Ag, Na, Tl, V, Zn, Hg)	QA1	*(Lab Report - Integral review)*
Expanded Preliminary Assessment Data Report - Union Pacific Railroad Albina Yard (11/00) by Jacobs Engineering	WLCAYH00		Cat 1	Yes - Data packages received		SW846 M.8270 (SIM)	SVOCs	QA1	*(Lab Report - Integral review)*
Expanded Preliminary Assessment Data Report - Union Pacific Railroad Albina Yard (11/00) by Jacobs Engineering	WLCAYH00		Cat 1	Yes - Data packages received		SW846 8082	PCBs (as Aroclors)	QA1	*(Lab Report - Integral review)*
Expanded Preliminary Assessment Data Report - Union Pacific Railroad Albina Yard (11/00) by Jacobs Engineering	WLCAYH00		Cat 1	Yes - Data packages received		GC/FPD (Krone et al. 1989)	TBT	QA1	*(Lab Report - Integral review)*
Expanded Preliminary Assessment Data Report - Union Pacific Railroad Albina Yard (11/00) by Jacobs Engineering	WLCAYH00		Cat 1	Yes - Data packages received		SW846 M.9060	TOC	QA1	*(Lab Report - Integral review)*

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Comments	Recommend Category Revision (Y/N-comment)	Reason for Category 2 Designation	Analytical Method(s)	Parameter group	QA Review	DV Survey Code
Forensic Geochemical Assessment of Near Shore Sediments - Remedial Investigation Work Plan - Atlantic Richfield/BP Terminal 22T Portland, Oregon October 3, 2002 by SECOR	WLCARI99		Cat 2		Holding time unknown, laboratory QC results referenced in report but not provided for review - *additional information to be provided*	EPA Method 8021B	VOCs	NA	*(none)*
Forensic Geochemical Assessment of Near Shore Sediments - Remedial Investigation Work Plan - Atlantic Richfield/BP Terminal 22T Portland, Oregon October 3, 2002 by SECOR	WLCARI99		Cat 2		Holding time unknown, laboratory QC results referenced in report but not provided for review - *additional information to be provided*	EPA 8270 SIM	PAHs	NA	*(none)*
Forensic Geochemical Assessment of Near Shore Sediments - Remedial Investigation Work Plan - Atlantic Richfield/BP Terminal 22T Portland, Oregon October 3, 2002 by SECOR	WLCARI99		Cat 2		Holding time unknown, laboratory QC results referenced in report but not provided for review - *additional information to be provided*	Plumb 1981, EPA ??, EPA 9060	Grain size, AVS/SEM, TOC	NA	*(none)*
Forensic Geochemical Assessment of Near Shore Sediments - Remedial Investigation Work Plan - Atlantic Richfield/BP Terminal 22T Portland, Oregon October 3, 2002 by SECOR	WLCARI99		Cat 2		Method unknown, holding time unknown, no precision and limited accuracy documentation from laboratory QC data - *additional information to be provided*	Unknown	Metals (Sb, As, Be, Cd, Dr, Du, Pb, Hg, Ni, Se, Ag, Tl, Zn)	NA	*(none)*
Results of Bioassay Analyses - Cargill Irving Elevator Terminal USACE Permit 95-1063 and DSL Permit RP3158 (10/1/01) by Harding ESE, Inc.	WLCCIF01		Cat2 due to no QC data	No	No COC, holding time unknown, no replicates	unreferenced	Grain size	NA	*(none)*
Results of Sediment Sampling & Analysis, Cargill Irving Elevator Terminal (8/3/01) by Harding ESE	WLCCIF01		Cat1	No		PSEP, Plumb & ASTM D422	Conventionals (TOC, total solids, grain size, NH3, & total sulfides)	QA1	*(Lab report - DMD review, 12/01)*
Results of Sediment Sampling & Analysis, Cargill Irving Elevator Terminal (8/3/01) by Harding ESE	WLCCIF01		Cat1	No		U.S. EPA 200.8 & 7471A (Hg)	Metals (Sb, As, Cd, Cr, Cu, Pb, Hg, Ni, Ag & Zn)	QA1	*(Lab report - DMD review, 12/01)*
Results of Sediment Sampling & Analysis, Cargill Irving Elevator Terminal (8/3/01) by Harding ESE	WLCCIF01		Cat1	No		GC/FPD (Krone et al. 1989)	TBT	QA1	*(Lab report - DMD review, 12/01)*
Results of Sediment Sampling & Analysis, Cargill Irving Elevator Terminal (8/3/01) by Harding ESE	WLCCIF01		Cat1, with qualification as indicated.	No		SW846 M.8270C (SIM)	SVOCs	QA1	*(Lab report - DMD review, 12/01)*
Results of Sediment Sampling & Analysis, Cargill Irving Elevator Terminal (8/3/01) by Harding ESE	WLCCIF01		Cat1, with qualification as indicated.	No		SW846 M.8081A / 8082	Chlorin. pesticides & PCBs (Aroclors)	QA1	*(Lab report - DMD review, 12/01)*
Results of Sediment Sampling & Analysis, Cargill Irving Elevator Terminal (8/3/01) by Harding ESE	WLCCIF01		Cat1	No		SW846 M.8260B	VOCs	QA1	*(Lab report - DMD review, 12/01)*
Chevron Willbridge Terminal Dock Sediment Sampling (06/27/01), PNG Environmental	WLCCPF01		Cat1	No		SW846 M.8260B	VOCs	QA1	*(Lab report - SEA review, 04/02)*
Chevron Willbridge Terminal Dock Sediment Sampling (06/27/01), PNG Environmental	WLCCPF01		Cat1	No		SW846 M.8270C	SVOCs		*(Lab report - SEA review, 04/02)*
Chevron Willbridge Terminal Dock Sediment Sampling (06/27/01), PNG Environmental	WLCCPF01		Cat1	No		SW846 M.8270C (SIM)	PAHs	QA1	*(Lab report - SEA review, 04/02)*
Chevron Willbridge Terminal Dock Sediment Sampling (06/27/01), PNG Environmental	WLCCPF01		Cat1	No		SW846 M.8081A	Chlorin. Pesticides	QA1, all data estimate "J" due to CCV non conforman	*(Lab report - SEA review, 04/02)*

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Comments	Recommend Category Revision (Y/N-comment)	Reason for Category 2 Designation	Analytical Method(s)	Parameter group	QA Review	DV Survey Code
Chevron Willbridge Terminal Dock Sediment Sampling (06/27/01), PNG Environmental	WLCCPF01		Cat1	No		SW846 M.8082	PCBs (Aroclors)	QA1	*(Lab report - SEA review, 04/02)*
Chevron Willbridge Terminal Dock Sediment Sampling (06/27/01), PNG Environmental	WLCCPF01		Cat1	No		NWTPH-Dx	diesel & lube oil	QA1	*(Lab report - SEA review, 04/02)*
Chevron Willbridge Terminal Dock Sediment Sampling (06/27/01), PNG Environmental	WLCCPF01		Cat1	No		SW846 M.6020 & 7471 (Hg)	Metals (Sb, As, Cd, Cr, Cu, Pb, Ni, Ag, Zn, Hg)	QA1	*(Lab report - SEA review, 04/02)*
Chevron Willbridge Terminal Dock Sediment Sampling (06/27/01), PNG Environmental	WLCCPF01		Cat1	No		EPA 160.3	Total Solids	QA1	*(Lab report - SEA review, 04/02)*
Chevron Willbridge Terminal Dock Sediment Sampling (06/27/01), PNG Environmental	WLCCPF01		Cat1	No		EPA 160.4	Total Volatile Solids	QA1	*(Lab report - SEA review, 04/02)*
Chevron Willbridge Terminal Dock Sediment Sampling (06/27/01), PNG Environmental	WLCCPF01		Cat1	No		EPA 350.3	Ammonia	QA1	*(Lab report - SEA review, 04/02)*
Chevron Willbridge Terminal Dock Sediment Sampling (06/27/01), PNG Environmental	WLCCPF01		Cat1	No		EPA 9030	Sulfide	QA1	*(Lab report - SEA review, 04/02)*
Polychlorinated Biphenyl and Trace-Metal Concentrations in Columbia River and Willamette Harbor Bottom Sediment (5/2/87) by ACOE/Portland	WLCDRE87		Cat2	No	Method unknown, no COC, holding time unknown, no precision or accuracy documentation from laboratory QC data	Compilation of Previous Studies (see Fuhrer 1989). Methods not reported.	Trace Metals, pesticides/PCBs, SVOCs, grain size, TOC	none	*(Data report - DMD review, 12/01)*
Preliminary Assessment and Dredging Sampling Results, Goldendale Alumina Unloading Facility (3/01) by CH2MHill	WLCGAF00, WLCGAL00		Cat1	No		ASTM D4129-82, 160.3M, 160.4M, 350.1M & PSEP 1986	conventionals (TOC, total solids, total vol. solids, NH_3, & total sulfides)	QA1	*(Lab report - DMD review, 12/01)*
Preliminary Assessment and Dredging Sampling Results, Goldendale Alumina Unloading Facility (3/01) by CH2MHill	WLCGAF00, WLCGAL00		Cat1	No		U.S. EPA 200.8, 6010B (Al) & 7471A (Hg)	Metals (Al, Sb, As, Cd, Cr, Cu, Pb, Ni, Ag, Zn & Hg)	QA1	*(Lab report - DMD review, 12/01)*
Preliminary Assessment and Dredging Sampling Results, Goldendale Alumina Unloading Facility (3/01) by CH2MHill	WLCGAF00, WLCGAL00		Cat1	No		SW846 M.8081A / 8082	Chlorin. pesticides & PCBs (Aroclors)	QA1	*(Lab report - DMD review, 12/01)*
Preliminary Assessment and Dredging Sampling Results, Goldendale Alumina Unloading Facility (3/01) by CH2MHill	WLCGAF00, WLCGAL00		Cat1	No		SW846 M.8260B	VOCs	QA1	*(Lab report - DMD review, 12/01)*
Preliminary Assessment and Dredging Sampling Results, Goldendale Alumina Unloading Facility (3/01) by CH2MHill	WLCGAF00, WLCGAL00		Cat1	No		SW846 M.8270 (SIM)	SVOCs	QA1	*(Lab report - DMD review, 12/01)*
Preliminary Assessment and Dredging Sampling Results, Goldendale Alumina Unloading Facility (3/01) by CH2MHill	WLCGAF00, WLCGAL00		Cat1 (reported in terms of cation conc.)	No		GC/FPD (Krone et al. 1989)	TBT	QA1	*(Lab report - DMD review, 12/01)*
Preliminary Assessment and Dredging Sampling Results, Goldendale Alumina Unloading Facility (3/01) by CH2MHill	WLCGAF00, WLCGAL00		Cat1	No		SW846 M.8270C (SIM)	PAHs	QA1	*(Lab report - DMD review, 12/01)*
Expanded Preliminary Assessment for the Linnton Site (Georgia-Pacific) 8/00 by CH2MHill	WLCGPE00		Cat2; no QC data	No - received laboratory results and case narrative but did not receive laboratory data package - request made for back-up	No COC, holding time unknown, no precision or accuracy documentation from laboratory QC data	SW846 M.8270M (SIM)	PAHs & phenols	NA	*(none)*
Expanded Preliminary Assessment for the Linnton Site (Georgia-Pacific) 8/00 by CH2MHill	WLCGPE00		Cat2; no QC data	No - received laboratory results and case narrative but did not receive laboratory data package - request made for back-up	No COC, holding time unknown, no precision or accuracy documentation from laboratory QC data	NWTPH-Dx	TPH	NA	*(none)*

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Comments	Recommend Category Revision (Y/N-comment)	Reason for Category 2 Designation	Analytical Method(s)	Parameter group	QA Review	DV Survey Code
Expanded Preliminary Assessment for the Linnton Site (Georgia-Pacific) 8/00 by CH2MHill	WLCGPE00		Cat2; no QC data	No - received laboratory results and case narrative but did not receive laboratory data package - request made for back-up	No COC, holding time unknown, no precision or accuracy documentation from laboratory QC data	ASTM E777-81	TOC	NA	*(none)*
Expanded Preliminary Assessment for the Linnton Site (Georgia-Pacific) 8/00 by CH2MHill	WLCGPE00		Cat2; no QC data	No - received laboratory results and case narrative but did not receive laboratory data package - request made for back-up	No COC, holding time unknown, no precision or accuracy documentation from laboratory QC data	SW846 M.6010B, 7471A(Hg)	Metals (Sb, As, Ba, Be, Cd, Cr, Co, Pb, Hg, Ni, Se, V & Zn)	NA	*(none)*
Expanded Preliminary Assessment for the Linnton Site (Georgia-Pacific) 8/00 by CH2MHill	WLCGPE00		Cat2; no QC data	No - received laboratory results and case narrative but did not receive laboratory data package - request made for back-up	No COC, holding time unknown, no precision or accuracy documentation from laboratory QC data	ASTM D422	Grain size	NA	*(none)*
Phase I Remedial Investigation Summary Report & Preliminary Analysis of Soil Data - Volume 2 (10/9/98), Hahn & Assoc.	WLCGSA96		Cat 1	Yes - Laboratory data packages received		"ODEQ" method	TPH-G	NA	*(Lab report - Integral review)*
Phase I Remedial Investigation Summary Report & Preliminary Analysis of Soil Data - Volume 2 (10/9/98), Hahn & Assoc.	WLCGSA96		Cat 1	Yes - Laboratory data packages received		"ODEQ" method / 418.1M	TPH-D	NA	*(Lab report - Integral review)*
Phase I Remedial Investigation Summary Report & Preliminary Analysis of Soil Data - Volume 2 (10/9/98), Hahn & Assoc.	WLCGSA96		Cat 1	Yes - Laboratory data packages received		SW846 M.8270 (SIM)	PAHs	NA	*(Lab report - Integral review)*
Phase I Remedial Investigation Summary Report & Preliminary Analysis of Soil Data - Volume 2 (10/9/98), Hahn & Assoc.	WLCGSA96		Cat 1	Yes - Laboratory data packages received		SW846 M.8020	BTEX	NA	*(Lab report - Integral review)*
Phase I Remedial Investigation Summary Report & Preliminary Analysis of Soil Data - Volume 2 (10/9/98), Hahn & Assoc.	WLCGSA96		Cat 1	Yes - Laboratory data packages received		EPA 415.1	TOC	NA	*(Lab report - Integral review)*
Phase I Remedial Investigation Summary Report & Preliminary Analysis of Soil Data - Volume 2 (10/9/98), Hahn & Assoc.	WLCGSA96		Cat 1	Yes - Laboratory data packages received		SW846 M.6010	Pb only	NA	*(Lab report - Integral review)*
NW Natural "Gasco" Site, Draft Screening Level Nearshore Source Control Evaluation Results Report. July 2001	WLCGSD01		Cat1	No		PSEP (1986; TOC), EPA 160.3 (solids) & EPA 9010B (CN)	conventionals (TOC, total solids & cyanide)	QA2	*(K. Gunderson, 6/01)*
NW Natural "Gasco" Site, Draft Screening Level Nearshore Source Control Evaluation Results Report. July 2001	WLCGSD01		Cat1; some results qual. as estimates due to high variability	No		SW846 M.6020	Metals (As, Cr, Cu, Pb, Ni & Zn)	QA2	*(K. Gunderson, 6/01)*
NW Natural "Gasco" Site, Draft Screening Level Nearshore Source Control Evaluation Results Report. July 2001	WLCGSD01		Cat1	No		SW846 M.8270C (SIM)	PAHs only	QA2	*(K. Gunderson, 6/01)*
NW Natural "Gasco" Site, Draft Screening Level Nearshore Source Control Evaluation Results Report. July 2001	WLCGSD01		Cat1	No		SW846 M.8021B	BTEX	QA2	*(K. Gunderson, 6/01)*
Environmental Site Assessment GATX Terminals Corporation KHM Environmental Management December 1999	WLCGXV99		Cat 1	--		TPH - NW TPH-Gx - Dx and - oil; EPA 8021B for BTEX; EPA 8260B for VOCs	TPH & BTEX & PAHs & VOCs	QA1	*(Lab report - Integral review)*
Environmental Site Assessment GATX Terminals Corporation KHM Environmental Management December 1999	WLCGXV99		Cat 1	--		EPA 6000/7000 for Metals	Metals	QA1	*(Lab report - Integral review)*
Environmental Site Assessment GATX Terminals Corporation KHM Environmental Management December 1999	WLCGXV99		Cat 1	--		EPA 8082/8081A	Pesticides /PCB Aroclors	QA1	*(Lab report - Integral review)*
Environmental Site Assessment GATX Terminals Corporation KHM Environmental Management December 1999	WLCGXV99		Cat 1	--		PSEP, APHA/USEPA	Grain Size, TOC, Ammonia	QA1	*(Lab report - Integral review)*

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Comments	Recommend Category Revision (Y/N-comment)	Reason for Category 2 Designation	Analytical Method(s)	Parameter group	QA Review	DV Survey Code
Environmental Site Assessment GATX Terminals Corporation KHM Environmental Management December 1999	WLCGXV99		Cat 1	--		EPA 8270; EPA 8270-SIM for PAHs	SVOCs	QA1	*(Lab report - Integral review)*
McCormick & Baxter Creosoting Co., Portland; 10/99 & 1/01	WLCMBJ99, WLCMBA01		Cat 1	Yes - Categorization revised to be consistent with other data sets.		EPA 200.9	arsenic	NA	*(Sediment Remedial Design Data Summary Report, Feb. 2001: E&E)*
McCormick & Baxter Creosoting Co., Portland; 10/99 & 1/01	WLCMBJ99, WLCMBA01		Cat1	No		ASTM D422-63	Grain size	NA	*(Sediment Remedial Design Data Summary Report, Feb. 2001: E&E)*
McCormick & Baxter Creosoting Co., Portland; 10/99 & 1/01	WLCMBJ99, WLCMBA01		Cat1	No		SW846 M.8270 (SIM)	PAHs & pentachlorophenol	NA	*(Sediment Remedial Design Data Summary Report, Feb. 2001: E&E)*
McCormick & Baxter Creosoting Co., Portland; 10/99 & 1/01	WLCMBJ99, WLCMBA01		Cat1	No		SW846 M.8290	chlorinated dioxins & furans	NA	*(Sediment Remedial Design Data Summary Report, Feb. 2001: E&E)*
McCormick & Baxter Creosoting Co., Portland; 10/99 & 1/01	WLCMBJ99, WLCMBA01		Cat1	No		ASTM D422	Grain size	NA	*(Sediment Remedial Design Data Summary Report, Feb. 2001: E&E)*
McCormick & Baxter Creosoting Co., Portland; 10/99 & 1/01	WLCMBJ99, WLCMBA01		Cat1	No		SW846 M.8270 (SIM)	PAHs & pentachlorophenol	NA	*(Sediment Remedial Design Data Summary Report, Feb. 2001: E&E)*
February 2002 3 sediment samples collected downstream of two stormwater outfalls adjacent to site	WLCMCB02		Cat 1	No		EPA 6000/7000	Metals (Al, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Hg, Ni, K, Se, Ag, Na, Tl, V, Zn)	QA1	*(Lab report - Integral review)*
February 2002 3 sediment samples collected downstream of two stormwater outfalls adjacent to site	WLCMCB02		Cat 1	No		EPA 8270-M SIM	PAHs	QA1	*(Lab report - Integral review)*
February 2002 3 sediment samples collected downstream of two stormwater outfalls adjacent to site	WLCMCB02		Cat 1	No		PSEP	Organotins	QA1	*(Lab report - Integral review)*
Expanded Preliminary Assessment Data Report - Marine Finance Site, Portland (11/00) by Jacobs Engineering	WLCMFH00		Cat 1	Yes - Received Laboratory Data Packages		NWTPH-Dx	TPH	QA1	*(Lab report - Integral review)*
Expanded Preliminary Assessment Data Report - Marine Finance Site, Portland (11/00) by Jacobs Engineering	WLCMFH00		Cat 1	Yes - Received Laboratory Data Packages		SW846 Method 8082	PCBs (as Aroclors)	QA1	*(Lab report - Integral review)*
Expanded Preliminary Assessment Data Report - Marine Finance Site, Portland (11/00) by Jacobs Engineering	WLCMFH00		Cat 1	Yes - Received Laboratory Data Packages		Krone	TBT	QA1	*(Lab report - Integral review)*
Expanded Preliminary Assessment Data Report - Marine Finance Site, Portland (11/00) by Jacobs Engineering	WLCMFH00		Cat 1	Yes - Received Laboratory Data Packages		ASTM D4129-82M	TOC	QA1	*(Lab report - Integral review)*
Expanded Preliminary Assessment Data Report - Marine Finance Site, Portland (11/00) by Jacobs Engineering	WLCMFH00		Cat 1	Yes - Received Laboratory Data Packages		SW846 6020, 7471	Metals (Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Tl, Zn)	QA1	*(Lab report - Integral review)*
Expanded Preliminary Assessment Data Report - Marine Finance Site, Portland (11/00) by Jacobs Engineering	WLCMFH00		Cat 1	Yes - Received Laboratory Data Packages		EPA 8270 SIM	SVOCs	QA1	*(Lab report - Integral review)*
Lab Data for Phase 1 Data Evaluation & Phase 2 Work Planning for City of Portland Outfall 18	WLCOFH02		Cat 1	--		EPA 8270C	SVOCs	QA1	*(Lab report - Integral review)*
Lab Data for Phase 1 Data Evaluation & Phase 2 Work Planning for City of Portland Outfall 18	WLCOFH02		Cat 1	--		EPA 8151M	Chlorinated Herbicides	QA1	*(Lab report - Integral review)*
Lab Data for Phase 1 Data Evaluation & Phase 2 Work Planning for City of Portland Outfall 18	WLCOFH02		Cat 1	--		EPA 8081	Pesticides	QA1	*(Lab report - Integral review)*
Lab Data for Phase 1 Data Evaluation & Phase 2 Work Planning for City of Portland Outfall 18	WLCOFH02		Cat 1	--		EPA 6010B (Al) and 6020	Metals (Al, Sb, As, Cd, Cr, Cu, Pb, Ni, Se, Ag, Zn)	QA1	*(Lab report - Integral review)*

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Comments	Recommend Category Revision (Y/N-comment)	Reason for Category 2 Designation	Analytical Method(s)	Parameter group	QA Review	DV Survey Code
Lab Data for Phase 1 Data Evaluation & Phase 2 Work Planning for City of Portland Outfall 18	WLCOFH02		Cat 2	No replicates	No replicates	ASTM D422	Grain Size	QA1	*(Lab report - Integral review)*
Lab Data for Phase 1 Data Evaluation & Phase 2 Work Planning for City of Portland Outfall 18	WLCOFH02		Cat 1	--		NWTPH-Dx	TPH	QA1	*(Lab report - Integral review)*
Lab Data for Phase 1 Data Evaluation & Phase 2 Work Planning for City of Portland Outfall 18	WLCOFH02		Cat 1	--		EPA 8082/8081A	PCBs (as Aroclors)	QA1	*(Lab report - Integral review)*
Lab Data for Phase 1 Data Evaluation & Phase 2 Work Planning for City of Portland Outfall 18	WLCOFH02		Cat 2	No lab duplicate or replicates identified in data package	No documentaion of precision	EPA 7471A	Mercury	QA1	*(Lab report - Integral review)*
Lab Data for Phase 1 Data Evaluation & Phase 2 Work Planning for City of Portland Outfall 18	WLCOFH02		Cat 1	--		ASTM E-777	TOC	QA1	*(Lab report - Integral review)*
Lab Data for City of Portland Outfall M-1	WLCOFH02		Cat 1	--		EPA 8270C	SVOCs	QA1	*(Lab report - Integral review)*
Lab Data for City of Portland Outfall M-1	WLCOFH02		Cat 1	--		EPA 8151M	Chlorinated Herbicides	QA1	*(Lab report - Integral review)*
Lab Data for City of Portland Outfall M-1	WLCOFH02		Cat 1	--		EPA 8081	Pesticides	QA1	*(Lab report - Integral review)*
Lab Data for City of Portland Outfall M-1	WLCOFH02		Cat 1	--		EPA 6010B (Al) and 6020	Metals (Al, Sb, As, Cd, Cr, Cu, Pb, Ni, Se, Ag, Zn)	QA1	*(Lab report - Integral review)*
Lab Data for City of Portland Outfall M-1	WLCOFH02		Cat 2	Grain Size data referenced in cover letter but not appended to lab data package.	No COC, holding time unknown, no replicates	ASTM D422-PSEP	Grain Size	QA1	*(Lab report - Integral review)*
Lab Data for City of Portland Outfall M-1	WLCOFH02		Cat 1	--		NWTPH-Dx	TPH	QA1	*(Lab report - Integral*
Lab Data for City of Portland Outfall M-1	WLCOFH02		Cat 1	--		EPA 8082/8081A	PCBs (as Aroclors)	QA1	*(Lab report - Integral*
Lab Data for City of Portland Outfall M-1	WLCOFH02		Cat 1	--		EPA 7471A	Mercury	QA1	*(Lab report - Integral review)*
Lab Data for City of Portland Outfall M-1	WLCOFH02		Cat 1	--		ASTM E-777	TOC	QA1	*(Lab report - Integral*
Pre-Remedial Investigation Field Activities Data Report, Oregon Steel Mills, Inc. 2/01 by Exponent	WLCOSJ00		Cat1	No		SW846 M.8270C (SIM)	SVOCs	QA1	*(Lab report - DMD review, 12/01)*
Pre-Remedial Investigation Field Activities Data Report, Oregon Steel Mills, Inc. 2/01 by Exponent	WLCOSJ00		Cat1	No		SW846 M.8082	PCBs (as Aroclors)	QA1	*(Lab report - DMD review, - 12/01)*
Pre-Remedial Investigation Field Activities Data Report, Oregon Steel Mills, Inc. 2/01 by Exponent	WLCOSJ00		Cat1	No		SW846 M.8015B	TPH	QA1	*(Lab report - DMD review, 12/01)*
Pre-Remedial Investigation Field Activities Data Report, Oregon Steel Mills, Inc. 2/01 by Exponent	WLCOSJ00		Cat1	No		SW846 6010B, 7060A (As), 7740 (Se), 7841 (Tl) &7470A (Hg)	Metals (Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Tl & Zn)	QA1	*(Lab report - DMD review, 12/01)*
Pre-Remedial Investigation Field Activities Data Report, Oregon Steel Mills, Inc. 2/01 by Exponent	WLCOSJ00		Cat1	No		ASTM D4129-82M & PSEP 1986	TOC & grain size	QA1	*(Lab report - DMD review, 12/01)*
Rose Festival Moorage / Front Ave. Seawall - Sediment Sampling & Analysis Report; AGI 7/95	WLCRFE95		Cat 1	Yes - MS/MSD, Replicate, Surrogate Documention Found	Method unknown, no COC, no replicates, holding time unknown	SW846 M.8080; extraction by M.3550	Chlorin Pest. & PCBs (Aroclors)	QA1	*(Lab report - DMD review, 12/01)*
Rose Festival Moorage / Front Ave. Seawall - Sediment Sampling & Analysis Report; AGI 7/95	WLCRFE95		Cat1	No		ASTM D4129-82	TOC	QA1	*(Lab report - DMD review, 12/01)*
Rose Festival Moorage / Front Ave. Seawall - Sediment Sampling & Analysis Report; AGI 7/95	WLCRFE95		Cat1	No		SW846 M.6010A & EPA 200.8 (As, Cr, Cd, Cu, Pb, Ni, Ag, Zn); M.7470 (Hg)	Metals	QA1	*(Lab report - DMD review, 12/01)*
Rose Festival Moorage / Front Ave. Seawall - Sediment Sampling & Analysis Report; AGI 7/95	WLCRFE95		Cat1	No		SW846 M. 8310; extraction by M. 3540 / 3550	PAHs only	QA1	*(Lab report - DMD review, 12/01)*
Rose Festival Moorage / Front Ave. Seawall - Sediment Sampling & Analysis Report; AGI 7/95	WLCRFE95		Cat1	No		GC/FPD & GC/MS (SIM) (Krone et al., 1989)	TBT	QA1	*(Lab report - DMD review, 12/01)*
Rose Festival Moorage / Front Ave. Seawall - Sediment Sampling & Analysis Report; AGI 7/95	WLCRFE95		Cat2	No	Laboratory unknown, no COC, no replicates, holding time unknown	ASTM D422	Grain size	QA1	*(Lab report - DMD review, 12/01)*
Baseline Sediment Characterization In-Water Clear Zone Sampling Results, Ross Island Lagoon (1/24/00) by Landau (P. Stoltz & J. Wilson)	WLCRIJ99		Cat1	No		SW846 M.6020 (Sb, Ag), 200.8 & 7471A (Hg)	Metals (Sb, Ag, As, Cd, Cr, Cu, Pb, Ni, Zn, Hg)	QA1	*EcoChem (1/24/00)*

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Comments	Recommend Category Revision (Y/N-comment)	Reason for Category 2 Designation	Analytical Method(s)	Parameter group	QA Review	DV Survey Code
Baseline Sediment Characterization In-Water Clear Zone Sampling Results, Ross Island Lagoon (1/24/00) by Landau (P. Stoltz & J. Wilson)	WLCRIJ99		Cat1	No		SW846 M.8081A / 8082	Chlorin. pesticides & PCBs (Aroclors)	QA1	*EcoChem (1/24/00)*
Baseline Sediment Characterization In-Water Clear Zone Sampling Results, Ross Island Lagoon (1/24/00) by Landau (P. Stoltz & J. Wilson)	WLCRIJ99		Cat1	No		GC/FPD (Krone et al. 1989)	TBT	QA1	*EcoChem (1/24/00)*
Baseline Sediment Characterization In-Water Clear Zone Sampling Results, Ross Island Lagoon (1/24/00) by Landau (P. Stoltz & J. Wilson)	WLCRIJ99		Cat1	No		SW846 M.8270 (SIM)	SVOCs	QA1	*EcoChem (1/24/00)*
Baseline Sediment Characterization In-Water Clear Zone Sampling Results, Ross Island Lagoon (1/24/00) by Landau (P. Stoltz & J. Wilson)	WLCRIJ99		Cat1	No		PSEP	TOC	QA1	*EcoChem (1/24/00)*
Appendix A: Data Validation Summary and Complied Chemical Laboratory Analytical Data - Ross Island Lagoon, by Hart Crowser	WLCRIL99		Cat 1	Yes - Complete QA reports submitted by Port		U.S.EPA 200.8 & SW846 M.7471A (Hg)	Metals (Sb, As, Cd, Cu, Pb, Ni, Ag, Zn, Hg)	QA1	*Environmental Synectics, Inc.*
Appendix A: Data Validation Summary and Complied Chemical Laboratory Analytical Data - Ross Island Lagoon, by Hart Crowser	WLCRIL99		Cat 1	Yes - Complete QA reports submitted by Port		Krone et al. 1989	TBT	QA1	*Environmental Synectics, Inc.*
Appendix A: Data Validation Summary and Complied Chemical Laboratory Analytical Data - Ross Island Lagoon, by Hart Crowser	WLCRIL99		Cat 1	Yes - Complete QA reports submitted by Port		SW846 M.8270 (SIM)	SVOCs	QA1	*Environmental Synectics, Inc.*
Appendix A: Data Validation Summary and Complied Chemical Laboratory Analytical Data - Ross Island Lagoon, by Hart Crowser	WLCRIL99		Cat 1	Yes - Complete QA reports submitted by Port		SW846 M.8260B	VOCs	QA1	*Environmental Synectics, Inc.*
Appendix A: Data Validation Summary and Complied Chemical Laboratory Analytical Data - Ross Island Lagoon, by Hart Crowser	WLCRIL99		Cat 1	Yes - Complete QA reports submitted by Port		SW846 M.8081	Chlorin. pesticides (DDTs only)	QA1	*Environmental Synectics, Inc.*
Appendix A: Data Validation Summary and Complied Chemical Laboratory Analytical Data - Ross Island Lagoon, by Hart Crowser	WLCRIL99		Cat 1	Yes - Complete QA reports submitted by Port		SW846 M.8082	PCBs (as Aroclors)	QA1	*Environmental Synectics, Inc.*
Appendix A: Data Validation Summary and Complied Chemical Laboratory Analytical Data - Ross Island Lagoon, by Hart Crowser	WLCRIL99		Cat 1	Yes - Complete QA reports submitted by Port		SW846 M.9060	TOC	QA1	*Environmental Synectics, Inc.*
Phase I Remedial Investigation Ross Island Sand & Gravel Co. (3/00) by Landau Assoc.	WLCRIV99		Cat 1	Subsurface Sediment Data Added to Table		ASTM D4129	TOC	QA2	*EcoChem (2/24/00)*
Phase I Remedial Investigation Ross Island Sand & Gravel Co. (3/00) by Landau Assoc.	WLCRIV99		Cat 1	Subsurface Sediment Data Added to Table		SW846 M.8270 (SIM)	SVOCs	QA2	*EcoChem (2/24/00)*
Phase I Remedial Investigation Ross Island Sand & Gravel Co. (3/00) by Landau Assoc.	WLCRIV99		Cat 1	Subsurface Sediment Data Added to Table		SW846 M.8081A / 8082	Chlorin. pesticides & PCBs (Aroclors)	QA2	*EcoChem (2/24/00)*
Phase I Remedial Investigation Ross Island Sand & Gravel Co. (3/00) by Landau Assoc.	WLCRIV99		Cat 1	Subsurface Sediment Data Added to Table		GC/FPD (Krone et al. 1989)	TBT	QA2	*EcoChem (2/24/00)*
Phase I Remedial Investigation Ross Island Sand & Gravel Co. (3/00) by Landau Assoc.	WLCRIV99		Cat 1	Subsurface Sediment Data Added to Table		U.S. EPA 200.8 & 7471A (Hg)	Metals (Sb, As, Cd, Cr, Cu, Pb, Hg, Ni, Ag & Zn)	QA2	*EcoChem (2/24/00)*
Phase I Remedial Investigation Ross Island Sand & Gravel Co. (3/00) by Landau Assoc.	WLCRIV99		Cat1	No		PSEP 1986	Grain size & TOC	QA2	*EcoChem (2/24/00)*
Phase I Remedial Investigation Ross Island Sand & Gravel Co. (3/00) by Landau Assoc.	WLCRIV99		Cat1	No		SW846 M.8270 (SIM)	PAHs	QA2	*EcoChem (2/24/00)*
Phase I Remedial Investigation Ross Island Sand & Gravel Co. (3/00) by Landau Assoc.	WLCRIV99		Cat1	No		SW846 M.8081A / 8082	Chlorin. pesticides & PCBs (Aroclors)	QA2	*EcoChem (2/24/00)*
Phase I Remedial Investigation Ross Island Sand & Gravel Co. (3/00) by Landau Assoc.	WLCRIV99		Cat1	No		GC/FPD (Krone et al. 1989)	TBT	QA2	*EcoChem (2/24/00)*
Phase I Remedial Investigation Ross Island Sand & Gravel Co. (3/00) by Landau Assoc.	WLCRIV99		Cat1	No		U.S. EPA 200.8 & 7471A (Hg)	Metals (Sb, As, Cd, Cr, Cu, Pb, Hg, Ni, Ag & Zn)	QA2	*EcoChem (2/24/00)*
Phase I Remedial Investigation Ross Island Sand & Gravel Co. (3/00) by Landau Assoc.	WLCRIV99		Cat1	No		SW846 M.8260B	VOCs	QA2	*EcoChem (2/24/00)*

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Comments	Recommend Category Revision (Y/N-comment)	Reason for Category 2 Designation	Analytical Method(s)	Parameter group	QA Review	DV Survey Code
RI/FS Quarterly Progress Report, 1st quarter 1995, Surface Water & Sediment, Rhône-Poulenc (6/95) by Woodward-Clyde Consultants	WLCRPB95		Cat 1	Yes - no explicit reference to COC		SW846 M.8010/8020	Halogenated/Aromatic Organics	QA1	*Woodward-Clyde (6/95)*
RI/FS Quarterly Progress Report, 1st quarter 1995, Surface Water & Sediment, Rhône-Poulenc (6/95) by Woodward-Clyde Consultants	WLCRPB95		Cat 1	Yes - no explicit reference to COC		SW846 M.8080	Chlorin. pesticides & PCBs (Aroclors)	QA1	*Woodward-Clyde (6/95)*
RI/FS Quarterly Progress Report, 1st quarter 1995, Surface Water & Sediment, Rhône-Poulenc (6/95) by Woodward-Clyde Consultants	WLCRPB95		Cat 1	Yes - no explicit reference to COC		SW846 M.8140	Phosphate ester pesticides	QA1	*Woodward-Clyde (6/95)*
RI/FS Quarterly Progress Report, 1st quarter 1995, Surface Water & Sediment, Rhône-Poulenc (6/95) by Woodward-Clyde Consultants	WLCRPB95		Cat 1	Yes - no explicit reference to COC		SW846 M.8150	Chlorin. herbicides	QA1	*Woodward-Clyde (6/95)*
RI/FS Quarterly Progress Report, 1st quarter 1995, Surface Water & Sediment, Rhône-Poulenc (6/95) by Woodward-Clyde Consultants	WLCRPB95		Cat 1	Yes - no explicit reference to COC		SW846 M.8290	chlorinated dioxins & furans	QA1	*Woodward-Clyde (6/95)*
RI/FS Quarterly Progress Report, 1st quarter 1995, Surface Water & Sediment, Rhône-Poulenc (6/95) by Woodward-Clyde Consultants	WLCRPB95		Cat 1	Yes - no explicit reference to COC		SW846 M.6010	Metals	QA1	*Woodward-Clyde (6/95)*
RI/FS Quarterly Progress Report, 1st quarter 1995, Surface Water & Sediment, Rhône-Poulenc (6/95) by Woodward-Clyde Consultants	WLCRPB95		Cat 1	Yes - no explicit reference to COC		SW846 M.9060	TOC	QA1	*Woodward-Clyde (6/95)*
RI/FS Quarterly Progress Report, 1st quarter 1995, Surface Water & Sediment, Rhône-Poulenc (6/95) by Woodward-Clyde Consultants	WLCRPB95		Cat 1	Yes - no explicit reference to COC		SW846 M.8270	SVOCs	QA1	*Woodward-Clyde (6/95)*
COE Willamette River Channel Deepening 1997 Data	WLCT0F01		Cat 1	Yes - Laboratory case narrative references accompanying COC		PSEP, U.S.EPA 350.1M, PSEP & 160.4	Conventionals (TOC, NH_3, total sulfides & total vol. solids)	QA1	*Hart Crowser 8/24/01*
Dredge Material Characterization Study; Marine Terminal 2, Berths 203-206; Marine Terminal 5, Berth 501 (8/24/01) by Hart Crowser	WLCT0F01		Cat 1	Yes - Laboratory case narrative references accompanying COC		U.S.EPA 200.8 & SW846 M.7471	Metals (Sb, As, Cd, Cr, Cu, Pb, Ni, Ag, Zn, Hg)	QA1	*Hart Crowser 8/24/01*
Dredge Material Characterization Study; Marine Terminal 2, Berths 203-206; Marine Terminal 5, Berth 501 (8/24/01) by Hart Crowser	WLCT0F01		Cat 1	Yes - Laboratory case narrative references accompanying COC		GC/FPD (Krone et al. 1989)	TBT	QA1	*Hart Crowser 8/24/01*
Dredge Material Characterization Study; Marine Terminal 2, Berths 203-206; Marine Terminal 5, Berth 501 (8/24/01) by Hart Crowser	WLCT0F01		Cat 1	Yes - Laboratory case narrative references accompanying COC		SW846 M.8270 (SIM)	SVOCs	QA1	*Hart Crowser 8/24/01*
Dredge Material Characterization Study; Marine Terminal 2, Berths 203-206; Marine Terminal 5, Berth 501 (8/24/01) by Hart Crowser	WLCT0F01		Cat 1	Yes - Laboratory case narrative references accompanying COC		SW846 M.8081	Chlorin. Pesticides	QA1	*Hart Crowser 8/24/01*
Dredge Material Characterization Study; Marine Terminal 2, Berths 203-206; Marine Terminal 5, Berth 501 (8/24/01) by Hart Crowser	WLCT0F01		Cat 1	Yes - Laboratory case narrative references accompanying COC		SW846 M.8082	PCBs (as Aroclors)	QA1	*Hart Crowser 8/24/01*
Sediment Characterization Study of Local Sponsors' Berths: Columbia & Willamette River prepared by Hart-Crowser	WLCT0I98	PTLDBRTH	Cat 1	Yes - found Method Blank results		ASTM D4129-82M (TOC), EPA 350.1 (NH3), PSEP 1986 (t.sulfides) & EPA 160.4 (TVS)	conventionals (TOC, NH_3, total sulfides & total volatile solids)	QA1	PTLDBRTH_Convs
Port of Portland, Sediment Characterization Study of Local Sponsors' Berths (2/1/99) - Terminal 4, Slip 1 Preliminary Assessment Appendix by Hart Crowser	WLCT0I98		Cat1	No		U.S.EPA 200.8 & SW846 M.7471 (Hg)	Metals (Sb, As, Cd, Cr, Cu, Pb, Hg, Ni, Ag & Zn)	QA1	*Hart Crowser (10/1/99)*
Port of Portland, Sediment Characterization Study of Local Sponsors' Berths (2/1/99) - Terminal 4, Slip 1 Preliminary Assessment Appendix by Hart Crowser	WLCT0I98		Cat1	No		SW846 M.8270 (SIM)	SVOCs	QA1	*Hart Crowser (10/1/99)*

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Comments	Recommend Category Revision (Y/N-comment)	Reason for Category 2 Designation	Analytical Method(s)	Parameter group	QA Review	DV Survey Code
Port of Portland, Sediment Characterization Study of Local Sponsors' Berths (2/1/99) - Terminal 4, Slip 1 Preliminary Assessment Appendix by Hart Crowser	WLCT0I98		Cat1	No		SW846 M.8260B	VOCs	QA1	*Hart Crowser (10/1/99)*
Port of Portland, Sediment Characterization Study of Local Sponsors' Berths (2/1/99) - Terminal 4, Slip 1 Preliminary Assessment Appendix by Hart Crowser	WLCT0I98		Cat1	No		SW846 M.8081 / 8082	Chlorin. pesticides & PCBs (Aroclors)	QA1	*Hart Crowser (10/1/99)*
Port of Portland, Sediment Characterization Study of Local Sponsors' Berths (2/1/99) - Terminal 4, Slip 1 Preliminary Assessment Appendix by Hart Crowser	WLCT0I98		Cat1	No		GC/FPD (Krone et al. 1989)	TBT	QA1	*Hart Crowser (10/1/99)*
Port of Portland, Sediment Characterization Study of Local Sponsors' Berths (2/1/99) - Terminal 4, Slip 1 Preliminary Assessment Appendix by Hart Crowser	WLCT0I98		Cat1	No		ASTM D4129-82M, U.S.EPA 350.1M, PSEP & 160.4M	Conventionals (TOC, NH_3, total sulfides & vol. solids)	QA1	*Hart Crowser (10/1/99)*
Sediment Characterization Study of Local Sponsors' Berths: Columbia & Willamette River prepared by Hart-Crowser	WLCT0I98	PTLDBRTH	Cat1	No		EPA 200.8 (Sb, As, Cd, Cr, Cu, Pb, Ni, Ag & Zn) & SW846 M.7471 (Hg); digestion: M.3050 & M.7471A	Metals	QA1	PTLDBRTH_Metals
Sediment Characterization Study of Local Sponsors' Berths: Columbia & Willamette River prepared by Hart-Crowser	WLCT0I98	PTLDBRTH	Cat1	No		SW846 M.8080 (pesticides) & M.8082 (PCBs [Aroclors]); extraction: M.3550	Chlorin. pesticides & PCBs (Aroclors)	QA1	PTLDBRTH_PestPCB
Sediment Characterization Study of Local Sponsors' Berths: Columbia & Willamette River prepared by Hart-Crowser	WLCT0I98	PTLDBRTH	Cat1; use results from initial analyses.	No		SW846 M.8270 (SIM); extraction by M.3550 (sonication) & M.3540 (soxhlet)	SVOCs	QA1	PTLDBRTH_SVOCs
Sediment Characterization Study of Local Sponsors' Berths: Columbia & Willamette River prepared by Hart-Crowser	WLCT0I98	PTLDBRTH	Cat1 - require qual. as estimates when any surrogate <50%.	No		GC/FPD (Krone et al., 1989)	TBT	QA1	PTLDBRTH_TBT
Sediment Characterization Study of Local Sponsors' Berths: Columbia & Willamette River prepared by Hart-Crowser	WLCT0I98	PTLDBRTH	Cat1	No		SW846 M.8260	dichlorobenzenes	QA1	PTLDBRTH_VOCs
Sediment Characterization Study of Local Sponsors' Berths: Columbia & Willamette River prepared by Hart-Crowser	WLCT0I98	PTLDBRTH	Cat 1	Yes - Revised to Cat 1		ASTM D4129-82M (TOC), EPA 350.1 (NH3), PSEP 1986 (t.sulfides) & EPA 160.4 (TVS)	conventionals (TOC, NH_3, total sulfides & total volatile solids)	QA1	PTLDBRTH_Convs
Sediment Characterization Study, River Terminals 1, 2 and 5, Willamette River (1/14/97) by Hart Crowser	WLCT0K96		Cat1	No		PSEP	Grain size	QA1	*Hart Crowser 1/14/97 / (Lab report - DMD review, 1/02)*
Sediment Characterization Study, River Terminals 1, 2 and 5, Willamette River (1/14/97) by Hart Crowser	WLCT0K96		Cat1	No		U.S.EPA 200.8 & SW846 M.7471 (Hg)	Metals (As, Cd, Cu, Pb, Ni, Ag, Zn, Hg)	QA1	*Hart Crowser 1/14/97 / (Lab report - DMD review, 1/02)*
Sediment Characterization Study, River Terminals 1, 2 and 5, Willamette River (1/14/97) by Hart Crowser	WLCT0K96		Cat1	No		SW846 M.8270 (SIM)	SVOCs	QA1	*Hart Crowser 1/14/97 / (Lab report - DMD review, 1/02)*
Sediment Characterization Study, River Terminals 1, 2 and 5, Willamette River (1/14/97) by Hart Crowser	WLCT0K96		Cat1	No		SW846 M.8080	Chlorin. pesticides & PCBs (Aroclors)	QA1	*Hart Crowser 1/14/97 / (Lab report - DMD review, 1/02)*
Sediment Characterization Study, River Terminals 1, 2 and 5, Willamette River (1/14/97) by Hart Crowser	WLCT0K96		Cat1	No		GC/FPD (Krone et al. 1989)	TBT	QA1	*Hart Crowser 1/14/97 / (Lab report - DMD review, 1/02)*
Sediment Characterization Study, River Terminals 1, 2 and 5, Willamette River (1/14/97) by Hart Crowser	WLCT0K96		Cat1	No		ASTM D4129-82M, U.S.EPA 350.1M & PSEP	Conventionals (TOC, NH_3 & total sulfides)	QA1	*Hart Crowser 1/14/97 / (Lab report - DMD review, 1/02)*
Marine Terminal 1 Baseline Investigation, Final Report (8/25/00) by Striplin Environmental	WLCT1F00		Cat1	No		ASTM D4129M, PSEP/9030M & PSEP	Conventionals (TOC, total sulfides & grain size)	QA1	*SEA (8/00)*
Marine Terminal 1 Baseline Investigation, Final Report (8/25/00) by Striplin Environmental	WLCT1F00		Cat1	No		U.S.EPA 200.8 & SW846 M.7471 (Hg)	Metals (Sb, As, Cd, Cr, Cu, Pb, Hg, Ni, Ag & Zn)	QA1	*SEA (8/00)*
Marine Terminal 1 Baseline Investigation, Final Report (8/25/00) by Striplin Environmental	WLCT1F00		Cat1	No		GC/FPD (Krone et al. 1989)	TBT	QA1	*SEA (8/00)*
Marine Terminal 1 Baseline Investigation, Final Report (8/25/00) by Striplin Environmental	WLCT1F00		Cat1	No		SW846 M.8081	Chlorin. pesticides	QA1	*SEA (8/00)*

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Comments	Recommend Category Revision (Y/N-comment)	Reason for Category 2 Designation	Analytical Method(s)	Parameter group	QA Review	DV Survey Code
Marine Terminal 1 Baseline Investigation, Final Report (8/25/00) by Striplin Environmental	WLCT1F00		Cat1	No		SW846 M.8082	PCBs (as Aroclors)	QA1	*SEA (8/00)*
Marine Terminal 1 Baseline Investigation, Final Report (8/25/00) by Striplin Environmental	WLCT1F00		Cat1	No		SW846 M.8270 (SIM)	SVOCs	QA1	*SEA (8/00)*
Marine Terminal 1 Baseline Investigation, Final Report (8/25/00) by Striplin Environmental	WLCT1F00		Cat1	No		SW846 M.8260	VOCs	QA1	*SEA (8/00)*
Port of Portland Terminal 1, Berth 104, 1992 Sediment Characterization	WLCT1L91		Cat2	No	No replicates	ASTM D422(M)	Grain size	QA1	*(Lab report - DMD review, 1/02)*
Port of Portland Terminal 1, Berth 104, 1992 Sediment Characterization	WLCT1L91		Cat 1	Yes - COC referenced in data package		SW846 M.8080	Chlorin. pesticides & PCBs (Aroclors)	QA1	*(Lab report - DMD review, 1/02)*
Port of Portland Terminal 1, Berth 104, 1992 Sediment Characterization	WLCT1L91		Cat 1	Yes - COC referenced in data package		SW846 M.8270 (SIM)	SVOCs	QA1	*(Lab report - DMD review, 1/02)*
Port of Portland Terminal 1, Berth 104, 1992 Sediment Characterization	WLCT1L91		Cat 1	Yes - COC referenced in data package		SW846 M.8260B	VOCs (TCE, PCE, ethylbenzene, xylenes, dichlorobenzenes)	QA1	*(Lab report - DMD review, 1/02)*
Sediment Characterization Study - Terminal 4, Berth 416 Willamette River (3/10/98) by Hart Crowser	WLCT4J97		Cat2; no QC data	No	Laboratory unknown, no COC, no replicates, holding time unknown	unreferenced	Grain size	QA1	*Hart Crowser (3/10/98)*
Sediment Characterization Study - Terminal 4, Berth 416 Willamette River (3/10/98) by Hart Crowser	WLCT4J97		Cat 1	Yes - no explicit reference to COC		SW846 M.9060, U.S.EPA 350.3, PSEP & 160.4	Conventionals (TOC, NH_3, total sulfides & total vol. solids)	QA1	*Hart Crowser (3/10/98)*
Sediment Characterization Study - Terminal 4, Berth 416 Willamette River (3/10/98) by Hart Crowser	WLCT4J97		Cat 1	Yes - no explicit reference to COC		Sw846 M.6010 & 7471 (Hg)	Metals (Sb, As, Cd, Cu, Pb, Ni, Ag, Zn, Hg)	QA1	*Hart Crowser (3/10/98)*
Sediment Characterization Study - Terminal 4, Berth 416 Willamette River (3/10/98) by Hart Crowser	WLCT4J97		Cat 1	Yes - no explicit reference to COC		GC/FPD (Krone et al. 1989)	TBT	QA1	*Hart Crowser (3/10/98)*
Sediment Characterization Study - Terminal 4, Berth 416 Willamette River (3/10/98) by Hart Crowser	WLCT4J97		Cat 1	Yes - no explicit reference to COC		SW846 M.8081	Chlorin. pesticides & PCBs (Aroclors)	QA1	*Hart Crowser (3/10/98)*
Sediment Characterization Study - Terminal 4, Berth 416 Willamette River (3/10/98) by Hart Crowser	WLCT4J97		Cat 1	Yes - no explicit reference to COC		SW846 M.8270 (SIM)	SVOCs	QA1	*Hart Crowser (3/10/98)*
1998 Terminal 4, Slip 3 Sediment Investigation, Port of Portland	WLCT4J98	HC-10-98	Cat1	No		PSEP 1986 (sulfides), EPA 350.1 (NH_3) & ASTM D4129-82 (TOC)	conventionals (total sulfides, NH_3 & TOC)	QA1	POP_Convs_DV
1998 Terminal 4, Slip 3 Sediment Investigation, Port of Portland	WLCT4J98	HC-10-98	Cat1	No		NWTPH-Dx	diesel & lube oil	QA1	POP_HC_DV
1998 Terminal 4, Slip 3 Sediment Investigation, Port of Portland	WLCT4J98	HC-10-98	Cat1; selected results qual. as estimates due to low MS and LCS recoveries.	No		EPA 200.8 & SW846 M.7471A (Hg)	Metals	QA1	POP_Metals_DV
1998 Terminal 4, Slip 3 Sediment Investigation, Port of Portland	WLCT4J98	HC-10-98	Cat1; all results qual. as estimates due to HT exceedances.	No		SW846 M.8081A	Chlorinated pesticides	QA1	POP_Pest_DV
1998 Terminal 4, Slip 3 Sediment Investigation, Port of Portland	WLCT4J98	HC-10-98	Cat1; phenolics qual. as estimates due to low recoveries.	No		SW846 M.8270C	SVOCs	QA1	POP_SVOC_DV
1998 Terminal 4, Slip 3 Sediment Investigation, Port of Portland	WLCT4J98	HC-10-98	Cat1	No		SW846 M.8260B	VOCs (benzene, Cl_3ethene, toluene, Cl_4ethene, ethylbenzene, xylenes, Cl_2benzenes)	QA1	POP_VOC_DV
Terminal 4 - Slip 1 and Berth 401 Sediment Characterization Study (5/31/00) by Hart Crowser	WLCT4K99	PPTLDSL1	Cat2 (no QC data presented, only results)	No	Laboratory unknown, method unknown, no COC, holding time unknown, no precision or accuracy documentation from laboratory QC data	unknown	Metals (Sb, As, Cd, Cr, Cu, Pb, Ni, Ag & Zn), TOC, Chlorin. Pesticides/PCBs (Aroclors) & SVOCs	NA	*(none)*
Terminal 4 Berth 408 Dredging Sediment Quality (1/19/94) by Port of Portland	WLCT4L93		Cat1	No		GC/FPD (Krone et al. 1989)	TBT	QA1	*(Lab report - DMD review, 1/02)*

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Project Description	SURVEY_CD	SedQual Survey Code	Comments	Recommend Category Revision (Y/N-comment)	Reason for Category 2 Designation	Analytical Method(s)	Parameter group	QA Review	DV Survey Code
Terminal 4 Berth 408 Dredging Sediment Quality (1/19/94) by Port of Portland	WLCT4L93		Cat1	No		ASTM D422(M)	Grain size	QA1	*(Lab report - DMD review, 1/02)*
Terminal 4 Berth 408 Dredging Sediment Quality (1/19/94) by Port of Portland	WLCT4L93		Cat1	No		SW846 M.8080	Chlorin. pesticides & PCBs (Aroclors)	QA1	*(Lab report - DMD review, 1/02)*
Terminal 4 Berth 408 Dredging Sediment Quality (1/19/94) by Port of Portland	WLCT4L93		Cat1	No		SW846 M.8240	VOCs (TCE, PCE, ethylbenzene, xylenes, dichlorobenzenes)	QA1	*(Lab report - DMD review, 1/02)*
Terminal 4 Berth 408 Dredging Sediment Quality (1/19/94) by Port of Portland	WLCT4L93		Cat1 with qualification of data as indicated.	No		SW846 M.8270 (SIM)	SVOCs	QA1	*(Lab report - DMD review, 1/02)*
Terminal 4 Berth 408 Dredging Sediment Quality (1/19/94) by Port of Portland	WLCT4L93		Cat2 (minimal QC data presented)	No	No precision or accuracy documentation from laboratory QC data	U.S.EPA 200.8, SW846 M.6010 (Cr, Cu, Zn) & SW846 M.7471 (Hg)	Metals (Sb, As, Cd,Pb, Ni, Ag, Cr, Cu, Zn, Hg)	QA1	*(Lab report - DMD review, 1/02)*
Sediment Characterization at Marine Terminal 5, Barge Berth 501 and Berth 503 (2/1/00) by Hart Crowser	WLCT5K99		Cat2 (no QC data presented, only results)	No	No replicates	unreferenced	Grain size	NA	*Hart Crowser (2/1/00)*
Sediment Characterization at Marine Terminal 5, Barge Berth 501 and Berth 503 (2/1/00) by Hart	WLCT5K99		Cat1	No		SW846 M.6020 & 7471 (Hg)	Metals (Sb, As, Cd, Cr, Cu, Pb, Ni, Ag, Zn, Hg)	QA1	*Hart Crowser (2/1/00)*
Sediment Characterization at Marine Terminal 5, Barge Berth 501 and Berth 503 (2/1/00) by Hart	WLCT5K99		Cat1	No		SW846 M.8270(SIM)	SVOCs	QA1	*Hart Crowser (2/1/00)*
Sediment Characterization at Marine Terminal 5, Barge Berth 501 and Berth 503 (2/1/00) by Hart	WLCT5K99		Cat1	No		SW846 M.8080A	Chlorin. pesticides & PCBs (Aroclors)	QA1	*Hart Crowser (2/1/00)*
Sediment Characterization at Marine Terminal 5, Barge Berth 501 and Berth 503 (2/1/00) by Hart	WLCT5K99		Cat1	No		GC/FPD (Krone et al. 1989)	TBT	QA1	*Hart Crowser (2/1/00)*
Sediment Characterization at Marine Terminal 5, Barge Berth 501 and Berth 503 (2/1/00) by Hart Crowser	WLCT5K99		Cat1 (qual. sulfides)	No		ASTM D4129-82M, U.S.EPA 350.1M, PSEP & 160.4M	Conventionals (TOC, NH_3, total sulfides & vol. solids)	QA1	*Hart Crowser (2/1/00)*
Oregon Department of Environmental Quality. DEQ Site Assessment, Willamette Cove	WLCWCJ95	WILLCOVE	Cat1	No		SW846 M.6010A (Sb, Be, Cd, Cr, Cu, Ni, Ag & Zn); M.7060 (As); M.7421 (Pb); M.7740 (Se); M.7841 (Tl); M.7471 (Hg); digestion via M.3050 & M.7471A	Metals	QA1	WillCove_Metals
Oregon Department of Environmental Quality. DEQ Site Assessment, Willamette Cove	WLCWCJ95	WILLCOVE	Cat1	No		SW846 M.8080; extraction by M.3540 (soxhlet)	PCBs (as Aroclors) only	QA1	WillCove_PestPCB
Oregon Department of Environmental Quality. DEQ Site Assessment, Willamette Cove	WLCWCJ95	WILLCOVE	Cat1	No		SW846 M.8270; M.8310 (PAHs); M.8150A (chl. phenols); extraction by M.3540 & M.3550	SVOCs	QA1	WillCove_SVOCs
Oregon Department of Environmental Quality. DEQ Site Assessment, Willamette Cove	WLCWCJ95	WILLCOVE	Cat1	No		GC/FPD (Krone et al., 1989)	TBT	QA1	WillCove_TBT
Oregon Department of Environmental Quality. DEQ Site Assessment, Willamette Cove	WLCWCJ95	WILLCOVE	Cat1	No		SW846 M.8260	VOCs	QA1	WillCove_VOCs
Revised 60-inch Storm Sewer Interim Remedial Actions Report Tosco Willbridge Terminal by KHM Environmental Management Inc.	WLCWTI00		Cat 1			NWTPH - Dx, -D, -HCID	TPH	QA1	*(Lab report - Integral review)*
Revised 60-inch Storm Sewer Interim Remedial Actions Report Tosco Willbridge Terminal by KHM Environmental Management Inc.	WLCWTI00		Cat 1			EPA SW846 6020, 6010A, 7471A	RCRA Metals (As, Ba, Cd, Cr, Pb, Hg, Se, Ag)	QA1	*(Lab report - Integral review)*
Revised 60-inch Storm Sewer Interim Remedial Actions Report Tosco Willbridge Terminal by KHM Environmental Management Inc.	WLCWTI00		Cat 1			EPA SW846 8260B	VOCs	QA1	*(Lab report - Integral review)*

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Comments	Recommend Category Revision (Y/N-comment)	Reason for Category 2 Designation	Analytical Method(s)	Parameter group	QA Review	DV Survey Code
USACE Willamette Falls Lock Sediment Investigation 1996 Event	WLFL0496	WLFL96	Cat2; no analysis dates, COC, replication or referenced methods	No	Method unknown, no COC, no replicates	(unreferenced)	Grain size (particle size)	QA1	Convs_WFL
USACE Willamette Falls Lock Sediment Investigation 1996 Event	WLFL0496	WLFL96	Cat2; lack of documentation and QC data.	No	No COC, no precision of accuracy documentation from laboratory QC data	SW846 M.6010 (As, Cd, Cr, Cu, Pb, Ni, Ag, Zn), M.7471 (Hg)	Metals	QA1	Metals_WFL
USACE Willamette Falls Lock Sediment Investigation 1996 Event	WLFL0496	WLFL96	Cat2	No	No COC, no precision of accuracy documentation from laboratory QC data	SW846 M.8270C (PAHs by SIM, others via full-scan) & M.3550 (ultrasonic)	SVOCs	QA1	SVOCs_WFL
Willamette River Reference Area Study - Phase I Results and Recommendations for Phase II Sampling Locations (9/01) by Hart-Crowser	WLLRSH01		Cat2; no QC data	No	No COC, no replicates	ASTM D422 Modified	Grain size	QA1	*(Lab report - DMD review, 12/01)*
Willamette River Reference Area Study - Phase I Results and Recommendations for Phase II Sampling Locations (9/01) by Hart-Crowser	WLLRSH01		Cat1	No		SW846 M.8015M	TPH	QA1	*(Lab report - DMD review, 12/01)*
Willamette River Reference Area Study - Phase I Results and Recommendations for Phase II Sampling Locations (9/01) by Hart-Crowser	WLLRSH01		Cat1	No		SW846 M.8081A / 8082	Chlorin. pesticides & PCBs (Aroclors)	QA1	*(Lab report - DMD review, 12/01)*
Phase I & II Lower Willamette River Reference Area Study USACOE - Hart Crowser, Inc.	WLLRSI01		Cat 1	Yes - Validation report acceptable (previously DV report noted as very brief).		Krone	TBT	QA2	*(Appendix C SEA review 04/02)*
Phase I & II Lower Willamette River Reference Area Study USACOE - Hart Crowser, Inc.	WLLRSI01		Cat1	No		SW846 M.8270C	SVOCs	QA1	*(Appendix C SEA review 04/02)*
Phase I & II Lower Willamette River Reference Area Study USACOE - Hart Crowser, Inc.	WLLRSI01		Cat1	No		SW846 M.8081A	Chlorin. Pesticides	QA1	*(Appendix C SEA review 04/02)*
Phase I & II Lower Willamette River Reference Area Study USACOE - Hart Crowser, Inc.	WLLRSI01		Cat1	No		SW846 M.8082	PCBs (Aroclors)	QA1	*(Appendix C SEA review 04/02)*
Phase I & II Lower Willamette River Reference Area Study USACOE - Hart Crowser, Inc.	WLLRSI01		Cat1	No		SW846 M.8270C (SIM)	PAHs	QA1	*(Appendix C SEA review 04/02)*
Phase I & II Lower Willamette River Reference Area Study USACOE - Hart Crowser, Inc.	WLLRSI01		Cat1	No		SW846 M.200.8 & 7470 (Hg)	Metals (Sb, As, Cd, Cr, Cu, Ni, Ag, Zn, Hg)	QA1	*(Appendix C SEA review 04/02)*
Phase I & II Lower Willamette River Reference Area Study USACOE - Hart Crowser, Inc.	WLLRSI01		Cat1	No		ASTM D4129-82M	Total Organic Carbon	QA1	*(Appendix C SEA review 04/02)*
Phase I & II Lower Willamette River Reference Area Study USACOE - Hart Crowser, Inc.	WLLRSI01		Cat1	No		EPA 160.4M	Total Volatile Solids	QA1	*(Appendix C SEA review 04/02)*
Phase I & II Lower Willamette River Reference Area Study USACOE - Hart Crowser, Inc.	WLLRSI01		Cat1	No		EPA 160.3M	Total Solids	QA1	*(Appendix C SEA review 04/02)*
Analyses of Bottom Material from the Willamette River (1977) by McKenzie/USGS	WLR0277		Cat2 (no QC data presented, only results)	No	Method unknown, no COC, holding time unknown, no precision or accuracy documentation from laboratory QC data	unreferenced	Metals (As, Cd, Cr, Co, Cu, Fe, Pb, Mn, Hg, Ni, Se, Zn)	NA	*(none)*
Analyses of Bottom Material from the Willamette River (1977) by McKenzie/USGS	WLR0277		Cat2 (no QC data presented, only results)	No	No COC, holding time unknown, no precision or accuracy documentation from laboratory QC data	USGS methods	nutrients & TOC (P, Kjeldahl N, NO_3, NO_2, NH_3)	NA	*(none)*
Analyses of Bottom Material from the Willamette River (1977) by McKenzie/USGS	WLR0277		Cat2 (no QC data presented, only results - nondetects reported as "zero")	No	No COC, holding time unknown, no precision or accuracy documentation from laboratory QC data	USGS methods	Organics (chlorin. Pesticides, total PCBs, phosphate ester & carbamate pesticides)	NA	*(none)*
Evaluation of Sediment Lead (Pb) Levels, Corps Operations Dredging at Broadway Bridge, lower Willamette River (6/30/88) by ACOE/Portland	WLR0388		Cat2 (no QC data presented, only results - limited lab data report)	No	Method unknown, no COC, holding time unknown, no precision or accuracy documentation from laboratory QC data	unknown	Pb only	NA	*(none)*

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Comments	Recommend Category Revision (Y/N-comment)	Reason for Category 2 Designation	Analytical Method(s)	Parameter group	QA Review	DV Survey Code
USACE Lower Willamette River, 1986, 1988 (2 events) and 1992 Sampling Events	WLR0488, WLR0988, WLR0692, MCAL0986 & MCAL1286	WLR0388, WLR0988, WLR0692, WLMD0986 & WLMD1286	Cat2; lack of documentation and QC data.	No	COC and holding time documentation available only for selected results; precision and accuracy documentation available for selected results	12/86: Bloom & Crecelius (1983)(Hg), Crecelius (1978)(As), Bloom & Crecelius (1984)(Cu, Pb, Cd), unspecified methods (Zn & Cr). 3/88 & 9/88: unspecified methods. 12/92: SW846 M.7060 (As), M.7131 (Cd), M.6010 (Cr, Cu, Zn), M.7421 (Pb), M.7471 (Hg), EPA 249.2 (Ni).	Metals	QA1	Metals_LWR
USACE Lower Willamette River, 1986, 1988 (2 events) and 1992 Sampling Events	WLR0488, WLR0988, WLR0692, MCAL0986 & MCAL1286	WLR0388, WLR0988, WLR0692, WLMD0986 & WLMD1286	Cat2	No	Method unknown, no COC, holding time unknown, no precision or accuracy documentation from laboratory QC data	(unreferenced)	Chlorin. pesticides & PCBs (Aroclors)	QA1	Pest_PCB_LWR
USACE Lower Willamette River, 1986, 1988 (2 events) and 1992 Sampling Events	WLR0488, WLR0988, WLR0692, MCAL0986 & MCAL1286	WLR0388, WLR0988, WLR0692, WLMD0986 & WLMD1286	Cat2	No	Method unknown, holding time unknown, no precision and limited accuracy documentation from laboratory QC data	(unreferenced)	SVOCs	QA1	SVOCs_LWR
USACE Lower Willamette River, 1986, 1988 (2 events) and 1992 Sampling Events	WLR0488, WLR0988, WLR0692, MCAL0986 & MCAL1286	WLR0388, WLR0988, WLR0692, WLMD0986 & WLMD1286	Cat 1	Yes - Revised to Cat 1 - MSDs provide precision information		SW846 M.8080	Chlorin. pesticides & PCBs (Aroclors)	QA1	Pest_PCB_LWR
USACE Lower Willamette River, 1986, 1988 (2 events) and 1992 Sampling Events	WLR0488, WLR0988, WLR0692, MCAL0986 & MCAL1286	WLR0388, WLR0988, WLR0692, WLMD0986 & WLMD1286	Cat2	No	Holding time unknown, no precision and limited accuracy documentation from laboratory QC data	SW846 M.8080	Chlorin. pesticides & PCBs (Aroclors)	QA1	Pest_PCB_LWR
USACE Lower Willamette River, 1986, 1988 (2 events) and 1992 Sampling Events	WLR0488, WLR0988, WLR0692, MCAL0986 & MCAL1286	WLR0388, WLR0988, WLR0692, WLMD0986 & WLMD1286	Cat2	No	Method unknown, no COC, holding time unknown, no precision and limited accuracy documentation from laboratory QC data	(unreferenced)	Chlorin. pesticides & PCBs (Aroclors)	QA1	Pest_PCB_LWR
USACE Lower Willamette River, 1986, 1988 (2 events) and 1992 Sampling Events	WLR0488, WLR0988, WLR0692, MCAL0986 & MCAL1286	WLR0388, WLR0988, WLR0692, WLMD0986 & WLMD1286	Cat2	No	Method unknown, holding time unknown, no precision and limited accuracy documentation from laboratory QC data	(unreferenced)	SVOCs	QA1	SVOCs_LWR
USACE Lower Willamette River, 1986, 1988 (2 events) and 1992 Sampling Events	WLR0488, WLR0988, WLR0692, MCAL0986 & MCAL1286	WLR0388, WLR0988, WLR0692, WLMD0986 & WLMD1286	Cat2; no analysis dates, COC, replication or referenced methods. General lack of documentation.	No	No COC, holding time unknown, limited replicate documentation	(unreferenced for GS; assumed to be ASTM) ASTM EM1110-2-1906 for oil & grease	Grain size, volatile solids & oil&grease	QA1	Convs_LWR
USACE Lower Willamette River, 1986, 1988 (2 events) and 1992 Sampling Events	WLR0488, WLR0988, WLR0692, MCAL0986 & MCAL1286	WLR0388, WLR0988, WLR0692, WLMD0986 & WLMD1286	Cat2; general lack of documentation.	No	Method unknown, no COC, holding time unknown, limited replicate documentation	(unreferenced)	TOC	QA1	Convs_LWR
USACE Lower Willamette River, 1986, 1988 (2 events) and 1992 Sampling Events	WLR0488, WLR0988, WLR0692, MCAL0986 & MCAL1286	WLR0388, WLR0988, WLR0692, WLMD0986 & WLMD1286	Cat2; general lack of documentation.	No	Method unknown, no COC, holding time unknown, no replicates	(unreferenced)	TOC	QA1	Convs_LWR
USACE Lower Willamette River, 1986, 1988 (2 events) and 1992 Sampling Events	WLR0488, WLR0988, WLR0692, MCAL0986 & MCAL1286	WLR0388, WLR0988, WLR0692, WLMD0986 & WLMD1286	Cat2	No	No COC, holding time unknown, no replicates	SW846 M.9060 (TOC) & unreferenced (NH_3)	TOC and NH_3	QA1	Convs_LWR

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Project Description	SURVEY_CD	SedQual Survey Code	Comments	Recommend Category Revision (Y/N-comment)	Reason for Category 2 Designation	Analytical Method(s)	Parameter group	QA Review	DV Survey Code
USACE Lower Willamette River, 1986, 1988 (2 events) and 1992 Sampling Events	WLR0488, WLR0988, WLR0692, MCAL0986 & MCAL1286	WLR0388, WLR0988, WLR0692, WLMD0986 & WLMD1286	Cat1	No		ASTM (GS & VS), EPA 1991 (AVS), EPA 415.1 (TOC)	grains size, volatile solids, acid volatile sulfides, TOC	QA1	Convs_LWR
USACE Lower Willamette River, 1986, 1988 (2 events) and 1992 Sampling Events	WLR0488, WLR0988, WLR0692, MCAL0986 & MCAL1286	WLR0388, WLR0988, WLR0692, WLMD0986 & WLMD1286	Cat1	No		SW846 M.8270 (SIM)	SVOCs	QA1	SVOCs_LWR
Willamette River Sediment Sampling Event, U.S. Moorings (4/28/99)	WLR0499	WLR0499	Cat 1	Yes - COC present for all other parameters		ASTM D422 (COE mod.)	Grain size	QA1	*(Lab report - DMD review, 1/02)*
Willamette River Sediment Sampling Event, U.S. Moorings (4/28/99)	WLR0499	WLR0499	Cat2	No	No precision or accuracy documentation from laboratory QC	SW846 M.6010, 6020 (As, Cd, Ag) & 7471 (Hg)	Metals (Sb, As, Cu, Cd, Pb, Ni, Ag, Zn & Hg)	QA1	*(Lab report - DMD review, 1/02)*
Willamette River Sediment Sampling Event, U.S. Moorings (4/28/99)	WLR0499	WLR0499	Cat2	No	No replicates	SW846 M.9060	TOC	QA1	*(Lab report - DMD review, 1/02)*
Willamette River Sediment Sampling Event, U.S. Moorings (4/28/99)	WLR0499	WLR0499	Cat1	No		SW846 M.8270	SVOCs	QA1	*(Lab report - DMD review, 1/02)*
Willamette River Sediment Sampling Event, U.S. Moorings (4/28/99)	WLR0499	WLR0499	Cat1	No		PSEP / Krone et al. 1989	TBT	QA1	*(Lab report - DMD review, 1/02)*
Willamette River Sediment Sampling Event, U.S. Moorings (4/28/99)	WLR0499	WLR0499	Cat1	No		SW846 M.8081A / 8082	Chlorin. pesticides & PCBs (Aroclors)	QA1	*(Lab report - DMD review, 1/02)*
Willamette River Sediment Sampling Event, U.S. Moorings (4/28/99)	WLR0499	WLR0499	Cat1	No		SW846 M.8151(M)	Chlorin. herbicides	QA1	*(Lab report - DMD review, 1/02)*
Willamette River Sediment Sampling Event, U.S. Moorings (4/28/99)	WLR0499	WLR0499	Cat1	No		SW846 M.8290	chlorinated dioxins & furans	QA1	*(Lab report - DMD review, 1/02)*
Elutriation Study of Willamette River Bottom Material and Willamette-Columbia River Water (1977) by USGS/Rinella & McKenzie	WLR0577		Cat2 (no QC data presented, only results)	No	Method unknown, no COC, holding time unknown, no precision or accuracy documentation from laboratory QC data	unreferenced	NH_3, CN, COD, TOC	NA	*(none)*
Elutriation Study of Willamette River Bottom Material and Willamette-Columbia River Water (1977) by USGS/Rinella & McKenzie	WLR0577		Cat2 (no QC data presented, only results)	No	Method unknown, no COC, holding time unknown, no precision or accuracy documentation from laboratory QC data	unreferenced	Metals (As, Cr, Cu, Fe, Pb, Mn, Hg, Zn)	NA	*(none)*
Elutriation Study of Willamette River Bottom Material and Willamette-Columbia River Water (1977) by USGS/Rinella & McKenzie	WLR0577		Cat2 (no QC data presented, only results)	No	Method unknown, no COC, holding time unknown, no precision or accuracy documentation from laboratory QC data	unreferenced	Chlorin. Pest. & total PCBs	NA	*(none)*
Willamette River - Burlington Northern Railroad Bridge (8/14/89) by ACOE/Troutdale	WLR0789		Cat2 (no QC data presented, only results - nondetects reported as "zero")	No	Method unknown, no COC, holding time unknown, no precision or accuracy documentation from laboratory QC data	unreferenced	Grain size	NA	*(none)*
Willamette River - Burlington Northern Railroad Bridge (89/15/89) by Battelle/Sequim	WLR0789		Cat2 (no QC data presented, only results - limited lab data report)	No	No COC, no precision of accuracy documentation from laboratory QC data	SW846 M.3050 & "atomic absorption"	Metals (Ag, As, Cd, Cr, Cu, Pb, Hg, Ni, Zn)	QA1	*(Lab report - DMD review, 1/02)*
Willamette River - Burlington Northern Railroad Bridge (89/15/89) by Battelle/Sequim	WLR0789		Cat2 (no QC data presented, only results - limited lab data report)	No	Method unknown, no COC, holding time unknown, no precision or accuracy documentation from laboratory QC data	reported as SM502 (1975), which is incorrect	Oil & Grease	QA1	*(Lab report - DMD review, 1/02)*
Willamette River - Burlington Northern Railroad Bridge (89/15/89) by Battelle/Sequim	WLR0789		Cat2 (no QC data presented, only results - limited lab data report)	No	No COC, holding time unknown, no precision and limited accuracy documentation from laboratory QC data	SW846 M.8270	SVOCs	QA1	*(Lab report - DMD review, 1/02)*

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Project Description	SURVEY_CD	SedQual Survey Code	Comments	Recommend Category Revision (Y/N-comment)	Reason for Category 2 Designation	Analytical Method(s)	Parameter group	QA Review	DV Survey Code
Willamette River - Burlington Northern Railroad Bridge (89/15/89) by Battelle/Sequim	WLR0789		Cat2 (no QC data presented, only results - limited lab data report)	No	Method unknown, no COC, holding time unknown, no precision or accuracy documentation from laboratory QC data	reported as SM502 (1975), which is incorrect	TOC	QA1	*(Lab report - DMD review, 1/02)*
Willamette River - Burlington Northern Railroad Bridge (89/15/89) by Battelle/Sequim	WLR0789		Cat2 (no QC data presented, only results - limited lab data report)	No	No COC, holding time unknown, no precision and limited accuracy documentation from laboratory QC data	SW846 M.8080	Chlorin. pesticides & PCBs (Aroclors)	QA1	*(Lab report - DMD review, 1/02)*
COE Willamette River Channel Deepening 1997 Data	WLR0797	WRCHDEEP	Cat2; no analysis dates, COC, replication	No	No COC, no replicates	EM1110-9-1906	Grain size & volatile solids	QA1	COE_CD_Convs
COE Willamette River Channel Deepening 1997 Data	WLR0797	WRCHDEEP	Cat1	No		ASTM D4129-82 & EPA draft method for VS	TOC, volatile sulfides	QA1	COE_CD_Convs
COE Willamette River Channel Deepening 1997 Data	WLR0797	WRCHDEEP	Cat1	No		EPA 200.8 (As, Cd, Cr, Cu, Pb, Ni, Ag, Zn [M.3050 digestion]); SW846 M.7471A	Metals	QA1	COE_CD_Metals
COE Willamette River Channel Deepening 1997 Data	WLR0797	WRCHDEEP	Cat1; MB shows DDT & "B" qualified, could be "U" qual.	No		SW846 M.8080; extraction by M.3550 (sonication)	Chlorin. pesticides & PCBs (Aroclors)	QA1	COE_CD_PestPCB
COE Willamette River Channel Deepening 1997 Data	WLR0797	WRCHDEEP	Cat1; results qual. as estimates due to low surrogates, MS & LCS recov.; MB showed some analytes & "B" qual. Note: check units - ppb or ppm?	No		SW847 M.8270 (SIM); extraction by M.3545 (PFE)	18 PAHs	QA1	COE_CD_SVOCs
COE Willamette River Channel Deepening 1997 Data	WLR0797	WRCHDEEP	Cat1	No		GC/FPD (Krone et al., 1989)	TBT	QA1	COE_CD_TBT
Quality of Bottom Material & Elutriates in the Lower Willamette River (1989) by Fuhrer /USGS	WLR1083		Cat2 (no QC data presented, only results)	No	No COC, holding time unknown, no precision or accuracy documentation from laboratory QC data	Fishman & Friedman 1985	Metals (As, Ba, Cd, Cr, Cu, Fe, Pb, Mn, Ni, Zn, Hg)	NA	*(none)*
Quality of Bottom Material & Elutriates in the Lower Willamette River (1989) by Fuhrer /USGS	WLR1083		Cat2 (no QC data presented, only results)	No	No COC, holding time unknown, no precision or accuracy documentation from laboratory QC data	Wershaw 1983	Pesticides & total PCBs	NA	*(none)*
Quality of Bottom Material & Elutriates in the Lower Willamette River (1989) by Fuhrer /USGS	WLR1083		Cat2 (no QC data presented, only results)	No	No COC, holding time unknown, no precision or accuracy documentation from laboratory QC data	Wershaw 1983	SVOCs	NA	*(none)*
Quality of Bottom Material & Elutriates in the Lower Willamette River (1989) by Fuhrer /USGS	WLR1083		Cat2 (no QC data presented, only results)	No	No COC, holding time unknown, no precision or accuracy documentation from laboratory QC data	Wershaw 1983	Chlorin. phenoxy herbicides	NA	*(none)*
Quality of Bottom Material & Elutriates in the Lower Willamette River (1989) by Fuhrer /USGS	WLR1083		Cat2 (no QC data presented, only results)	No	No COC, holding time unknown, no replicates	"pipet method"	Grain size	NA	*(none)*
USACE Willamette River, Portland Harbor 1996 Event	WLR1196	WLR1196	Cat2; no analysis dates, COC, replication or referenced methods	No	No COC, no replicates	(unreferenced)	Grain size (particle size)	QA1	Convs_WRPH
USACE Willamette River, Portland Harbor 1996 Event	WLR1196	WLR1196	Cat1	No		EPA 410.1 (phenols), 591 AVSM, AVS-SEM EPA 1991, ASTM D4129-82M	phenols, acid volatile sulfides, AVS metals (simultaneous extracted), TOC	QA1	Convs_WRPH
USACE Willamette River, Portland Harbor 1996 Event	WLR1196	WLR1196	Cat1	No		EPA 200.8 (As, Cd, Cr, Cu, Pb, Ni, Ag, Zn [M.3050 digestion]); SW846 M.7471A	Metals	QA1	Metals_WRPH
USACE Willamette River, Portland Harbor 1996 Event	WLR1196	WLR1196	Cat1; results qual. as estimates due to low surrogates	No		SW846 M.8080A; extraction by M.3540 (soxhlet)	Chlorin. pesticides & PCBs (Aroclors)	QA1	Pest_PCB_WRPH
USACE Willamette River, Portland Harbor 1996	WLR1196	WLR1196	Cat1	No		SW846 M.8270C (SIM)	PAHs only	QA1	SVOCs_WRPH
USACE Willamette River, Portland Harbor 1996 Event	WLR1196	WLR1196	Cat1	No		GC/FPD (Krone et al., 1989)	TBT (& DBT & MBT)	QA1	TBT_WRPH
Willamette River Sediment Sampling Event, U.S. Moorings (11/29/99)	WLR1199	WLR1199	Cat2	No	No precision or accuracy documentation from laboratory QC data	SW846 M.6010 (Cu, Ni, Zn), 6020 & 7471 (Hg)	Metals (Cu, Ni, Zn, As, Sb, Cd, Pb, Ag, Hg)	QA1	*(Lab report - DMD review, 1/02)*

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Comments	Recommend Category Revision (Y/N-comment)	Reason for Category 2 Designation	Analytical Method(s)	Parameter group	QA Review	DV Survey Code
Willamette River Sediment Sampling Event, U.S. Moorings (11/29/99)	WLR1199	WLR1199	Cat2	No	No precision or accuracy documentation from laboratory QC data	SW846 M.9060	TOC	QA1	*(Lab report - DMD review, 1/02)*
Willamette River Sediment Sampling Event, U.S. Moorings (11/29/99)	WLR1199	WLR1199	Cat 1	Yes - Data package cover letter refers to COC		ASTM D422 (COE mod.)	Grain size	QA1	*(Lab report - DMD review, 1/02)*
Willamette River Sediment Sampling Event, U.S. Moorings (11/29/99)	WLR1199	WLR1199	Cat1	No		SW846 M.8270	SVOCs	QA1	*(Lab report - DMD review, 1/02)*
Willamette River Sediment Sampling Event, U.S. Moorings (11/29/99)	WLR1199	WLR1199	Cat1	No		PSEP	TBT	QA1	*(Lab report - DMD review, 1/02)*
Willamette River Sediment Sampling Event, U.S. Moorings (11/29/99)	WLR1199	WLR1199	Cat1	No		SW846 M.8081A	Chlorin. pesticides	QA1	*(Lab report - DMD review, 1/02)*
1998 and 1999 Elf Atochem: River Sediment and Riverbank Sediment Investigation	WLRELF99	WLRELF99	Cat1; note: same samples listed as sub and surficial	No		PSEP 1986 (grain size), EPA 415.1 (TOC)	conventionals (grain size & TOC)	QA1	Convs_DV
1998 and 1999 Elf Atochem: River Sediment and Riverbank Sediment Investigation	WLRELF99	WLRELF99	Cat1	No		SW846 M.8081A	Chlorinated pesticides	QA1	Pest_DV
1998 and 1999 Elf Atochem: River Sediment and Riverbank Sediment Investigation	WLRELF99	WLRELF99	Cat1; report highest detected value from two sets of analyses and qual. as estimates; all nondetects are unusable and should not be reported	No		SW846 M.8270C (SIM) & M.3550B (sonication)	SVOCs	QA1	SVOCs_DV
1998 and 1999 Elf Atochem: River Sediment and Riverbank Sediment Investigation	WLRELF99	WLRELF99	Cat1	No		SW846 M.8260B	VOCs	QA1	VOCs_DV
Port of Portland Terminal 2 Berth 203 5/1994	WLRPT294		Cat1	Y - referece to COC in data package		EPA 160.3 M/ASTM D422M	Solids/Grainsize	QA2	*(Hart Crowser)*
Port of Portland Terminal 2 Berth 203 5/1994	WLRPT294		Cat1	Y - referece to COC in data package		SW846 M.6020 & 7471 (Hg)	Metals (Sb, As, Cd, Cr, Cu, Pb, Ni, Ag, Zn, Hg)	QA2	*(Hart Crowser)*
Port of Portland Terminal 2 Berth 203 5/1994	WLRPT294		Cat1	Y - referece to COC in data package		SW846 M.8081A / 8082	Chlorin. pesticides & PCBs (Aroclors)	QA2	*(Hart Crowser)*
Port of Portland Terminal 2 Berth 203 5/1994	WLRPT294		Cat1	Y - referece to COC in data package		SW846 M.8260B	VOCs	QA2	*(Hart Crowser)*
Port of Portland Terminal 2 Berth 203 5/1994	WLRPT294		Cat1	Y - referece to COC in data package		PSEP - Krone et al. 1989	Organotins	QA2	*(Hart Crowser)*
Port of Portland Terminal 2 Berth 203 5/1994	WLRPT294		Cat1	Y - referece to COC in data package		SW846 M.8270C (SIM)	Phthalates Esters, Phenols, PAHs	QA2	*(Hart Crowser)*
Willamette River Basin Water Quality Study. Component 2: Review & Summary of Toxic Pollutants in the Willamette River and Major Tributaries (8/27/92) by Tetra Tech	WLRWQH92	from STORET	Cat2	No	Method unknown, laboratory unknown, no COC, holding time unknown, no precision or accuracy documentation from laboratory QC	unknown	metals (As, Ba, Cd, Cr, Cu, Pb, Ni, Ag, Zn, Sb, Se, Tl, Hg), chlorin. pest./PCBs, VOCs, SVOCs & chlorin. dioxin/furan (2,3,7,8-TCDD & 2,3,7,8-TCDF, only)	NA	*(none)*
Willbridge Terminal Facility, Portland Sediment Investigation	WLRWTF98	WLRWTF98	Cat1	No		SW846 M.8020A	BTEX	QA1	BTEX_QA_DV
Willbridge Terminal Facility, Portland Sediment Investigation	WLRWTF98	WLRWTF98	Cat1	No		SW846 M.6020 (As, Se), M.6010A (Ba, Cd, Cr, Cu, Pb, Ag, Zn), M.7470A/7471A (Hg)	Metals	QA1	Metals_QA_DV
Willbridge Terminal Facility, Portland Sediment Investigation	WLRWTF98	WLRWTF98	Cat1	No		SW846 M.8081	Chlorinated pesticides	QA1	Pest_QA_DV

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Comments	Recommend Category Revision (Y/N-comment)	Reason for Category 2 Designation	Analytical Method(s)	Parameter group	QA Review	DV Survey Code
Willbridge Terminal Facility, Portland Sediment Investigation	WLRWTF98	WLRWTF98	Cat1; qual. as estimates due to low recoveries	No		SW846 M.8270C (PAHs by SIM, others via full-scan)	SVOCs	QA1	SVOCs_QA_DV
Willbridge Terminal Facility, Portland Sediment Investigation	WLRWTF98	WLRWTF98	Cat1	No		EPA 9060	TOC	QA1	TOC_QA_MEMO (& reinspection)
Chemical Characterization of Sediments Adjacent to Storm Water Discharges in the Willamette River Near Portland. Feb. 20, 1995. Submitted to the U.S. EPA; prepared by Hartman Assoc. & Fishman Environ. Serv.	WRSTRM94	WRSTRM94	Cat1; some documentation lacking	No		SW846 M.6010A (Sb, Be, Cd, Cr, Cu, Pb, Ni, Ag & Zn); M.7060 (As); M.7740 (Se); M.7841 (Tl); M.7471 (Hg); digestion via M.3050 & M.7471A	Metals	QA1	Stormwater_Metals
Chemical Characterization of Sediments Adjacent to Storm Water Discharges in the Willamette River Near Portland. Feb. 20, 1995. Submitted to the U.S. EPA; prepared by Hartman Assoc. & Fishman	WRSTRM94	WRSTRM94	Cat1	No		SW846 M.8080 & M.3540 (soxhlet)	Chlorin. pesticides & PCBs (Aroclors)	QA1	Stormwater_PestPCB
Chemical Characterization of Sediments Adjacent to Storm Water Discharges in the Willamette River Near Portland. Feb. 20, 1995. Submitted to the U.S. EPA; prepared by Hartman Assoc. & Fishman Environ. Serv.	WRSTRM94	WRSTRM94	Cat1	No		SW846 M.8270 & M.3540C (soxhlet)	SVOCs	QA1	Stormwater_SVOCs
Chemical Characterization of Sediments Adjacent to Storm Water Discharges in the Willamette River Near Portland. Feb. 20, 1995. Submitted to the U.S. EPA; prepared by Hartman Assoc. & Fishman Environ. Serv.	WRSTRM94	WRSTRM94	Cat1	No		SW846 M.8240	VOCs	QA1	Stormwater_VOCs
Portland Harbor Sediment Investigation Report (5/98) by Roy F. Weston, Inc.	WR-WSI98	WR-WSI98	Cat2 (no QC data reported)	No	Laboratory unknown, holding time unknonw, no precision or accuracy documentation from laboratory QC	SW846 M.8151A	Chlorin. phenoxy herbicides	none	*(none)*
Portland Harbor Sediment Investigation Report (5/98) by Roy F. Weston, Inc.	WR-WSI98	WR-WSI98	Cat1 (some results qual.)	No		SW846 M.6010 & 7471A (Hg)	Metals	QA2	*Weston (1-2/98)*
Portland Harbor Sediment Investigation Report (5/98) by Roy F. Weston, Inc.	WR-WSI98	WR-WSI98	Cat1	No		SW846 M.6010	Titanium	QA2	*Weston (1-2/98)*
Portland Harbor Sediment Investigation Report (5/98) by Roy F. Weston, Inc.	WR-WSI98	WR-WSI98	Cat1 (some results required qualification due to method blank performance)	No		SW846 M.8270 - PSEP	SVOCs	QA2	*Weston (1-2/98)*

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Comments	Recommend Category Revision (Y/N-comment)	Reason for Category 2 Designation	Analytical Method(s)	Parameter group	QA Review	DV Survey Code
Portland Harbor Sediment Investigation Report (5/98) by Roy F. Weston, Inc.	WR-WSI98	WR-WSI98	Cat1 (some results qual.)	No		SW846 M.8081 - PSEP	Chlorin. Pesticides	QA2	*Weston (1-2/98)*
Portland Harbor Sediment Investigation Report (5/98) by Roy F. Weston, Inc.	WR-WSI98	WR-WSI98	Cat1 (some results qual.)	No		SW846 M.8081 - PSEP	PCBs (as Aroclors)	QA2	*Weston (1-2/98)*
Portland Harbor Sediment Investigation Report (5/98) by Roy F. Weston, Inc.	WR-WSI98	WR-WSI98	Cat1 (some results qual.)	No		PSEP - Krone et al. 1989	TBT	QA2	*Weston (1-2/98)*
Portland Harbor Sediment Investigation Report (5/98) by Roy F. Weston, Inc.	WR-WSI98	WR-WSI98	Cat1 (some results qual.)	No		ASTM D442-63/PSEP & SW846 M.9060/PSEP	Grain size & TOC	QA2	*Weston (1-2/98)*
Portland Harbor Sediment Investigation Report (5/98) by Roy F. Weston, Inc.	WR-WSI98	WR-WSI98	Cat1 (some results qual.)	No		SW846 M.8290	chlorinated dioxins & furans	QA2	*Weston (2/98)*

Notes: Definition of headings in Attachments F1-F3:
"Survey CD" is the survey code as assigned in the LWG database.
"SedQual Survey Code" is data taken from SEDQUAL database.
The "Comments" column contains the recommended QC assignment of data based on fulfillment or nonfulfillment of the data quality performance factors.
"Analytical Method" is as noted.
"Parameter Group" lists the reported analytes using the specified method(s).
"QA Review" - either QA1, QA2 or NA (not available).
"DV Survey Code" identifies the document or source for the data review - it may be published or could be (in the case of DMD QA1) as presented/summarized in this "decision matrix".
"Matrix" is as specified.
"Laboratory" is the analytical lab that performed the analyses.
"C-O-C" indicates whether or not a means of determining sample accountability/integrity between the lab and the field is available.
"HT's" indicates that sample holding times are able to be determined - they could have been exceeded with consequent assignment of pertinent data qualifier codes, as indicated in the "decision matrix".
"Method Blanks", "MS/MSD," "LCS," "Replicates" and "Surrogate(s)" are evaluated as indicated - blanks indicates that the factor was not evaluated and may not be necessary to establish data quality for the samples/analytes of concern.
"??" means that the info is required to establish data quality and is unavailable.

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Matrix	Laboratory	C-O-C	HT's	Method Blank(s)	MS/MSD's	LCS's	Replicates	Surrogate(s)
EPA Region 10, Columbia River Basin Contaminant Aquatic Biota and Sediment Data - On-line Database (biota 1987-1993; sediment 1984-1994). Sources include USFWS	CLBC8494		biota and sediments	(unknown)							
Sediment Quality (Dioxin/Furan) Evaluation - Lower Columbia & Willamette Rivers (5/90)	COLWIL90	COLWIL90		Twin City Testing / St. Paul, MN	none	Unknown conditions - 4 mo. HT	Acceptable	Acceptable		Acceptable	Acceptable
Sediment Quality (Dioxin/Furan) Evaluation - Lower Columbia & Willamette Rivers (5/90)	COLWIL90	COLWIL90		Twin City Testing / St. Paul, MN	none	Acceptable	none reported	none	none	Acceptable	
Sediment Quality (Dioxin/Furan) Evaluation - Lower Columbia & Willamette Rivers (5/90)	COLWIL90	COLWIL90		USACE / Troutdale, OR	none	Acceptable				Acceptable	
McCormick & Baxter Creosoting Company, Remedial Investigation Report, Vol. II of IV (Appendices A-D) by PTI Environmental Services (9/92)	MBCREOS1, MBCREOS2	MBCREOS1, MBCREOS2	67 surface seds. and 29 cores	Columbia Analytical Services	Referenced in data validaton report	Acceptable	Acceptable		Acceptable	Acceptable	
McCormick & Baxter Creosoting Company, Remedial Investigation Report, Vol. II of IV (Appendices A-D) by PTI Environmental Services (9/92)	MBCREOS1, MBCREOS2	MBCREOS1, MBCREOS2	66 surface seds. and 25 cores	Analytical Technologies Inc.	Referenced in data validaton report	within 180 days	Acceptable		Acceptable	Acceptable	
McCormick & Baxter Creosoting Company, Remedial Investigation Report, Vol. II of IV (Appendices A-D) by PTI Environmental Services (9/92)	MBCREOS1, MBCREOS2	MBCREOS1, MBCREOS2	8 surface seds. and 4 cores	Triangle Laboratories Inc.	Referenced in data validaton report	Acceptable	HxCDD, OCDD, HpCDF & OCDF detected			Acceptable	Acceptable
McCormick & Baxter Creosoting Company, Remedial Investigation Report, Vol. II of IV (Appendices A-D) by PTI Environmental Services (9/92)	MBCREOS1, MBCREOS2	MBCREOS1, MBCREOS2	66 surface seds. and 29 cores	Analytical Technologies Inc.	Referenced in data validaton report	within 180 days	Acceptable	Acceptable	none		Some data qual. due to low recovereis.
McCormick & Baxter Creosoting Company, Remedial Investigation Report, Vol. II of IV (Appendices A-D) by PTI Environmental Services (9/92)	MBCREOS1, MBCREOS2	MBCREOS1, MBCREOS2	66 surface seds. and 25 cores	Columbia Analytical Services	Referenced in data validaton report	Some exceeded by up to 5 months.	Acceptable	Some data qual. ("J" & "R") due to low recoveries	Acceptable	none	
McCormick & Baxter Creosoting Company, Remedial Investigation Report, Vol. II of IV (Appendices A-D) by PTI Environmental Services (9/92)	MBCREOS1, MBCREOS2	MBCREOS1, MBCREOS2	60 surface seds. and 8 cores	Columbia Analytical Services	Referenced in data validaton report	Some exceeded by up to 14 days (qual. As "G").	Acceptable	Low recov. (0-30%)	Low recov. (0-30%)	Acceptable	
U.S. Moorings 1995 Data	MOOR0595	COEUSM95	13 subsurface sediments	USACE / Troutdale,	Acceptable	Acceptable				Acceptable	
U.S. Moorings 1995 Data	MOOR0595	COEUSM95	42 subsurface sediments	CAS / Kelso	Acceptable	Acceptable				Acceptable	
U.S. Moorings 1995 Data	MOOR0595	COEUSM95	42 subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	MS acceptable	none	Acceptable	
U.S. Moorings 1995 Data	MOOR0595	COEUSM95	7 subsurface sediments	Alta / ElDorado Hills, CA	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
U.S. Moorings 1995 Data	MOOR0595	COEUSM95	42 subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
U.S. Moorings 1995 Data	MOOR0595	COEUSM95	42 subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Matrix	Laboratory	C-O-C	HT's	Method Blank(s)	MS/MSD's	LCS's	Replicates	Surrogate(s)
U.S. Moorings 1995 Data	MOOR0595	COEUSM95	7 subsurface sediments	CAS / Kelso	Acceptable	Acceptable; with qual. As estimates due to HT exceedances by 26 days.	Acceptable	Acceptable	Acceptable		Acceptable
U.S. Moorings 1994 Data	MOOR0694	COEUSM94	21 surface sediments	USACE / Troutdale,	none	Acceptable				none	
U.S. Moorings 1994 Data	MOOR0694	COEUSM94	15 surface sediments	CAS / Kelso	none	Acceptable	Acceptable	MS acceptable; no data for TOC & low recoveries for AVS	none	Acceptable	
U.S. Moorings 1994 Data	MOOR0694	COEUSM94	15 surface sediments	CAS / Kelso	none	Acceptable	Acceptable	MS acceptable	Acceptable	Acceptable	
U.S. Moorings 1994 Data	MOOR0694	COEUSM94	15 surface sediments	CAS / Kelso	none	Acceptable; exceeded HT by 11 days	Acceptable	Acceptable	none		Acceptable
U.S. Moorings 1994 Data	MOOR0694	COEUSM94	15 surface sediments	CAS / Kelso	none	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
U.S. Moorings 1994 Data	MOOR0694	COEUSM94	15 surface sediments	CAS / Kelso	none	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable; low recoveries requiring qual. as estimates
U.S. Moorings 1994 Data	MOOR0694	COEUSM94	4 surface sediments	Alta / ElDorado Hills, CA	Acceptable	Acceptable	Acceptable	none required	Acceptable		Acceptable
Results of 1989 U.S. Moorings Sediment Quality Evaluation	MOOR1089	COEUSM89	3 subsurface sediments (10/12/89)	Battelle / Sequim	none	unknown	none		Acceptable	Acceptable	
Results of 1989 U.S. Moorings Sediment Quality Evaluation	MOOR1089	COEUSM89	3 subsurface sediments (10/12/89)	Battelle / Sequim	none	(more than 16 weeks)	none	MS acceptable		Acceptable	
Results of 1989 U.S. Moorings Sediment Quality Evaluation	MOOR1089	COEUSM89	3 subsurface sediments (10/12/89)	Battelle / Sequim	none	Acceptable	Acceptable	none	none		Acceptable
Results of 1989 U.S. Moorings Sediment Quality Evaluation	MOOR1089	COEUSM89	3 subsurface sediments (10/12/89)	Battelle / Sequim	none	Acceptable	none	none	none		
Results of 1989 U.S. Moorings Sediment Quality Evaluation	MOOR1089	COEUSM89	3 subsurface sediments (10/12/89)	Battelle / Sequim	none	Acceptable	none	none	none		Acceptable
Results of 1989 U.S. Moorings Sediment Quality Evaluation	MOOR1089	COEUSM89	1 subsurface composite (10/12/89)	Twin City Testing	none	Acceptable	none				Acceptable
Results of 1989 U.S. Moorings Sediment Quality Evaluation	MOOR1089	COEUSM89	3 subsurface sediments (10/12/89)	USACE / Troutdale, OR	none	unknown				none	
U.S. Moorings 12/20/94 Data	MOOR1294	MOOR1294		NET Pacific / Santa Rosa, CA	Acceptable	Acceptable	Acceptable	Acceptable (require J qualification of all Pb & Zn results)	Acceptable	Acceptable	
Sediment Characterization Study Marine Terminal 2, Berths 203-206 (3/17/99) AND Terminal 4, Berth 416 (4/20/99) by Hart Crowser	PPTLDT24	PPTLDT24	30 surface and subsurface sediments	CAS / Kelso	Acceptable	Acceptable	none	MS acceptable; total sulfides as estimates due to low recoveries.	Acceptable	Acceptable	

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Matrix	Laboratory	C-O-C	HT's	Method Blank(s)	MS/MSD's	LCS's	Replicates	Surrogate(s)
Sediment Characterization Study Marine Terminal 2, Berths 203-206 (3/17/99) AND Terminal 4, Berth 416 (4/20/99) by Hart Crowser	PPTLDT24	PPTLDT24	30 surface and subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable; some Cd reported with "B" - recommend replacing with"U" code.	MS acceptable; variable recov. require qual. as estimates.	Acceptable; variable recov. require qual. as estimates.	Acceptable	
Sediment Characterization Study Marine Terminal 2, Berths 203-206 (3/17/99) AND Terminal 4, Berth 416 (4/20/99) by Hart Crowser	PPTLDT24	PPTLDT24	30 surface and subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Sediment Characterization Study Marine Terminal 2, Berths 203-206 (3/17/99) AND Terminal 4, Berth 416 (4/20/99) by Hart Crowser	PPTLDT24	PPTLDT24	30 surface and subsurface sediments	CAS / Kelso	Acceptable	Acceptable (initial analyses OK; reanalyses outside HTs)	Acceptable	Acceptable; consistently low recov. for phenolics - qual. as estimates	Acceptable		Acceptable; large # of surrogates outside specification - require qual. of many results as estimates
Sediment Characterization Study Marine Terminal 2, Berths 203-206 (3/17/99) AND Terminal 4, Berth 416 (4/20/99) by Hart Crowser	PPTLDT24	PPTLDT24	24 surface and subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable - recov. consistent with surrogate recov.	Acceptable - recov. consistent with surrogate recov.		Acceptable - require qual. of all results when any surrogate recov. <50%.
Sediment Characterization Study Marine Terminal 2, Berths 203-206 (3/17/99) AND Terminal 4, Berth 416 (4/20/99) by Hart Crowser	PPTLDT24	PPTLDT24	30 surface and subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Sediment Testing at PSY Berth 311	PSBTH311	PSBTH311	11 subsurface sediments	USACE / Troutdale, OR	none	unknown				none	
Sediment Testing at PSY Berth 311	PSBTH311	PSBTH311	4 subsurface sediments	CAS / Kelso	Acceptable	Acceptable				Acceptable (GS)	
Sediment Testing at PSY Berth 311	PSBTH311	PSBTH311	4 subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	none	none		Acceptable
Sediment Testing at PSY Berth 311	PSBTH311	PSBTH311	4 subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	none	none		Acceptable
Sediment Testing at PSY Berth 311	PSBTH311	PSBTH311	4 subsurface sediments	Pacific Environmental Laboratory / Beaverton	none	unknown	Acceptable	none	none		none
Sediment Testing at PSY Berth 311	PSBTH311	PSBTH311	6 subsurface sediments	USACE / Troutdale, OR	none	unknown	Acceptable	none	none	none	
Sediment Testing at PSY Berth 311	PSBTH311	PSBTH311	6 subsurface sediments	Pacific Environmental Laboratory / Beaverton	none	unknown	Acceptable	none	none		none
Sediment Testing at PSY Berth 311	PSBTH311	PSBTH311	6 subsurface sediments	CAS / Kelso	Acceptable	Acceptable	All phenol hits qualify as nondetected "U" qualifier.	none	none		none
Sediment Testing at PSY Berth 311	PSBTH311	PSBTH311	6 subsurface sediments	Pacific Environmental Laboratory / Beaverton	none	unknown	Acceptable	none	none		none

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Matrix	Laboratory	C-O-C	HT's	Method Blank(s)	MS/MSD's	LCS's	Replicates	Surrogate(s)
Appendix D: Dames & Moore Data	PSYD&M97, WRD&M98	PSYD&M97, WRD&M98	23 surface sediments	North Creek Analytical / Beaverton, OR	Acceptable	Acceptable	Acceptable	Acceptable MS	Acceptable	Acceptable	
Appendix D: Dames & Moore Data	PSYD&M97, WRD&M98	PSYD&M97, WRD&M98	22 surface sediments	North Creek Analytical / Beaverton, OR	Acceptable	Acceptable	Acceptable	Acceptable MS	Acceptable	Acceptable	
Appendix D: Dames & Moore Data	PSYD&M97, WRD&M98	PSYD&M97, WRD&M98	19 surface sediments	North Creek Analytical / Beaverton, OR	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Appendix D: Dames & Moore Data	PSYD&M97, WRD&M98	PSYD&M97, WRD&M98	19 surface sediments	North Creek Analytical / Beaverton, OR	Acceptable	Acceptable	Acceptable (some analytes reported)	Acceptable	Acceptable		Acceptable
Appendix D: Dames & Moore Data	PSYD&M97, WRD&M98	PSYD&M97, WRD&M98	14 surface sediments	ToxScan	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Appendix D: Dames & Moore Data	PSYD&M97, WRD&M98	PSYD&M97, WRD&M98	3 surface sediments	North Creek Analytical /	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Sediment Testing at PSY Dry Dock #3, Post Dredging (Port of Portland) and Sediment Testing at PSY Dry Dock #4, Post Dredging (Port of Portland)	PSYDD3	PSYDD3	9 subsurface sediments (Dry Dock 3)	North Creek Analytical / Beaverton	Acceptable	Acceptable				Acceptable	
Sediment Testing at PSY Dry Dock #3, Post Dredging (Port of Portland) and Sediment Testing at PSY Dry Dock #4, Post Dredging (Port of Portland)	PSYDD3	PSYDD3	9 subsurface sediments (Dry Dock 3) [6 surface seds??]	North Creek Analytical / Beaverton	Acceptable	Acceptable	Acceptable	MS acceptable - some results qualified as estimated due to aberrant recoveries.	Acceptable	Acceptable	
Sediment Testing at PSY Dry Dock #3, Post Dredging (Port of Portland) and Sediment Testing at PSY Dry Dock #4, Post Dredging (Port of Portland)	PSYDD3	PSYDD3	6 subsurface sediments (Dry Dock 3)	North Creek Analytical / Beaverton	Acceptable	Acceptable	Acceptable	Acceptable	none		Acceptable
Sediment Testing at PSY Dry Dock #3, Post Dredging (Port of Portland) and Sediment Testing at PSY Dry Dock #4, Post Dredging (Port of Portland)	PSYDD3	PSYDD3	9 subsurface sediments (Dry Dock 3)	North Creek Analytical / Beaverton	Acceptable	Acceptable	Acceptable	Acceptable - some low recoveries	none		Acceptable - one sample required all results qualified as estimates ("J") due to low recoveries.
Sediment Testing at PSY Dry Dock #3, Post Dredging (Port of Portland) and Sediment Testing at PSY Dry Dock #4, Post Dredging (Port of Portland)	PSYDD3	PSYDD3	6 subsurface sediments (Dry Dock 3)	ToxScan, Inc. / Watsonville, CA	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Sediment Testing at PSY Dry Dock #3, Post Dredging (Port of Portland) and Sediment Testing at PSY Dry Dock #4, Post Dredging (Port of Portland)	PSYDD3	PSYDD3	6 subsurface sediments (Dry Dock 3)	North Creek Analytical / Beaverton	Acceptable	Acceptable	Acceptable	Acceptable	none		Acceptable
Sediment Testing at PSY Dry Dock #3, Post Dredging (Port of Portland) and Sediment Testing at PSY Dry Dock #4, Post Dredging (Port of Portland)	PSYDD4	PSYDD4	8 surface sediments (Dry Dock 4)	CAS / Kelso	Acceptable	Acceptable				Acceptable - do not use triplicate result of very high fine sand.	

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Matrix	Laboratory	C-O-C	HT's	Method Blank(s)	MS/MSD's	LCS's	Replicates	Surrogate(s)
Sediment Testing at PSY Dry Dock #3, Post Dredging (Port of Portland) and Sediment Testing at PSY Dry Dock #4, Post Dredging (Port of Portland)	PSYDD4	PSYDD4	8 surface sediments (Dry Dock 4)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	none		Acceptable
Sediment Testing at PSY Dry Dock #3, Post Dredging (Port of Portland) and Sediment Testing at PSY Dry Dock #4, Post Dredging (Port of Portland)	PSYDD4	PSYDD4	8 surface sediments (Dry Dock 4)	CAS / Kelso	Acceptable	Acceptable	Acceptable - all bis(2-ethylhexyl)phthalate results require a "U" qualifier code due to MB results.	Acceptable	none		Acceptable
Sediment Testing at PSY Dry Dock #3, Post Dredging (Port of Portland) and Sediment Testing at PSY Dry Dock #4, Post Dredging (Port of Portland)	PSYDD4	PSYDD4	8 surface sediments (Dry Dock 4)	Battelle / Sequim	Acceptable	Potentially exceeded HTs - all data qualified as estimates ("J")	Acceptable	none	Acceptable		Acceptable
Sediment Testing at PSY Dry Dock #3, Post Dredging (Port of Portland) and Sediment Testing at PSY Dry Dock #4, Post Dredging (Port of Portland)	PSYDD4	PSYDD4	8 surface sediments (Dry Dock 4)	CAS / Kelso	Acceptable	Acceptable	Acceptable	none	none		Acceptable
Sediment Testing at PSY Dry Dock #3, Post Dredging (Port of Portland) and Sediment Testing at PSY Dry Dock #4, Post Dredging (Port of Portland)	PSYDD4	PSYDD4	8 surface sediments (Dry Dock 4)	CAS / Kelso	Acceptable	Acceptable	Acceptable	none	none	Acceptable	
Portland Shipyard Sediment Investigation, Port of Portland and Cascade General, Inc. October 1, 1998.	PSYSEA98	PSYSEA98	122 surface and subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable MS; low MS recov. for Sb with qual. as estimates.	Acceptable	Acceptable; some results qual. as estimates due to high variabilities (RPDs).	
Portland Shipyard Sediment Investigation, Port of Portland and Cascade General, Inc. October 1, 1998.	PSYSEA98	PSYSEA98	103 surface and subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Portland Shipyard Sediment Investigation, Port of Portland and Cascade General, Inc. October 1, 1998.	PSYSEA98	PSYSEA98	103 surface and subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable: bis(2-ethylhexyl)phthalate reported in MB - recommend "U" code replace "B" codes.	Acceptable; large variabilities showing high and low recoveries.	Acceptable; large variabilities showing high and low recoveries.		Acceptable; low and high recoveries require qual. of results as estimates.
Portland Shipyard Sediment Investigation, Port of Portland and Cascade General, Inc. October 1, 1998.	PSYSEA98	PSYSEA98	56 porewaters and 16 sub and surficial sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable; highly variable recoveries requiring qual. as estimates
Portland Shipyard Sediment Investigation, Port of Portland and Cascade General, Inc. October 1, 1998.	PSYSEA98	PSYSEA98	5 surface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Portland Shipyard Sediment Investigation, Port of Portland and Cascade General, Inc. October 1, 1998.	PSYSEA98	PSYSEA98	129 surface and subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	
Reidel/Triangle Park 1997 Data	RIEDEL97	RIEDEL97	28 subsurface sediments	CAS / Kelso	Acceptable	Acceptable		MS acceptable	Acceptable	Acceptable	
Reidel/Triangle Park 1997 Data	RIEDEL97	RIEDEL97	20 subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	MS acceptable	Acceptable	Acceptable	

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Matrix	Laboratory	C-O-C	HT's	Method Blank(s)	MS/MSD's	LCS's	Replicates	Surrogate(s)
Reidel/Triangle Park 1997 Data	RIEDEL97	RIEDEL97	8 subsurface sediments	CAS / Kelso	Acceptable	Two samples extracted 30 days after the max recommended HT - all associated results require qualification as estimates ("J"). Substitute J for H qual. data.	Acceptable	Generally low recoveries - requiring qual. as estimates for many PAHs.	Acceptable		Acceptable - generally low recoveries
Reidel/Triangle Park 1997 Data	RIEDEL97	RIEDEL97	20 subsurface sediments	CAS / Kelso	Acceptable	Four samples extracted 30 days after the max recommended HT - all associated results require qualification as estimates ("J"). Substitute J for H qual. data.	Acceptable	Acceptable	Acceptable		Acceptable
TOSCO Willamette TPT Sediment Investigation	TOSCO99	TOSCO99	4 subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	MS acceptable	Acceptable	Acceptable	
TOSCO Willamette TPT Sediment Investigation	TOSCO99	TOSCO99	3 subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	MS acceptable	Acceptable	Acceptable	
TOSCO Willamette TPT Sediment Investigation	TOSCO99	TOSCO99	3 subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
TOSCO Willamette TPT Sediment Investigation	TOSCO99	TOSCO99	3 subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
TOSCO Willamette TPT Sediment Investigation	TOSCO99	TOSCO99	3 subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
USGS Water-Resources Investigations Report 97-4082-D - Dioxins and Furans in Bed Sediment and Fish Tissue of the Willamette Basin, 1992-95	WBWRIR98		finfish/sediment from 8 stations	Quanterra Environmental Services / W. Sacramento, CA	None	??	??	??	??	??	
Expanded Preliminary Assessment Data Report - Union Pacific Railroad Albina Yard (11/00) by Jacobs Engineering	WLCAYH00		8 sediments, 2 soils (8/00)	CAS / Kelso	Acceptable	Acceptable	Acceptable		Acceptable	Acceptable	Acceptable
Expanded Preliminary Assessment Data Report - Union Pacific Railroad Albina Yard (11/00) by Jacobs Engineering	WLCAYH00		9 sediments, 2 soils (8/00)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Expanded Preliminary Assessment Data Report - Union Pacific Railroad Albina Yard (11/00) by Jacobs Engineering	WLCAYH00		8 sediments, 2 soils (8/00)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Expanded Preliminary Assessment Data Report - Union Pacific Railroad Albina Yard (11/00) by Jacobs Engineering	WLCAYH00		8 sediments, 2 soils (8/00)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Expanded Preliminary Assessment Data Report - Union Pacific Railroad Albina Yard (11/00) by Jacobs Engineering	WLCAYH00		8 sediments (8/00)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Expanded Preliminary Assessment Data Report - Union Pacific Railroad Albina Yard (11/00) by Jacobs Engineering	WLCAYH00		8 sediments (8/00)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Matrix	Laboratory	C-O-C	HT's	Method Blank(s)	MS/MSD's	LCS's	Replicates	Surrogate(s)
Forensic Geochemical Assessment of Near Shore Sediments - Remedial Investigation Work Plan - Atlantic Richfield/BP Terminal 22T Portland, Oregon October 3, 2002 by SECOR	WLCARI99		15 surface sediments plus 1 opportunistic sample plus 1 field duplicate	CAS / Kelso	Referenced in report		Acceptable	Acceptable		Acceptable	Acceptable
Forensic Geochemical Assessment of Near Shore Sediments - Remedial Investigation Work Plan - Atlantic Richfield/BP Terminal 22T Portland, Oregon October 3, 2002 by SECOR	WLCARI99		15 surface sediments plus 1 opportunistic sample plus 1 field duplicate	CAS / Kelso	Referenced in report		Acceptable				
Forensic Geochemical Assessment of Near Shore Sediments - Remedial Investigation Work Plan - Atlantic Richfield/BP Terminal 22T Portland, Oregon October 3, 2002 by SECOR	WLCARI99		15 surface sediments plus 1 opportunistic sample plus 1 field duplicate	CAS / Kelso	Referenced in report		Acceptable - TOC, AVS/SEM			Acceptable TOC, Grain Size. Field replicate not analyzed for AVS/SEM	
Forensic Geochemical Assessment of Near Shore Sediments - Remedial Investigation Work Plan - Atlantic Richfield/BP Terminal 22T Portland, Oregon October 3, 2002 by SECOR	WLCARI99		15 surface sediments plus 1 opportunistic sample plus 1 field duplicate	CAS / Kelso	Referenced in report					Acceptable	
Results of Bioassay Analyses - Cargill Irving Elevator Terminal USACE Permit 95-1063 and DSL Permit RP3158 (10/1/01) by Harding ESE, Inc.	WLCCIF01		3 sediments (6/23/01)	unknown	none	unknown					
Results of Sediment Sampling & Analysis, Cargill Irving Elevator Terminal (8/3/01) by Harding ESE	WLCCIF01		5 sediment cores (6/29/01)	CAS / Kelso	Acceptable	Acceptable	Acceptable	MS acceptable	Acceptable	Acceptable	
Results of Sediment Sampling & Analysis, Cargill Irving Elevator Terminal (8/3/01) by Harding ESE	WLCCIF01		5 sediment cores (6/29/01)	CAS / Kelso	Acceptable	Acceptable	Acceptable (some hits qual. appropriately)	MS acceptable	Acceptable	Acceptable	
Results of Sediment Sampling & Analysis, Cargill Irving Elevator Terminal (8/3/01) by Harding ESE	WLCCIF01		5 sediment cores (6/29/01)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable (some low recoveries requiring some qual. as estimates)
Results of Sediment Sampling & Analysis, Cargill Irving Elevator Terminal (8/3/01) by Harding ESE	WLCCIF01		5 sediment cores (6/29/01)	CAS / Kelso	Acceptable	HT exceeded by 8 days qual. all hits as estimated "J".	High phenol - all phenol hits as nondetected with "U".	Acceptable	2,4-dimethylphenol very low recovery - all "U" replace with "R" (unusable), and hits as estimated "J"		Acceptable
Results of Sediment Sampling & Analysis, Cargill Irving Elevator Terminal (8/3/01) by Harding ESE	WLCCIF01		5 sediment cores (6/29/01)	CAS / Kelso	Acceptable	Acceptable	Acceptable	dieldrin not recovered - "R" qualify all dieldrin nondetects.	Acceptable		Acceptable
Results of Sediment Sampling & Analysis, Cargill Irving Elevator Terminal (8/3/01) by Harding ESE	WLCCIF01		5 sediment cores (6/29/01)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Chevron Willbridge Terminal Dock Sediment Sampling (06/27/01), PNG Environmental	WLCCPF01		15 sediments	North Creek Analytical, Inc.	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Chevron Willbridge Terminal Dock Sediment Sampling (06/27/01), PNG Environmental	WLCCPF01		15 sediments	North Creek Analytical, Inc.	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Chevron Willbridge Terminal Dock Sediment Sampling (06/27/01), PNG Environmental	WLCCPF01		15 sediments	North Creek Analytical, Inc.	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Chevron Willbridge Terminal Dock Sediment Sampling (06/27/01), PNG Environmental	WLCCPF01		15 sediments	North Creek Analytical, Inc.	Acceptable	Acceptable	Acceptable	Acceptable, 4,4'-DDT %R>40-160 no flag	Acceptable, Aldrin RPD>20 no flag	Acceptable	Acceptable

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Matrix	Laboratory	C-O-C	HT's	Method Blank(s)	MS/MSD's	LCS's	Replicates	Surrogate(s)
Chevron Willbridge Terminal Dock Sediment Sampling (06/27/01), PNG Environmental	WLCCPF01		15 sediments	North Creek Analytical, Inc.	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Chevron Willbridge Terminal Dock Sediment Sampling (06/27/01), PNG Environmental	WLCCPF01		15 sediments	North Creek Analytical, Inc.	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Chevron Willbridge Terminal Dock Sediment Sampling (06/27/01), PNG Environmental	WLCCPF01		15 sediments	North Creek Analytical, Inc.	Acceptable	Acceptable	Acceptable	Acceptable, Dup RPD for Sb > 20 matrix effects "J", Zn conc<MRL "J"	Acceptable, SRM = Cd & Pb < MRL "J"	Acceptable	none
Chevron Willbridge Terminal Dock Sediment Sampling (06/27/01), PNG Environmental	WLCCPF01		15 sediments	North Creek Analytical, Inc.	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	none
Chevron Willbridge Terminal Dock Sediment Sampling (06/27/01), PNG Environmental	WLCCPF01		15 sediments	North Creek Analytical, Inc.	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	none
Chevron Willbridge Terminal Dock Sediment Sampling (06/27/01), PNG Environmental	WLCCPF01		15 sediments	North Creek Analytical, Inc.	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	none
Chevron Willbridge Terminal Dock Sediment Sampling (06/27/01), PNG Environmental	WLCCPF01		15 sediments	North Creek Analytical, Inc.	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	none
Polychlorinated Biphenyl and Trace-Metal Concentrations in Columbia River and Willamette Harbor Bottom Sediment (5/2/87) by ACOE/Portland	WLCDRE87		sediment and elutriates	unknown	none	none	none	none	none	none	none
Preliminary Assessment and Dredging Sampling Results, Goldendale Alumina Unloading Facility (3/01) by CH2MHill	WLCGAF00, WLCGAL00		9 surface sediments (6/00 - phase I)	CAS / Kelso	Acceptable	Acceptable	Acceptable	MS acceptable	Acceptable	Acceptable	
Preliminary Assessment and Dredging Sampling Results, Goldendale Alumina Unloading Facility (3/01) by CH2MHill	WLCGAF00, WLCGAL00		9 surface sediments (6/00 - phase I)	CAS / Kelso	Acceptable	Acceptable	Acceptable	MS acceptable (Sb results estimates with "J" qualifier code)	Acceptable	Acceptable	
Preliminary Assessment and Dredging Sampling Results, Goldendale Alumina Unloading Facility (3/01) by CH2MHill	WLCGAF00, WLCGAL00		9 surface sediments (6/00 - phase I)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Preliminary Assessment and Dredging Sampling Results, Goldendale Alumina Unloading Facility (3/01) by CH2MHill	WLCGAF00, WLCGAL00		9 surface sediments (6/00 - phase I)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable (generally low recoveries)	Acceptable		Acceptable
Preliminary Assessment and Dredging Sampling Results, Goldendale Alumina Unloading Facility (3/01) by CH2MHill	WLCGAF00, WLCGAL00		9 surface sediments (6/00 - phase I)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable (generally low recoveries)
Preliminary Assessment and Dredging Sampling Results, Goldendale Alumina Unloading Facility (3/01) by CH2MHill	WLCGAF00, WLCGAL00		9 surface sediments (6/00 - phase I)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Preliminary Assessment and Dredging Sampling Results, Goldendale Alumina Unloading Facility (3/01) by CH2MHill	WLCGAF00, WLCGAL00		9 surface sediments (12/00 - phase II)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Expanded Preliminary Assessment for the Linnton Site (Georgia-Pacific) 8/00 by CH2MHill	WLCGPE00		13 surface sediment & 12 core composites	CH2MHill / Corvallis	??	??	??	??	??	??	??
Expanded Preliminary Assessment for the Linnton Site (Georgia-Pacific) 8/00 by CH2MHill	WLCGPE00		13 surface sediment & 12 core composites	CH2MHill / Corvallis	??	??	??	??	??	??	??

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Matrix	Laboratory	C-O-C	HT's	Method Blank(s)	MS/MSD's	LCS's	Replicates	Surrogate(s)
Expanded Preliminary Assessment for the Linnton Site (Georgia-Pacific) 8/00 by CH2MHill	WLCGPE00		13 surface sediment & 12 core composites	CH2MHill / Corvallis	??	??	??	??	??	??	
Expanded Preliminary Assessment for the Linnton Site (Georgia-Pacific) 8/00 by CH2MHill	WLCGPE00		13 surface sediment & 12 core composites	CH2MHill / Corvallis	??	??	??	??	??	??	
Expanded Preliminary Assessment for the Linnton Site (Georgia-Pacific) 8/00 by CH2MHill	WLCGPE00		13 surface sediment & 12 core composites	CAS / Kelso	??	??				??	
Phase I Remedial Investigation Summary Report & Preliminary Analysis of Soil Data - Volume 2 (10/9/98), Hahn & Assoc.	WLCGSA96		11 sediment samples (1/96)	NET Portland	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Phase I Remedial Investigation Summary Report & Preliminary Analysis of Soil Data - Volume 2 (10/9/98), Hahn & Assoc.	WLCGSA96		11 sediment samples (1/96)	NET Portland	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Phase I Remedial Investigation Summary Report & Preliminary Analysis of Soil Data - Volume 2 (10/9/98), Hahn & Assoc.	WLCGSA96		11 sediment samples (1/96)	NET Portland	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Phase I Remedial Investigation Summary Report & Preliminary Analysis of Soil Data - Volume 2 (10/9/98), Hahn & Assoc.	WLCGSA96		11 sediment samples (1/96)	NET Portland	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Phase I Remedial Investigation Summary Report & Preliminary Analysis of Soil Data - Volume 2 (10/9/98), Hahn & Assoc.	WLCGSA96		11 sediment samples (1/96)	NET Portland	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable	
Phase I Remedial Investigation Summary Report & Preliminary Analysis of Soil Data - Volume 2 (10/9/98), Hahn & Assoc.	WLCGSA96		11 sediment samples (1/96)	NET Portland	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		
NW Natural "Gasco" Site, Draft Screening Level Nearshore Source Control Evaluation Results Report. July 2001	WLCGSD01		27 surface & subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	MS acceptable	Acceptable	Acceptable	
NW Natural "Gasco" Site, Draft Screening Level Nearshore Source Control Evaluation Results Report. July 2001	WLCGSD01		27 surface & subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	MS acceptable	Acceptable	Acceptable	
NW Natural "Gasco" Site, Draft Screening Level Nearshore Source Control Evaluation Results Report. July 2001	WLCGSD01		27 surface & subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable (spike levels generally less than native levels)	Acceptable (some results qual. as estimates due to low recoveries		Acceptable
NW Natural "Gasco" Site, Draft Screening Level Nearshore Source Control Evaluation Results Report. July 2001	WLCGSD01		27 surface & subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Environmental Site Assessment GATX Terminals Corporation KHM Environmental Management December 1999	WLCGXV99		32 soil samples; 5 GW BTEX; 3 GW VOCs	NCA Beaverton	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Environmental Site Assessment GATX Terminals Corporation KHM Environmental Management December 1999	WLCGXV99		14 surface soil samples; 8 sediment samples; 5 groundwater samples	NCA Beaverton	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	
Environmental Site Assessment GATX Terminals Corporation KHM Environmental Management December 1999	WLCGXV99		8 sediment samples	NCA Beaverton	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Environmental Site Assessment GATX Terminals Corporation KHM Environmental Management December 1999	WLCGXV99		8 sediment samples	NCA Beaverton	Acceptable	Acceptable	Acceptable		Acceptable	Acceptable	

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Matrix	Laboratory	C-O-C	HT's	Method Blank(s)	MS/MSD's	LCS's	Replicates	Surrogate(s)
Environmental Site Assessment GATX Terminals Corporation KHM Environmental Management December 1999	WLCGXV99		8 sediment samples; 4 GW PAHs	NCA Beaverton	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
McCormick & Baxter Creosoting Co., Portland; 10/99 & 1/01	WLCMBJ99, WLCMBA01		43 surface sediments (1/00)	Oregon Analytical Labs / Beaverton	Acceptable	Acceptable	Not available - only cali blanks	MS acceptable	Acceptable	Acceptable	
McCormick & Baxter Creosoting Co., Portland; 10/99 & 1/01	WLCMBJ99, WLCMBA01		43 surface sediments (10/99)	PSI / Portland	Acceptable	Acceptable				none	
McCormick & Baxter Creosoting Co., Portland; 10/99 & 1/01	WLCMBJ99, WLCMBA01		43 surface sediments (1/00)	Oregon Analytical Labs / Beaverton	Acceptable	Acceptable	Acceptable	Acceptable			Acceptable
McCormick & Baxter Creosoting Co., Portland; 10/99 & 1/01	WLCMBJ99, WLCMBA01		43 surface sediments (1/00)	Pace Analytical / Minneapolis	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
McCormick & Baxter Creosoting Co., Portland; 10/99 & 1/01	WLCMBJ99, WLCMBA01		30 surface sediments (1/01)	Rosa Env. & Geotech / Seattle	Acceptable	Acceptable				Acceptable	
McCormick & Baxter Creosoting Co., Portland; 10/99 & 1/01	WLCMBJ99, WLCMBA01		30 surface sediments (2/01)	North Creek Analytical	Acceptable	Acceptable	Acceptable	Acceptable			Acceptable
February 2002 3 sediment samples collected downstream of two stormwater outfalls adjacent to site	WLCMCB02		3 sediment samples (2/02)	North Creek Analytical / Portland	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	
February 2002 3 sediment samples collected downstream of two stormwater outfalls adjacent to site	WLCMCB02		3 sediment samples (2/02)	North Creek Analytical / Portland	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
February 2002 3 sediment samples collected downstream of two stormwater outfalls adjacent to site	WLCMCB02		3 sediment samples (2/02)	Severn Trent Laboratory/Seattle	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Expanded Preliminary Assessment Data Report - Marine Finance Site, Portland (11/00) by Jacobs Engineering	WLCMFH00		11 sediments (8/00)	CAS / Kelso	Acceptable	Acceptable	Acceptable		Acceptable	Acceptable	Acceptable
Expanded Preliminary Assessment Data Report - Marine Finance Site, Portland (11/00) by Jacobs Engineering	WLCMFH00		9 sediments (8/00)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Expanded Preliminary Assessment Data Report - Marine Finance Site, Portland (11/00) by Jacobs Engineering	WLCMFH00		11 sediments (8/00)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Expanded Preliminary Assessment Data Report - Marine Finance Site, Portland (11/00) by Jacobs Engineering	WLCMFH00		8 sediments (8/00)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	
Expanded Preliminary Assessment Data Report - Marine Finance Site, Portland (11/00) by Jacobs Engineering	WLCMFH00		11 sediments (8/00)	CAS/Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	
Expanded Preliminary Assessment Data Report - Marine Finance Site, Portland (11/00) by Jacobs Engineering	WLCMFH00		11 sediments (8/00)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Lab Data for Phase 1 Data Evaluation & Phase 2 Work Planning for City of Portland Outfall 18	WLCOFH02		9 sediments (8/02)	Severn Trent Laboratory/Seattle	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Lab Data for Phase 1 Data Evaluation & Phase 2 Work Planning for City of Portland Outfall 18	WLCOFH02		9 sediments (8/02)	Severn Trent Laboratory/Seattle	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Lab Data for Phase 1 Data Evaluation & Phase 2 Work Planning for City of Portland Outfall 18	WLCOFH02		9 sediments (8/02)	Severn Trent Laboratory/Seattle	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Lab Data for Phase 1 Data Evaluation & Phase 2 Work Planning for City of Portland Outfall 18	WLCOFH02		9 sediments (8/02)	Severn Trent Laboratory/Seattle	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Matrix	Laboratory	C-O-C	HT's	Method Blank(s)	MS/MSD's	LCS's	Replicates	Surrogate(s)
Lab Data for Phase 1 Data Evaluation & Phase 2 Work Planning for City of Portland Outfall 18	WLCOFH02		10 sediments (8/02)	Severn Trent Laboratory/Burlington	Acceptable	Acceptable					
Lab Data for Phase 1 Data Evaluation & Phase 2 Work Planning for City of Portland Outfall 18	WLCOFH02		9 sediments (8/02)	CH2M Hill Corvallis	Acceptable	Acceptable	Acceptable		Acceptable		Acceptable
Lab Data for Phase 1 Data Evaluation & Phase 2 Work Planning for City of Portland Outfall 18	WLCOFH02		9 sediments (8/02)	CH2M Hill Corvallis	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Lab Data for Phase 1 Data Evaluation & Phase 2 Work Planning for City of Portland Outfall 18	WLCOFH02		9 sediments (8/02)	CH2M Hill Corvallis	Acceptable	Acceptable	Calibration Blanks Acceptables		Acceptable		
Lab Data for Phase 1 Data Evaluation & Phase 2 Work Planning for City of Portland Outfall 18	WLCOFH02		9 sediments (8/02)	CH2M Hill Corvallis	Acceptable	Acceptable	Acceptable		Acceptable		
Lab Data for City of Portland Outfall M-1	WLCOFH02		10 sediments (8/02)	Severn Trent Laboratory/Seattle	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Lab Data for City of Portland Outfall M-1	WLCOFH02		10 sediments (8/02)	Severn Trent Laboratory/Seattle	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Lab Data for City of Portland Outfall M-1	WLCOFH02		10 sediments (8/02)	Severn Trent Laboratory/Seattle	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Lab Data for City of Portland Outfall M-1	WLCOFH02		10 sediments (8/02)	Severn Trent Laboratory/Seattle	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	
Lab Data for City of Portland Outfall M-1	WLCOFH02		3 sediments (8/02)	STL Burlington							
Lab Data for City of Portland Outfall M-1	WLCOFH02		10 sediments (8/02)	CH2M Hill Corvallis	Acceptable	Acceptable	Acceptable		Acceptable		Acceptable
Lab Data for City of Portland Outfall M-1	WLCOFH02		10 sediments (8/02)	CH2M Hill Corvallis	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Lab Data for City of Portland Outfall M-1	WLCOFH02		10 sediments (8/02)	CH2M Hill Corvallis	Acceptable	Acceptable	Calibration Blanks Acceptables		Acceptable	Acceptable	
Lab Data for City of Portland Outfall M-1	WLCOFH02		10 sediments (8/02)	CH2M Hill Corvallis	Acceptable	Acceptable	Acceptable		Acceptable		
Pre-Remedial Investigation Field Activities Data Report, Oregon Steel Mills, Inc. 2/01 by Exponent	WLCOSJ00		16 surface sediments (10/10/00)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Pre-Remedial Investigation Field Activities Data Report, Oregon Steel Mills, Inc. 2/01 by Exponent	WLCOSJ00		16 surface sediments (10/10/00)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Pre-Remedial Investigation Field Activities Data Report, Oregon Steel Mills, Inc. 2/01 by Exponent	WLCOSJ00		16 surface sediments (10/10/00)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Pre-Remedial Investigation Field Activities Data Report, Oregon Steel Mills, Inc. 2/01 by Exponent	WLCOSJ00		16 surface sediments (10/10/00)	CAS / Kelso	Acceptable	Acceptable	Acceptable	MS acceptable	Acceptable	Acceptable	
Pre-Remedial Investigation Field Activities Data Report, Oregon Steel Mills, Inc. 2/01 by Exponent	WLCOSJ00		16 surface sediments (10/10/00)	CAS / Kelso	Acceptable	Acceptable	Acceptable	MS acceptable		Acceptable	
Rose Festival Moorage / Front Ave. Seawall - Sediment Sampling & Analysis Report; AGI 7/95	WLCRFE95		5 subsurface composite sediments (5/95)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable	Acceptable
Rose Festival Moorage / Front Ave. Seawall - Sediment Sampling & Analysis Report; AGI 7/95	WLCRFE95		5 subsurface composite sediments (5/95)	CAS / Kelso	Acceptable	Acceptable	Acceptable			Acceptable	
Rose Festival Moorage / Front Ave. Seawall - Sediment Sampling & Analysis Report; AGI 7/95	WLCRFE95		5 subsurface composite sediments (5/95)	CAS / Kelso	Acceptable	Acceptable	Acceptable	MS acceptable			
Rose Festival Moorage / Front Ave. Seawall - Sediment Sampling & Analysis Report; AGI 7/95	WLCRFE95		5 subsurface composite sediments (5/95)	CAS / Kelso	Acceptable	Acceptable	Acceptable				Acceptable
Rose Festival Moorage / Front Ave. Seawall - Sediment Sampling & Analysis Report; AGI 7/95	WLCRFE95		5 subsurface composite sediments (5/95)	CAS / Kelso	Acceptable	Acceptable	Acceptable		Acceptable		Acceptable
Rose Festival Moorage / Front Ave. Seawall - Sediment Sampling & Analysis Report; AGI 7/95	WLCRFE95		5 subsurface composite sediments (5/95)	(unknown)	none						
Baseline Sediment Characterization In-Water Clear Zone Sampling Results, Ross Island Lagoon (1/24/00) by Landau (P. Stoltz & J. Wilson)	WLCRIJ99		12 sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	MS acceptable	Acceptable	Acceptable	

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Matrix	Laboratory	C-O-C	HT's	Method Blank(s)	MS/MSD's	LCS's	Replicates	Surrogate(s)
Baseline Sediment Characterization In-Water Clear Zone Sampling Results, Ross Island Lagoon (1/24/00) by Landau (P. Stoltz & J. Wilson)	WLCRIJ99		12 sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Baseline Sediment Characterization In-Water Clear Zone Sampling Results, Ross Island Lagoon (1/24/00) by Landau (P. Stoltz & J. Wilson)	WLCRIJ99		12 seds. & 4 sed. porewaters	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable			Acceptable
Baseline Sediment Characterization In-Water Clear Zone Sampling Results, Ross Island Lagoon (1/24/00) by Landau (P. Stoltz & J. Wilson)	WLCRIJ99		12 sediments	CAS / Kelso	Acceptable	Acceptable	Some detects - data qual. appropriately	Acceptable			
Baseline Sediment Characterization In-Water Clear Zone Sampling Results, Ross Island Lagoon (1/24/00) by Landau (P. Stoltz & J. Wilson)	WLCRIJ99		12 sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable		Acceptable	Acceptable	
Appendix A: Data Validation Summary and Complied Chemical Laboratory Analytical Data - Ross Island Lagoon, by Hart Crowser	WLCRIL99		63 sediments, 6 soils, 44 porewaters, 8 surfacewaters, 13 groundwaters & 45 leachates	Columbia Analytical Services	Referenced in data validaton report	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	
Appendix A: Data Validation Summary and Complied Chemical Laboratory Analytical Data - Ross Island Lagoon, by Hart Crowser	WLCRIL99		44 porewaters	Columbia Analytical Services	Referenced in data validaton report	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Appendix A: Data Validation Summary and Complied Chemical Laboratory Analytical Data - Ross Island Lagoon, by Hart Crowser	WLCRIL99		63 sediments, 6 soils, 44 porewaters, 8 surfacewaters, 13 groundwaters & 45 leachates	Columbia Analytical Services	Referenced in data validaton report	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Appendix A: Data Validation Summary and Complied Chemical Laboratory Analytical Data - Ross Island Lagoon, by Hart Crowser	WLCRIL99		63 sediments, 6 soils, 44 porewaters, 8 surfacewaters, 13 groundwaters & 45 leachates	Columbia Analytical Services	Referenced in data validaton report	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Appendix A: Data Validation Summary and Complied Chemical Laboratory Analytical Data - Ross Island Lagoon, by Hart Crowser	WLCRIL99		63 sediments, 6 soils, 44 porewaters, 8 surfacewaters, 13 groundwaters & 45 leachates	Columbia Analytical Services	Referenced in data validaton report	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Appendix A: Data Validation Summary and Complied Chemical Laboratory Analytical Data - Ross Island Lagoon, by Hart Crowser	WLCRIL99		63 sediments, 6 soils, 44 porewaters, 8 surfacewaters, 13 groundwaters & 45 leachates	Columbia Analytical Services	Referenced in data validaton report	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	
Phase I Remedial Investigation Ross Island Sand & Gravel Co. (3/00) by Landau Assoc.	WLCRIV99		31 subsurface sediments (Nov Dec 1999)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	
Phase I Remedial Investigation Ross Island Sand & Gravel Co. (3/00) by Landau Assoc.	WLCRIV99		37 subsurface sediments (Nov Dec 1999)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Phase I Remedial Investigation Ross Island Sand & Gravel Co. (3/00) by Landau Assoc.	WLCRIV99		33 subsurface sediments (Nov Dec 1999)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Phase I Remedial Investigation Ross Island Sand & Gravel Co. (3/00) by Landau Assoc.	WLCRIV99		36 subsurface sediments (Nov Dec 1999)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Phase I Remedial Investigation Ross Island Sand & Gravel Co. (3/00) by Landau Assoc.	WLCRIV99		40 subsurface sediments (Nov Dec99)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	
Phase I Remedial Investigation Ross Island Sand & Gravel Co. (3/00) by Landau Assoc.	WLCRIV99		4 surface sediments (10/28/99)	CAS / Kelso	Acceptable	Acceptable	Acceptable	MS acceptable	Acceptable	Acceptable	
Phase I Remedial Investigation Ross Island Sand & Gravel Co. (3/00) by Landau Assoc.	WLCRIV99		4 surface sediments (10/28/99)	CAS / Kelso	Acceptable	Acceptable	Acceptable (some hits qual. appropriately)	Acceptable	Acceptable		Acceptable
Phase I Remedial Investigation Ross Island Sand & Gravel Co. (3/00) by Landau Assoc.	WLCRIV99		4 surface sediments (10/28/99)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Phase I Remedial Investigation Ross Island Sand & Gravel Co. (3/00) by Landau Assoc.	WLCRIV99		4 surface sediments (10/28/99)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Phase I Remedial Investigation Ross Island Sand & Gravel Co. (3/00) by Landau Assoc.	WLCRIV99		4 surface sediments (10/28/99)	CAS / Kelso	Acceptable	Acceptable	Acceptable	MS acceptable	Acceptable	Acceptable	
Phase I Remedial Investigation Ross Island Sand & Gravel Co. (3/00) by Landau Assoc.	WLCRIV99		4 surface sediments (10/28/99)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Matrix	Laboratory	C-O-C	HT's	Method Blank(s)	MS/MSD's	LCS's	Replicates	Surrogate(s)
RI/FS Quarterly Progress Report, 1st quarter 1995, Surface Water & Sediment, Rhône-Poulenc (6/95) by Woodward-Clyde Consultants	WLCRPB95		8 surface sediments (1-2/95)	Quanterra Environmental Services / W.	none	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
RI/FS Quarterly Progress Report, 1st quarter 1995, Surface Water & Sediment, Rhône-Poulenc (6/95) by Woodward-Clyde Consultants	WLCRPB95		8 surface sediments (1-2/95)	Quanterra Environmental Services / W.	none	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
RI/FS Quarterly Progress Report, 1st quarter 1995, Surface Water & Sediment, Rhône-Poulenc (6/95) by Woodward-Clyde Consultants	WLCRPB95		8 surface sediments (1-2/95)	Quanterra Environmental Services / W.	none	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
RI/FS Quarterly Progress Report, 1st quarter 1995, Surface Water & Sediment, Rhône-Poulenc (6/95) by Woodward-Clyde Consultants	WLCRPB95		8 surface sediments (1-2/95)	Quanterra Environmental Services / W.	none	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
RI/FS Quarterly Progress Report, 1st quarter 1995, Surface Water & Sediment, Rhône-Poulenc (6/95) by Woodward-Clyde Consultants	WLCRPB95		8 surface sediments (1-2/95)	Quanterra Environmental Services / W.	none	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
RI/FS Quarterly Progress Report, 1st quarter 1995, Surface Water & Sediment, Rhône-Poulenc (6/95) by Woodward-Clyde Consultants	WLCRPB95		8 surface sediments (1-2/95)	Quanterra Environmental Services / W.	none	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
RI/FS Quarterly Progress Report, 1st quarter 1995, Surface Water & Sediment, Rhône-Poulenc (6/95) by Woodward-Clyde Consultants	WLCRPB95		8 surface sediments (1-2/95)	Quanterra Environmental Services / W.	none	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
COE Willamette River Channel Deepening 1997 Data	WLCT0F01		4 sediments & 54 waters (7/01)	CAS / Kelso	Lab case narrative references COC	Acceptable	Acceptable	MS acceptable	Acceptable	Acceptable	
Dredge Material Characterization Study; Marine Terminal 2, Berths 203-206; Marine Terminal 5, Berth 501 (8/24/01) by Hart Crowser	WLCT0F01		4 sediments & 54 waters (7/01)	CAS / Kelso	Lab case narrative references COC	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	
Dredge Material Characterization Study; Marine Terminal 2, Berths 203-206; Marine Terminal 5, Berth 501 (8/24/01) by Hart Crowser	WLCT0F01		4 sediment porewaters (7/01)	CAS / Kelso	Lab case narrative references COC	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Dredge Material Characterization Study; Marine Terminal 2, Berths 203-206; Marine Terminal 5, Berth 501 (8/24/01) by Hart Crowser	WLCT0F01		4 sediments & 54 waters (7/01)	CAS / Kelso	Lab case narrative references COC	All sample HT exceeded - require "J" qual. of all results.	Acceptable	Acceptable	Acceptable		Acceptable
Dredge Material Characterization Study; Marine Terminal 2, Berths 203-206; Marine Terminal 5, Berth 501 (8/24/01) by Hart Crowser	WLCT0F01		4 sediments & 54 waters (7/01)	CAS / Kelso	Lab case narrative references COC	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Dredge Material Characterization Study; Marine Terminal 2, Berths 203-206; Marine Terminal 5, Berth 501 (8/24/01) by Hart Crowser	WLCT0F01		4 sediments & 54 waters (7/01)	CAS / Kelso	Lab case narrative references COC	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Sediment Characterization Study of Local Sponsors' Berths: Columbia & Willamette River prepared by Hart-Crowser	WLCT0I98	PTLDBRTH	30 surface and subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	MS acceptable; total sulfides as estimates due to low recoveries.	Acceptable	Acceptable	
Port of Portland, Sediment Characterization Study of Local Sponsors' Berths (2/1/99) - Terminal 4, Slip 1 Preliminary Assessment Appendix by Hart Crowser	WLCT0I98		34 sediments (9/98)	CAS / Kelso	Acceptable	Acceptable	Acceptable	MS acceptable	Acceptable	Acceptable	
Port of Portland, Sediment Characterization Study of Local Sponsors' Berths (2/1/99) - Terminal 4, Slip 1 Preliminary Assessment Appendix by Hart Crowser	WLCT0I98		34 sediments (9/98)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Low recov. for phenols - "J" qual. required for all phenols.

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Matrix	Laboratory	C-O-C	HT's	Method Blank(s)	MS/MSD's	LCS's	Replicates	Surrogate(s)
Port of Portland, Sediment Characterization Study of Local Sponsors' Berths (2/1/99) - Terminal 4, Slip 1 Preliminary Assessment Appendix by Hart Crowser	WLCT0I98		34 sediments (9/98)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Port of Portland, Sediment Characterization Study of Local Sponsors' Berths (2/1/99) - Terminal 4, Slip 1 Preliminary Assessment Appendix by Hart Crowser	WLCT0I98		34 sediments (9/98)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Port of Portland, Sediment Characterization Study of Local Sponsors' Berths (2/1/99) - Terminal 4, Slip 1 Preliminary Assessment Appendix by Hart Crowser	WLCT0I98		12 sed. porewaters (9/98)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Some low recoveries	Acceptable		Some data qual. due to low recovereis.
Port of Portland, Sediment Characterization Study of Local Sponsors' Berths (2/1/99) - Terminal 4, Slip 1 Preliminary Assessment Appendix by Hart Crowser	WLCT0I98		34 sediments (9/98)	CAS / Kelso	Acceptable	Acceptable	Acceptable	MS acceptable	Acceptable	Acceptable	
Sediment Characterization Study of Local Sponsors' Berths: Columbia & Willamette River prepared by Hart-Crowser	WLCT0I98	PTLDBRTH	30 surface and subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable; some Cd reported with "B" - recommend replacing with"U" code	MS acceptable; variable recov. require qual. as estimates.	Acceptable; variable recov. require qual. as estimates.	Acceptable	
Sediment Characterization Study of Local Sponsors' Berths: Columbia & Willamette River prepared by Hart-Crowser	WLCT0I98	PTLDBRTH	30 surface and subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Sediment Characterization Study of Local Sponsors' Berths: Columbia & Willamette River prepared by Hart-Crowser	WLCT0I98	PTLDBRTH	30 surface and subsurface sediments	CAS / Kelso	Acceptable	Acceptable (initial analyses OK; reanalyses outside HTs)	Acceptable	Acceptable; consistently low recov. for phenolics - qual. as estimates	Acceptable		Acceptable; large # of surrogates outside specification - require qual. of many results as estimates
Sediment Characterization Study of Local Sponsors' Berths: Columbia & Willamette River prepared by Hart-Crowser	WLCT0I98	PTLDBRTH	24 surface and subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable - recov. consistent with surrogate recov.	Acceptable - recov. consistent with surrogate recov.		Acceptable - require qual. of all results when any surrogate recov. <50%
Sediment Characterization Study of Local Sponsors' Berths: Columbia & Willamette River prepared by Hart-Crowser	WLCT0I98	PTLDBRTH	30 surface and subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Sediment Characterization Study of Local Sponsors' Berths: Columbia & Willamette River prepared by Hart-Crowser	WLCT0I98	PTLDBRTH	30 surface and subsurface sediments	CAS / Kelso	Acceptable	Acceptable	none	MS acceptable; total sulfides as estimates due to low recoveries	Acceptable	Acceptable	
Sediment Characterization Study, River Terminals 1, 2 and 5, Willamette River (1/14/97) by Hart Crowser	WLCT0K96		8 sed. cores (includes 1 field dup.)	CAS / Kelso	Acceptable	Acceptable				Acceptable	
Sediment Characterization Study, River Terminals 1, 2 and 5, Willamette River (1/14/97) by Hart Crowser	WLCT0K96		8 sed. cores (includes 1 field dup.)	CAS / Kelso	Acceptable	Acceptable	Acceptable	MS acceptable	none	Acceptable - Hg shows high variability and	
Sediment Characterization Study, River Terminals 1, 2 and 5, Willamette River (1/14/97) by Hart Crowser	WLCT0K96		8 sed. cores (includes 1 field dup.)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable - pyrene RPD requires qual. of some results as "J".	none		Acceptable
Sediment Characterization Study, River Terminals 1, 2 and 5, Willamette River (1/14/97) by Hart Crowser	WLCT0K96		8 sed. cores (includes 1 field dup.)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Sediment Characterization Study, River Terminals 1, 2 and 5, Willamette River (1/14/97) by Hart Crowser	WLCT0K96		8 sed. cores (includes 1 field dup.)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Sediment Characterization Study, River Terminals 1, 2 and 5, Willamette River (1/14/97) by Hart Crowser	WLCT0K96		8 sed. cores (includes 1 field dup.)	CAS / Kelso	Acceptable	Acceptable	Acceptable	MS acceptable		Acceptable - sulfides show high variability and require hits as	
Marine Terminal 1 Baseline Investigation, Final Report (8/25/00) by Striplin Environmental	WLCT1F00		9 surface sediments (6/23/00)	CAS / Kelso	Acceptable	Acceptable	Acceptable		Acceptable	Acceptable	
Marine Terminal 1 Baseline Investigation, Final Report (8/25/00) by Striplin Environmental	WLCT1F00		9 surface sediments (6/23/00)	CAS / Kelso	Acceptable	Acceptable	Acceptable	MS acceptable	Acceptable	Acceptable	
Marine Terminal 1 Baseline Investigation, Final Report (8/25/00) by Striplin Environmental	WLCT1F00		9 surface sed. porewaters (6/23/00)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	none reported
Marine Terminal 1 Baseline Investigation, Final Report (8/25/00) by Striplin Environmental	WLCT1F00		9 surface sediments (6/23/00)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		none reported

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Matrix	Laboratory	C-O-C	HT's	Method Blank(s)	MS/MSD's	LCS's	Replicates	Surrogate(s)
Marine Terminal 1 Baseline Investigation, Final Report (8/25/00) by Striplin Environmental	WLCT1F00		9 surface sediments (6/23/00)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		none reported
Marine Terminal 1 Baseline Investigation, Final Report (8/25/00) by Striplin Environmental	WLCT1F00		9 surface sediments (6/23/00)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		none reported
Marine Terminal 1 Baseline Investigation, Final Report (8/25/00) by Striplin Environmental	WLCT1F00		9 surface sediments (6/23/00)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable			none reported
Port of Portland Terminal 1, Berth 104, 1992 Sediment Characterization	WLCT1L91		2 sediments (12/91)	CAS / Kelso	Data package references COC	Acceptable	Acceptable			none	
Port of Portland Terminal 1, Berth 104, 1992 Sediment Characterization	WLCT1L91		2 sediments (12/91)	CAS / Kelso	Data package references COC	Acceptable	Acceptable	none	none		Acceptable
Port of Portland Terminal 1, Berth 104, 1992 Sediment Characterization	WLCT1L91		2 sediments (12/91)	CAS / Kelso	Data package references COC	Acceptable	Acceptable	none	none		Acceptable
Port of Portland Terminal 1, Berth 104, 1992 Sediment Characterization	WLCT1L91		2 sediments (12/91)	CAS / Kelso	Data package references COC	Acceptable	Acceptable	none	none		Acceptable
Sediment Characterization Study - Terminal 4, Berth 416 Willamette River (3/10/98) by Hart Crowser	WLCT4J97		4 sediments (includes a dup. pair)	unknown	none	??				??	
Sediment Characterization Study - Terminal 4, Berth 416 Willamette River (3/10/98) by Hart Crowser	WLCT4J97		4 sediments (includes a dup. pair)	North Creek Analytical / Bothell	none	Acceptable - sulfides exceeded and require all qual. as "J"	Acceptable	Acceptable	Acceptable	Acceptable - sulfides show high variability and require hits as	
Sediment Characterization Study - Terminal 4, Berth 416 Willamette River (3/10/98) by Hart Crowser	WLCT4J97		4 sediments (includes a dup. pair)	North Creek Analytical / Bothell	none	Acceptable	Acceptable	MS acceptable	Acceptable	Acceptable	
Sediment Characterization Study - Terminal 4, Berth 416 Willamette River (3/10/98) by Hart Crowser	WLCT4J97		4 sed. porewaters (includes a dup. pair)	North Creek Analytical / Bothell	none	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Sediment Characterization Study - Terminal 4, Berth 416 Willamette River (3/10/98) by Hart Crowser	WLCT4J97		4 sediments (includes a dup. pair)	North Creek Analytical / Bothell	none	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Sediment Characterization Study - Terminal 4, Berth 416 Willamette River (3/10/98) by Hart Crowser	WLCT4J97		4 sediments (includes a dup. pair)	North Creek Analytical / Bothell	none	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
1998 Terminal 4, Slip 3 Sediment Investigation, Port of Portland	WLCT4J98	HC-10-98	49 surface sediments	CAS / Kelso	Acceptable	Acceptable; sulfides qual. as estimates due to exceedance of HT.	Acceptable	Acceptable MS	Acceptable		
1998 Terminal 4, Slip 3 Sediment Investigation, Port of Portland	WLCT4J98	HC-10-98	48 surface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable MS	Acceptable	Acceptable	Acceptable
1998 Terminal 4, Slip 3 Sediment Investigation, Port of Portland	WLCT4J98	HC-10-98	44 surface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable MS; low recoveries for Sb, Cd, Pb, Ni, Ag & Zn	Acceptable; low recoveries for Sb, Cd, Pb, Ni, Ag & Zn	Acceptable	
1998 Terminal 4, Slip 3 Sediment Investigation, Port of Portland	WLCT4J98	HC-10-98	5 surface and subsurface sediments	CAS / Kelso	Acceptable	All exceeded recommended HTs by 41 days.	Acceptable	Acceptable	Acceptable		Acceptable
1998 Terminal 4, Slip 3 Sediment Investigation, Port of Portland	WLCT4J98	HC-10-98	56 surface sediments	CAS / Kelso	Acceptable	Acceptable (initial analyses OK; reanalyses outside HTs)	Acceptable; rinsate blk showed bis(2-ethylhexyl)phthalate near RL.	Acceptable; consistently low recov. for phenolics - qual. as estimates	Acceptable; consistently low recov. for phenolics - qual. as estimates		Acceptable; consistently low recov. for phenolics - qual. as estimates
1998 Terminal 4, Slip 3 Sediment Investigation, Port of Portland	WLCT4J98	HC-10-98	55 surface and subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Terminal 4 - Slip 1 and Berth 401 Sediment Characterization Study (5/31/00) by Hart Crowser	WLCT4K99	PPTLDSL1	10 sediments (11/99)	unknown	??	??	??	??	??	??	??
Terminal 4 Berth 408 Dredging Sediment Quality (1/19/94) by Port of Portland	WLCT4L93		3 surface sediments (12/7/93)	CAS / Kelso	Acceptable	Acceptable	Acceptable				Acceptable

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Matrix	Laboratory	C-O-C	HT's	Method Blank(s)	MS/MSD's	LCS's	Replicates	Surrogate(s)
Terminal 4 Berth 408 Dredging Sediment Quality (1/19/94) by Port of Portland	WLCT4L93		3 surface sediments (12/7/93)	CAS / Kelso	Acceptable	Acceptable				Acceptable	
Terminal 4 Berth 408 Dredging Sediment Quality (1/19/94) by Port of Portland	WLCT4L93		3 surface sediments (12/7/93)	CAS / Kelso	Acceptable	Acceptable	Acceptable	none	none		Acceptable
Terminal 4 Berth 408 Dredging Sediment Quality (1/19/94) by Port of Portland	WLCT4L93		3 surface sediments (12/7/93)	CAS / Kelso	Acceptable	Acceptable	Acceptable	none	none		Acceptable
Terminal 4 Berth 408 Dredging Sediment Quality (1/19/94) by Port of Portland	WLCT4L93		3 surface sediments (12/7/93)	CAS / Kelso	Acceptable	Acceptable	Acceptable (bis(2-ethylhexyl)phthalate in all samples require "U" qualification due to MB hits)	none	none		All neutral surrogates not evaluated - require all neutrals to be "J" qualified.
Terminal 4 Berth 408 Dredging Sediment Quality (1/19/94) by Port of Portland	WLCT4L93		3 surface sediments (12/7/93)	CAS / Kelso	Acceptable	Acceptable	Acceptable	none	none	none	
Sediment Characterization at Marine Terminal 5, Barge Berth 501 and Berth 503 (2/1/00) by Hart Crowser	WLCT5K99		3 composite sediments (11/22/99)	CAS / Kelso	Report states that all samples collected under	Acceptable				none	
Sediment Characterization at Marine Terminal 5, Barge Berth 501 and Berth 503 (2/1/00) by Hart	WLCT5K99		3 composite sediments (11/22/99)	CAS / Kelso	Acceptable	Acceptable	Acceptable	MS acceptable	Acceptable		
Sediment Characterization at Marine Terminal 5, Barge Berth 501 and Berth 503 (2/1/00) by Hart	WLCT5K99		3 composite sediments (11/22/99)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Sediment Characterization at Marine Terminal 5, Barge Berth 501 and Berth 503 (2/1/00) by Hart	WLCT5K99		3 composite sediments (11/22/99)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Sediment Characterization at Marine Terminal 5, Barge Berth 501 and Berth 503 (2/1/00) by Hart	WLCT5K99		3 composite seds. & 2 sed. porewaters (11/22/99)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Sediment Characterization at Marine Terminal 5, Barge Berth 501 and Berth 503 (2/1/00) by Hart Crowser	WLCT5K99		3 composite sediments (11/22/99)	CAS / Kelso	Acceptable	Acceptable (HT unknown for sulfides - require qual. as estimates "J" for all sulfides).	Acceptable	MS acceptable	Acceptable	Acceptable	
Oregon Department of Environmental Quality. DEQ Site Assessment, Willamette Cove	WLCWCJ95	WILLCOVE	11 surface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	MS acceptable	none	Acceptable	
Oregon Department of Environmental Quality. DEQ Site Assessment, Willamette Cove	WLCWCJ95	WILLCOVE	11 surface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	none		Acceptable
Oregon Department of Environmental Quality. DEQ Site Assessment, Willamette Cove	WLCWCJ95	WILLCOVE	8 surface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable; some low recoveries requiring qual. as estimates
Oregon Department of Environmental Quality. DEQ Site Assessment, Willamette Cove	WLCWCJ95	WILLCOVE	1 surface sediment	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable; low recoveries	Acceptable; low recoveries		Acceptable
Oregon Department of Environmental Quality. DEQ Site Assessment, Willamette Cove	WLCWCJ95	WILLCOVE	9 surface sediment	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	none		Acceptable
Revised 60-inch Storm Sewer Interim Remedial Actions Report Tosco Willbridge Terminal by KHM Environmental Management Inc.	WLCWTI00		12 soil samples	NCA/Portland	Acceptable	Acceptable	Acceptable		Acceptabls	Acceptable	Acceptable
Revised 60-inch Storm Sewer Interim Remedial Actions Report Tosco Willbridge Terminal by KHM Environmental Management Inc.	WLCWTI00		1 soil sample	NCA/Portland	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	
Revised 60-inch Storm Sewer Interim Remedial Actions Report Tosco Willbridge Terminal by KHM Environmental Management Inc.	WLCWTI00		1 soil sample	NCA/Portland	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Matrix	Laboratory	C-O-C	HT's	Method Blank(s)	MS/MSD's	LCS's	Replicates	Surrogate(s)
USACE Willamette Falls Lock Sediment Investigation 1996 Event	WLFL0496	WLFL96	3 subsurface sediments	USACE / Troutdale, OR	none	Acceptable				none	
USACE Willamette Falls Lock Sediment Investigation 1996 Event	WLFL0496	WLFL96	1 subsurface sediment (composite)	ARDL / Mt. Vernon, IL	none	Acceptable	none	none	none	none	
USACE Willamette Falls Lock Sediment Investigation 1996 Event	WLFL0496	WLFL96	1 subsurface sediment (composite)	ARDL / Mt. Vernon, IL	none	Acceptable	Acceptable	none	none		Partial - only nonpolar surrogates used, no phenolics
Willamette River Reference Area Study - Phase I Results and Recommendations for Phase II Sampling Locations (9/01) by Hart-Crowser	WLLRSH01		10 surface sediments	Hart-Crowser	none	unknown				none	
Willamette River Reference Area Study - Phase I Results and Recommendations for Phase II Sampling Locations (9/01) by Hart-Crowser	WLLRSH01		10 surface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Willamette River Reference Area Study - Phase I Results and Recommendations for Phase II Sampling Locations (9/01) by Hart-Crowser	WLLRSH01		10 surface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Phase I & II Lower Willamette River Reference Area Study USACOE - Hart Crowser, Inc.	WLLRSI01		pore water	Columbia Analytical Services	Acceptable	Acceptable	Acceptable The results for n-butyltin is suspect due to low P&A results	Acceptable The results for n-butyltin is suspect due to low P&A results	Acceptable	Acceptable The results for n-butyltin is suspect due to low P&A results	Acceptable
Phase I & II Lower Willamette River Reference Area Study USACOE - Hart Crowser, Inc.	WLLRSI01		8 sediments	Columbia Analytical Services	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Phase I & II Lower Willamette River Reference Area Study USACOE - Hart Crowser, Inc.	WLLRSI01		9 sediments	Columbia Analytical Services	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Phase I & II Lower Willamette River Reference Area Study USACOE - Hart Crowser, Inc.	WLLRSI01		10 sediments	Columbia Analytical Services	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Phase I & II Lower Willamette River Reference Area Study USACOE - Hart Crowser, Inc.	WLLRSI01		11 sediments	Columbia Analytical Services	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Phase I & II Lower Willamette River Reference Area Study USACOE - Hart Crowser, Inc.	WLLRSI01		12 sediments	Columbia Analytical Services	Acceptable	Acceptable	MDL<Sb result<MRL and marked as an estimation "J" Note on Sb it is recovering low in all samples and QA	Acceptable Note on Sb it is recovering low in all samples and QA	Acceptable Note on Sb it is recovering low in all samples and QA	Acceptable Note on Sb it is recovering low in all samples and QA	none
Phase I & II Lower Willamette River Reference Area Study USACOE - Hart Crowser, Inc.	WLLRSI01		13 sediments	Columbia Analytical Services	Acceptable	Acceptable	none	none	Acceptable	Acceptable	none
Phase I & II Lower Willamette River Reference Area Study USACOE - Hart Crowser, Inc.	WLLRSI01		14 sediments	Columbia Analytical Services	Acceptable	Acceptable	none	none	Acceptable	Acceptable	none
Phase I & II Lower Willamette River Reference Area Study USACOE - Hart Crowser, Inc.	WLLRSI01		15 sediments	Columbia Analytical Services	Acceptable	Acceptable	none	none	Acceptable	Acceptable	none
Analyses of Bottom Material from the Willamette River (1977) by McKenzie/USGS	WLR0277		2 surface sediments (2/1/77)	USGS Lab	??	??	??	??	??	??	
Analyses of Bottom Material from the Willamette River (1977) by McKenzie/USGS	WLR0277		2 surface sediments (2/1/77)	USGS Lab	??	??	??	??	??	??	
Analyses of Bottom Material from the Willamette River (1977) by McKenzie/USGS	WLR0277		2 surface sediments (2/1/77)	USGS Lab	??	??	??	??	??	??	??
Evaluation of Sediment Lead (Pb) Levels, Corps Operations Dredging at Broadway Bridge, lower Willamette River (6/30/88) by ACOE/Portland	WLR0388		5 sediments (3/88)	Battelle / Sequim	none						

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Matrix	Laboratory	C-O-C	HT's	Method Blank(s)	MS/MSD's	LCS's	Replicates	Surrogate(s)
USACE Lower Willamette River, 1986, 1988 (2 events) and 1992 Sampling Events	WLR0488, WLR0988, WLR0692, MCAL0986 & MCAL1286	WLR0388, WLR0988, WLR0692, WLMD0986 & WLMD1286	24 subsurface sediments	Battelle / Sequim	sporadic	12/86: acceptable. Others unknown.	9/88 & 6/92: acceptable. Others no data.	6/92: acceptable. Others no data.	86 & 88: acceptable. Others no data.	88 & 92: acceptable. 86: no data.	
USACE Lower Willamette River, 1986, 1988 (2 events) and 1992 Sampling Events	WLR0488, WLR0988, WLR0692, MCAL0986 & MCAL1286	WLR0388, WLR0988, WLR0692, WLMD0986 & WLMD1286	25 subsurface sediments (1986 event)	Battelle / Sequim	none	unknown	Acceptable	none	none		none
USACE Lower Willamette River, 1986, 1988 (2 events) and 1992 Sampling Events	WLR0488, WLR0988, WLR0692, MCAL0986 & MCAL1286	WLR0388, WLR0988, WLR0692, WLMD0986 & WLMD1286	25 subsurface sediments (1986 event)	Battelle / Sequim	Acceptable	unknown	Acceptable	none	none		Acceptable
USACE Lower Willamette River, 1986, 1988 (2 events) and 1992 Sampling Events	WLR0488, WLR0988, WLR0692, MCAL0986 & MCAL1286	WLR0388, WLR0988, WLR0692, WLMD0986 & WLMD1286	25 subsurface sediments (6/92 event)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
USACE Lower Willamette River, 1986, 1988 (2 events) and 1992 Sampling Events	WLR0488, WLR0988, WLR0692, MCAL0986 & MCAL1286	WLR0388, WLR0988, WLR0692, WLMD0986 & WLMD1286	25 subsurface sediments (6/92 event)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
USACE Lower Willamette River, 1986, 1988 (2 events) and 1992 Sampling Events	WLR0488, WLR0988, WLR0692, MCAL0986 & MCAL1286	WLR0388, WLR0988, WLR0692, WLMD0986 & WLMD1286	25 subsurface sediments (9/88 event)	ARI / Seattle	none	unknown	Acceptable	none	none		Acceptable
USACE Lower Willamette River, 1986, 1988 (2 events) and 1992 Sampling Events	WLR0488, WLR0988, WLR0692, MCAL0986 & MCAL1286	WLR0388, WLR0988, WLR0692, WLMD0986 & WLMD1286	25 subsurface sediments (9/88 event)	ARI / Seattle	Acceptable	unknown	none	none	none		Acceptable
USACE Lower Willamette River, 1986, 1988 (2 events) and 1992 Sampling Events	WLR0488, WLR0988, WLR0692, MCAL0986 & MCAL1286	WLR0388, WLR0988, WLR0692, WLMD0986 & WLMD1286	42 subsurface sediments	USACE / Troutdale, OR	none	unknown			Acceptable - oil & grease	1988 grain size duplicate	
USACE Lower Willamette River, 1986, 1988 (2 events) and 1992 Sampling Events	WLR0488, WLR0988, WLR0692, MCAL0986 & MCAL1286	WLR0388, WLR0988, WLR0692, WLMD0986 & WLMD1286	subsurface sediments (1986 event)	Laucks / Seattle	none	unknown			Acceptable	1988 duplicate	
USACE Lower Willamette River, 1986, 1988 (2 events) and 1992 Sampling Events	WLR0488, WLR0988, WLR0692, MCAL0986 & MCAL1286	WLR0388, WLR0988, WLR0692, WLMD0986 & WLMD1286	subsurface sediments (1986 event)	Laucks / Seattle	none	unknown					
USACE Lower Willamette River, 1986, 1988 (2 events) and 1992 Sampling Events	WLR0488, WLR0988, WLR0692, MCAL0986 & MCAL1286	WLR0388, WLR0988, WLR0692, WLMD0986 & WLMD1286	subsurface sediments (1988 event)	Weston Analytics	none	unknown	Acceptable	Acceptable	Acceptable		

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Matrix	Laboratory	C-O-C	HT's	Method Blank(s)	MS/MSD's	LCS's	Replicates	Surrogate(s)
USACE Lower Willamette River, 1986, 1988 (2 events) and 1992 Sampling Events	WLR0488, WLR0988, WLR0692, MCAL0986 & MCAL1286	WLR0388, WLR0988, WLR0692, WLMD0986 & WLMD1286	subsurface sediments (1992 event)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable MS	Acceptable	Acceptable	
USACE Lower Willamette River, 1986, 1988 (2 events) and 1992 Sampling Events	WLR0488, WLR0988, WLR0692, MCAL0986 & MCAL1286	WLR0388, WLR0988, WLR0692, WLMD0986 & WLMD1286	25 subsurface sediments (6/92 event)	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Willamette River Sediment Sampling Event, U.S. Moorings (4/28/99)	WLR0499	WLR0499	9 sediments	Aquatic Research, Inc. / Seattle	none	Acceptable				Acceptable	
Willamette River Sediment Sampling Event, U.S. Moorings (4/28/99)	WLR0499	WLR0499	11 sediments	Sound Analytical Services / Tacoma	Acceptable	Acceptable		none	none	none	
Willamette River Sediment Sampling Event, U.S. Moorings (4/28/99)	WLR0499	WLR0499	11 sediments	Sound Analytical Services / Tacoma	Acceptable	Acceptable				none	
Willamette River Sediment Sampling Event, U.S. Moorings (4/28/99)	WLR0499	WLR0499	11 sediments	Sound Analytical Services / Tacoma	Acceptable	Acceptable	Acceptable	none	none		Acceptable
Willamette River Sediment Sampling Event, U.S. Moorings (4/28/99)	WLR0499	WLR0499	3 sed. porewaters	Sound Analytical Services / Tacoma	Acceptable	Acceptable		none	none		Acceptable
Willamette River Sediment Sampling Event, U.S. Moorings (4/28/99)	WLR0499	WLR0499	11 sediments	Sound Analytical Services / Tacoma	Acceptable	Acceptable		none	none		Acceptable
Willamette River Sediment Sampling Event, U.S. Moorings (4/28/99)	WLR0499	WLR0499	11 sediments	Sound Analytical Services / Tacoma	Acceptable	Acceptable		none	none		Acceptable
Willamette River Sediment Sampling Event, U.S. Moorings (4/28/99)	WLR0499	WLR0499	2 sediments	Quanterra Environmental Services / W.	Acceptable	Acceptable	Acceptable		Acceptable		Acceptable
Elutriation Study of Willamette River Bottom Material and Willamette-Columbia River Water (1977) by USGS/Rinella & McKenzie	WLR0577		1 sediment (2/1/77)	USGS / Arvada	none	??	??			??	
Elutriation Study of Willamette River Bottom Material and Willamette-Columbia River Water (1977) by USGS/Rinella & McKenzie	WLR0577		1 sediment (2/1/77)	USGS / Arvada	none	??	??			??	
Elutriation Study of Willamette River Bottom Material and Willamette-Columbia River Water (1977) by USGS/Rinella & McKenzie	WLR0577		1 sediment (2/1/77)	USGS / Arvada	none	??	??			??	
Willamette River - Burlington Northern Railroad Bridge (8/14/89) by ACOE/Troutdale	WLR0789		5 sediments (no collection dates - assume 7/89)	ACOE / Troutdale	none	*(probably OK)*					
Willamette River - Burlington Northern Railroad Bridge (89/15/89) by Battelle/Sequim	WLR0789		5 surface sediments (7/89)	Battelle / Sequim	none	Acceptable	none	none	none	none	
Willamette River - Burlington Northern Railroad Bridge (89/15/89) by Battelle/Sequim	WLR0789		5 surface sediments (7/89)	Battelle / Sequim	none	Acceptable	none	none	none	none	
Willamette River - Burlington Northern Railroad Bridge (89/15/89) by Battelle/Sequim	WLR0789		5 surface sediments (7/89)	ARI / Seattle	none	??	Acceptable	none	none		Acceptable

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Matrix	Laboratory	C-O-C	HT's	Method Blank(s)	MS/MSD's	LCS's	Replicates	Surrogate(s)
Willamette River - Burlington Northern Railroad Bridge (89/15/89) by Battelle/Sequim	WLR0789		5 surface sediments (7/89)	Battelle / Sequim	none	??					
Willamette River - Burlington Northern Railroad Bridge (89/15/89) by Battelle/Sequim	WLR0789		5 surface sediments (7/89)	ARI / Seattle	none	??	Acceptable	none	none		Acceptable
COE Willamette River Channel Deepening 1997 Data	WLR0797	WRCHDEEP	68 subsurface sediments	USACE / Troutdale, OR	none	Acceptable				none	
COE Willamette River Channel Deepening 1997 Data	WLR0797	WRCHDEEP	52 subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable	
COE Willamette River Channel Deepening 1997 Data	WLR0797	WRCHDEEP	52 subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable	
COE Willamette River Channel Deepening 1997 Data	WLR0797	WRCHDEEP	52 subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable (DDTreported)	Acceptable	Acceptable		Acceptable
COE Willamette River Channel Deepening 1997 Data	WLR0797	WRCHDEEP	52 subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable (some analytes reported)	Low recoveries; qual. results	Low recoveries; qual. results		Low recoveries; qual. results
COE Willamette River Channel Deepening 1997 Data	WLR0797	WRCHDEEP	18 sediment porewaters	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable MS	Acceptable		Acceptable
Quality of Bottom Material & Elutriates in the Lower Willamette River (1989) by Fuhrer /USGS	WLR1083		5 surface sed. composites (10/83)	USGS Central Lab / Arvada	??	??	??	??	??	??	
Quality of Bottom Material & Elutriates in the Lower Willamette River (1989) by Fuhrer /USGS	WLR1083		10 surface sediments (10/83)	USGS Central Lab / Arvada	??	??	??	??	??	??	??
Quality of Bottom Material & Elutriates in the Lower Willamette River (1989) by Fuhrer /USGS	WLR1083		10 surface sediments (10/83)	USGS Central Lab / Arvada	??	??	??	??	??	??	??
Quality of Bottom Material & Elutriates in the Lower Willamette River (1989) by Fuhrer /USGS	WLR1083		5 surface sediments (10/83)	USGS Central Lab / Arvada	??	??	??	??	??	??	??
Quality of Bottom Material & Elutriates in the Lower Willamette River (1989) by Fuhrer /USGS	WLR1083		10 surface sediments (10/83)	USGS Oregon Office Lab / Portland	??	??				??	
USACE Willamette River, Portland Harbor 1996 Event	WLR1196	WLR1196	6 subsurface sediments	USACE / Troutdale, OR	none	Acceptable				none	
USACE Willamette River, Portland Harbor 1996 Event	WLR1196	WLR1196	6 subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable MS		Acceptable	
USACE Willamette River, Portland Harbor 1996 Event	WLR1196	WLR1196	6 subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable MS	Acceptable	Acceptable	
USACE Willamette River, Portland Harbor 1996 Event	WLR1196	WLR1196	6 subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Low recoveries; qual. results
USACE Willamette River, Portland Harbor 1996	WLR1196	WLR1196	6 subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
USACE Willamette River, Portland Harbor 1996 Event	WLR1196	WLR1196	6 subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable; low recoveries for MBT (as estimates)	Acceptable; low recoveries for MBT (as estimates)		Acceptable
Willamette River Sediment Sampling Event, U.S. Moorings (11/29/99)	WLR1199	WLR1199	9 sediments	Sound Analytical Services / Tacoma	Acceptable	Acceptable	Acceptable	none	none	none	

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Matrix	Laboratory	C-O-C	HT's	Method Blank(s)	MS/MSD's	LCS's	Replicates	Surrogate(s)
Willamette River Sediment Sampling Event, U.S. Moorings (11/29/99)	WLR1199	WLR1199	9 sediments	Sound Analytical Services / Tacoma	Acceptable	Acceptable	none	none	none	none	
Willamette River Sediment Sampling Event, U.S. Moorings (11/29/99)	WLR1199	WLR1199	16 sediments	Aquatic Research, Inc. / Seattle	Data package references COC	Acceptable				Acceptable	
Willamette River Sediment Sampling Event, U.S. Moorings (11/29/99)	WLR1199	WLR1199	10 sediments	Sound Analytical Services / Tacoma	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Willamette River Sediment Sampling Event, U.S. Moorings (11/29/99)	WLR1199	WLR1199	8 sed. porewaters	Sound Analytical Services / Tacoma	Acceptable	Acceptable	none (no sample detects)				Acceptable
Willamette River Sediment Sampling Event, U.S. Moorings (11/29/99)	WLR1199	WLR1199	9 sediments	Sound Analytical Services / Tacoma	Acceptable	Acceptable	none (no sample detects)	Acceptable			Acceptable
1998 and 1999 Elf Atochem: River Sediment and Riverbank Sediment Investigation	WLRELF99	WLRELF99	28 surface and subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable MS		Acceptable	
1998 and 1999 Elf Atochem: River Sediment and Riverbank Sediment Investigation	WLRELF99	WLRELF99	28 surface and subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
1998 and 1999 Elf Atochem: River Sediment and Riverbank Sediment Investigation	WLRELF99	WLRELF99	28 surface and subsurface sediments	CAS / Kelso	Acceptable	Acceptable (initial analyses OK; reanalyses outside HTs)	Acceptable	Acceptable; generally low recoveries	Acceptable; generally low recoveries		Acceptable; initial analyses very low recov.; reanalyses better
1998 and 1999 Elf Atochem: River Sediment and Riverbank Sediment Investigation	WLRELF99	WLRELF99	28 surface and subsurface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Port of Portland Terminal 2 Berth 203 5/1994	WLRPT294		2 surface sediments	CAS	none	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Port of Portland Terminal 2 Berth 203 5/1994	WLRPT294		2 surface sediments	CAS	none	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Port of Portland Terminal 2 Berth 203 5/1994	WLRPT294		2 surface sediments	CAS	none	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Port of Portland Terminal 2 Berth 203 5/1994	WLRPT294		2 surface sediments	CAS	none	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Port of Portland Terminal 2 Berth 203 5/1994	WLRPT294		2 surface sediments	CAS	none	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Port of Portland Terminal 2 Berth 203 5/1994	WLRPT294		2 surface sediments	CAS	none	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Surrogate Recovery in MB<criteria for all associated samples. Qualify "UJ" or "J".
Willamette River Basin Water Quality Study. Component 2: Review & Summary of Toxic Pollutants in the Willamette River and Major Tributaries (8/27/92) by Tetra Tech	WLRWQH92	from STORET	25 sediment stations (1987-92)	from STORET	??	??	??	??	??	??	??
Willbridge Terminal Facility, Portland Sediment Investigation	WLRWTF98	WLRWTF98	14 surface sediments	North Creek Analytical / Portland	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Willbridge Terminal Facility, Portland Sediment Investigation	WLRWTF98	WLRWTF98	11 surface sediments	North Creek Analytical / Portland	Acceptable	Acceptable	Acceptable	Acceptable MS	Acceptable	Acceptable	
Willbridge Terminal Facility, Portland Sediment Investigation	WLRWTF98	WLRWTF98	10 surface sediments	North Creek Analytical / Portland	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Matrix	Laboratory	C-O-C	HT's	Method Blank(s)	MS/MSD's	LCS's	Replicates	Surrogate(s)
Willbridge Terminal Facility, Portland Sediment Investigation	WLRWTF98	WLRWTF98	14 surface sediments	North Creek Analytical / Portland	Acceptable	Acceptable	Acceptable	Acceptable; low recoveries reported	Acceptable; low recoveries reported		Acceptable; low recoveries reported similar to MS/MSD and LCS - some analytes qual. as estimates
Willbridge Terminal Facility, Portland Sediment Investigation	WLRWTF98	WLRWTF98	13 surface sediments	North Creek Analytical / Portland	Acceptable	Acceptable	Acceptable	none	Acceptable	Acceptable	
Chemical Characterization of Sediments Adjacent to Storm Water Discharges in the Willamette River Near Portland. Feb. 20, 1995. Submitted to the U.S. EPA; prepared by Hartman Assoc. & Fishman Environ. Serv.	WRSTRM94	WRSTRM94	29 surface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	MS acceptable	none	Acceptable	
Chemical Characterization of Sediments Adjacent to Storm Water Discharges in the Willamette River Near Portland. Feb. 20, 1995. Submitted to the U.S. EPA; prepared by Hartman Assoc. & Fishman	WRSTRM94	WRSTRM94	29 surface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
Chemical Characterization of Sediments Adjacent to Storm Water Discharges in the Willamette River Near Portland. Feb. 20, 1995. Submitted to the U.S. EPA; prepared by Hartman Assoc. & Fishman Environ. Serv.	WRSTRM94	WRSTRM94	29 surface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable	Acceptable; low recoveries reported	Acceptable; low recoveries reported		Acceptable; low recoveries reported similar to MS/MSD and LCS - phenols qual. as estimates
Chemical Characterization of Sediments Adjacent to Storm Water Discharges in the Willamette River Near Portland. Feb. 20, 1995. Submitted to the U.S. EPA; prepared by Hartman Assoc. & Fishman Environ. Serv.	WRSTRM94	WRSTRM94	29 surface sediments	CAS / Kelso	Acceptable	Acceptable	Acceptable; $MeCl_2$ reported & "B" qual. - recommend replace with "U" code	Acceptable	none		Acceptable
Portland Harbor Sediment Investigation Report (5/98) by Roy F. Weston, Inc.	WR-WSI98	WR-WSI98	7 surface sediments (8-9/97)	???	Acceptable						
Portland Harbor Sediment Investigation Report (5/98) by Roy F. Weston, Inc.	WR-WSI98	WR-WSI98	158 surface seds. (30 porewaters) & 61 cores (8-9/97)	ARI / Seattle	Acceptable	Acceptable	Acceptable (some results qual. due to presence of Al, Ca, K, Na, Zn)	MS acceptable (some Ca, Sb & Hg results qual. as estimates "J" due to low recoveries; some Sb nondetects "R" qual.)	Acceptable	Acceptable (some Hg results qual. as estimates "J" due to high variabilities)	
Portland Harbor Sediment Investigation Report (5/98) by Roy F. Weston, Inc.	WR-WSI98	WR-WSI98	68 surface seds. & 41 cores (8-9/97)	ARI / Seattle	Acceptable	Acceptable	Acceptable	MS acceptable	Acceptable	Acceptable	
Portland Harbor Sediment Investigation Report (5/98) by Roy F. Weston, Inc.	WR-WSI98	WR-WSI98	158 surface seds. & 61 cores (8-9/97)	ARI / Seattle	Acceptable	Acceptable	Acceptable (some results qual. due to presence of *bis* (2-ethylhexyl)phthalate)	Acceptable (some PCP results qual. as unusable due to low recoveries)		Acceptable	Acceptable

Attachment F1. Historical Sediment Chemical Data Quality Review.

Project Description	SURVEY_CD	SedQual Survey Code	Matrix	Laboratory	C-O-C	HT's	Method Blank(s)	MS/MSD's	LCS's	Replicates	Surrogate(s)
Portland Harbor Sediment Investigation Report (5/98) by Roy F. Weston, Inc.	WR-WSI98	WR-WSI98	47 surface seds. & 34 cores (8-9/97)	ARI / Seattle	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable	Acceptable (some results qual. as estimates due to low recoveries)
Portland Harbor Sediment Investigation Report (5/98) by Roy F. Weston, Inc.	WR-WSI98	WR-WSI98	53 surface seds. & 40 cores (8-9/97)	ARI / Seattle	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable	Acceptable (some results qual. as estimates due to low recoveries)
Portland Harbor Sediment Investigation Report (5/98) by Roy F. Weston, Inc.	WR-WSI98	WR-WSI98	66 surface seds. (30 porewaters) & 43 cores (8-9/97)	ARI / Seattle	Acceptable	Acceptable	Acceptable	Acceptable (some results qual. as estimates "J" due to low recoveries)	Acceptable (some MBT & DBT results qual. as estimates "J" due to low recoveries)	Acceptable	Acceptable (some results qual. as estimates "J" due to low recoveries)
Portland Harbor Sediment Investigation Report (5/98) by Roy F. Weston, Inc.	WR-WSI98	WR-WSI98	158 surface seds. & 61 cores (8-9/97)	Rosa Env. / Seattle & ARI / Seattle	Acceptable	Acceptable	Acceptable (TOC)	MS acceptable (some TOC results qual. as estimates due to low recoveries)	Acceptable (TOC)	Acceptable	
Portland Harbor Sediment Investigation Report (5/98) by Roy F. Weston, Inc.	WR-WSI98	WR-WSI98	3 surface seds. & 4 cores (8-9/97)	Maxim Technologies / Twin City Testing	Acceptable	Acceptable	Acceptable (some results qual. due to 2,3,7,8-TCDF, 2,3,4,6,7,8-HxCDF, OCDF & OCDD detections)	Acceptable (1,2,3,7,8-PeCDF & 1,2,3,6,7,8-HxCDF qual. as estimates due to high recoveries)	Acceptable		Acceptable

Attachment F2. Historical Water Chemical Data Quality Review.

Project Description	Survey CD	SedQual Survey Code	Comments	Recommend Category Revision (Y/N-comment)	Reason for Category 2 Designation	Analytical Method(s)	Parameter group	QA Review	DV Survey Code	Matrix	Laboratory	C-O-C	HT's	Method Blank(s)	MS/MSD's	LCS's	Replicates	Surrogate(s)
Ambient Water Quality Monitoring Program - Laboratory Analytical Storage and Retrieval Database	--	from LASAR	Cat2; no QC data	No	Method unknown, no COC, holding time unknown, no precision or accuracy documentation	unknown	metals, conventionals	NA	*(none)*	water-column	from LASAR	none	??	??	??	??	??	??
Occurrence of Selected Trace Elements and Organic Compounds and Their Relation to Land Use in The Willamette River Basin, Oregon, 1992-94; Anderson et al. (USGS Water-Resources Invest. Report 96-4234) 1996.	--	from STORET	Cat2; no QC data	No	Method unknown, no COC, holding time unknown, no precision or accuracy documentation	unknown	metals, VOCs & pest./PCBs	NA	*(none)*	water-column data for VOCs, metals & pesticides/PCBs	from STORET	none	??	??	??	??	??	??
Willamette River Basin Water Quality Study. Component 2: Review & Summary of Toxic Pollutants in the Willamette River and Major Tributaries (8/27/92) by Tetra Tech	--	from STORET	Cat2; no QC data	No	Method unknown, no COC, holding time unknown, no precision or accuracy documentation	unknown	metals (As, Ba, Cd, Cr, Cu, Pb, Ni, Ag, Zn, Sb, Se, Tl, Hg), chlorin. pest./PCBs, VOCs, SVOCs & chlorin. dioxin/furan (2,3,7,8-TCDD & 2,3,7,8-TCDF, only)	NA	*(none)*	water	from STORET	??	??	??	??	??	??	??
Water Quality of the Lower Columbia River Basin: Analysis of Current and Historical Water-Quality Data through 1994 by Fuhrer et al. (USGS Water-Resources Invest. Report 95-4294) 1996	--	from STORET	Cat2; no QC data	No	Method unknown, no COC, holding time unknown, no precision or accuracy documentation	unknown	nutrients, metals & pesticides	NA	*(none)*	water-column data for nutrients, metals & pesticides	from STORET	none	??	??	??	??	??	??
McCormick & Baxter Creosoting Co., Portland; 10/99 & 1/01	WLCMBJ99		Cat1	No		SW846 M.8270 (SIM)	PAHs & pentachlorophenol	NA	*(Sediment Remedial Design Data Summary Report, Feb. 2001; E&E)*	validation of 6 sediments - 10 percent of samples validated	OAL	none	Acceptable	Acceptable	Acceptable			Acceptable
McCormick & Baxter Creosoting Co., Portland; 10/99 & 1/01	WLCMBJ99		Cat1	No		SW846 M.8290	chlorinated dioxins & furans	NA	*(Sediment Remedial Design Data Summary Report, Feb. 2001; E&E)*	validation of 12 sediments - 10 percent of samples validated	Pace Analytical, Minneapolis Minnesota	none	Acceptable	Acceptabe		Acceptable		
McCormick & Baxter Creosoting Co., Portland; 10/99 & 1/01	WLCMBJ99		Cat1	No		SW846 M.8270 (SIM)	PAHs & pentachlorophenol	NA	*(Sediment Remedial Design Data Summary Report, Feb. 2001; E&E)*	validation of 3 sediments- 10 percent of samples validated	NCA	none	Acceptable	Acceptable	Acceptable			Acceptable
McCormick & Baxter Creosoting Co., Portland; 10/99 & 1/01	WLCMBJ99		Cat 1	Yes - Additional precision information found.		EPA 200.9	arsenic	NA	*(Sediment Remedial Design Data Summary Report, Feb. 2001; E&E)*	validation of 6 sediments - 10 percent of samples validated	OAL	None	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	
Appendix A: Data Validation Summary and Complied Chemical Laboratory Analytical Data - Ross Island Lagoon, by Hart Crowser	WLCRIL99		Cat 1	Yes - Complete QA reports submitted by Port		U.S.EPA 200.8 & SW846 M.7471A (Hg)	Metals (Sb, As, Cd, Cu, Pb, Ni, Ag, Zn, Hg)	QA1	*Environmental Synectics, Inc.*	63 sediments, 6 soils, 44 porewaters, 8 surfacewaters, 13 groundwaters & 45 leachates	CAS	Referenced in DV report	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	
Appendix A: Data Validation Summary and Complied Chemical Laboratory Analytical Data - Ross Island Lagoon, by Hart Crowser	WLCRIL99		Cat 1	Yes - Complete QA reports submitted by Port		SW846 M.8270 (SIM)	SVOCs	QA1	*Environmental Synectics, Inc.*	63 sediments, 6 soils, 44 porewaters, 8 surfacewaters, 13 groundwaters & 45 leachates	CAS	Referenced in DV report	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Appendix A: Data Validation Summary and Complied Chemical Laboratory Analytical Data - Ross Island Lagoon, by Hart Crowser	WLCRIL99		Cat 1	Yes - Complete QA reports submitted by Port		SW846 M.8260B	VOCs	QA1	*Environmental Synectics, Inc.*	63 sediments, 6 soils, 44 porewaters, 8 surfacewaters, 13 groundwaters & 45 leachates	CAS	Referenced in DV report	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

Attachment F2. Historical Water Chemical Data Quality Review.

Project Description	Survey CD	SedQual Survey Code	Comments	Recommend Category Revision (Y/N-comment)	Reason for Category 2 Designation	Analytical Method(s)	Parameter group	QA Review	DV Survey Code	Matrix	Laboratory	C-O-C	HT's	Method Blank(s)	MS/MSD's	LCS's	Replicates	Surrogate(s)
Appendix A: Data Validation Summary and Complied Chemical Laboratory Analytical Data - Ross Island Lagoon, by Hart Crowser	WLCRIL99		Cat 1	Yes - Complete QA reports submitted by Port		SW846 M.8081	Chlorin. pesticides (DDTs only)	QA1	*Environmental Synectics, Inc.*	63 sediments, 6 soils, 44 porewaters, 8 surfacewaters, 13 groundwaters & 45 leachates	CAS	Referenced in DV report	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Appendix A: Data Validation Summary and Complied Chemical Laboratory Analytical Data - Ross Island Lagoon, by Hart Crowser	WLCRIL99		Cat 1	Yes - Complete QA reports submitted by Port		SW846 M.8082	PCBs (as Aroclors)	QA1	*Environmental Synectics, Inc.*	63 sediments, 6 soils, 44 porewaters, 8 surfacewaters, 13 groundwaters & 45 leachates	CAS	Referenced in DV report	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Appendix A: Data Validation Summary and Complied Chemical Laboratory Analytical Data - Ross Island Lagoon, by Hart Crowser	WLCRIL99		Cat 1	Yes - Complete QA reports submitted by Port		SW846 M.9060/ EPA 415.1	TOC	QA1	*Environmental Synectics, Inc.*	63 sediments, 6 soils, 44 porewaters, 8 surfacewaters, 13 groundwaters & 45 leachates	CAS	Referenced in DV report	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	
Elutriation Study of Willamette River Bottom Material and Willamette-Columbia River Water (1977) by USGS/Rinella & McKenzie	WLR0577		Cat2 (no QC data presented, only results)	No	Method unknown, no COC, holding time unknown, no precision or accuracy documentation	unreferenced	NH_3, CN, COD, TOC	NA	*(none)*		USGS / Arvada							
Elutriation Study of Willamette River Bottom Material and Willamette-Columbia River Water (1977) by USGS/Rinella & McKenzie	WLR0577		Cat2 (no QC data presented, only results)	No	Method unknown, no COC, holding time unknown, no precision or accuracy documentation	unreferenced	Metals (As, Cr, Cu, Fe, Pb, Mn, Hg, Zn)	NA	*(none)*		USGS / Arvada							
Elutriation Study of Willamette River Bottom Material and Willamette-Columbia River Water (1977) by USGS/Rinella & McKenzie	WLR0577		Cat2 (no QC data presented, only results)	No	Method unknown, no COC, holding time unknown, no precision or accuracy documentation	unreferenced	Chlorin. Pest. & total PCBs	NA	*(none)*		USGS / Arvada							
RI/FS Quarterly Progress Report, 1st quarter 1995, Surface Water & Sediment, Rhône-Poulenc (6/95) by Woodward-Clyde Consultants	WLCRPB95		Cat 1	Yes - no explicit reference to COC		SW846 M.8010/8020	Halogenated/Aromatic Organics	QA1	*Woodward-Clyde (6/95)*	3 Surface water samples from Doane Lake and 4 surface water samples from Willamette River	Quanterra Environmental Services / W. Sacramento, CA	none	Acceptable	Acceptable	Acceptable		Acceptable	Acceptable
RI/FS Quarterly Progress Report, 1st quarter 1995, Surface Water & Sediment, Rhône-Poulenc (6/95) by Woodward-Clyde Consultants	WLCRPB95		Cat 1	Yes - no explicit reference to COC		SW846 M.8080	Chlorin. pesticides & PCBs (Aroclors)	QA1	*Woodward-Clyde (6/95)*	3 Surface water samples from Doane Lake and 4 surface water samples from Willamette River	Quanterra Environmental Services / W. Sacramento, CA	none	Acceptable	Acceptable	Acceptable		Acceptable	Acceptable
RI/FS Quarterly Progress Report, 1st quarter 1995, Surface Water & Sediment, Rhône-Poulenc (6/95) by Woodward-Clyde Consultants	WLCRPB95		Cat 1	Yes - no explicit reference to COC		SW846 M.8140	Phosphate ester pesticides	QA1	*Woodward-Clyde (6/95)*	3 Surface water samples from Doane Lake and 4 surface water samples from Willamette River	Quanterra Environmental Services / W. Sacramento, CA	none	Acceptable	Acceptable	Acceptable		Acceptable	Acceptable
RI/FS Quarterly Progress Report, 1st quarter 1995, Surface Water & Sediment, Rhône-Poulenc (6/95) by Woodward-Clyde Consultants	WLCRPB95		Cat 1	Yes - no explicit reference to COC		SW846 M.8150	Chlorin. herbicides	QA1	*Woodward-Clyde (6/95)*	3 Surface water samples from Doane Lake and 4 surface water samples from Willamette River	Quanterra Environmental Services / W. Sacramento, CA	none	Acceptable	Acceptable	Acceptable		Acceptable	Acceptable
RI/FS Quarterly Progress Report, 1st quarter 1995, Surface Water & Sediment, Rhône-Poulenc (6/95) by Woodward-Clyde Consultants	WLCRPB95		Cat 1	Yes - no explicit reference to COC		SW846 M.8290	chlorinated dioxins & furans	QA1	*Woodward-Clyde (6/95)*	3 Surface water samples from Doane Lake and 4 surface water samples from Willamette River	Quanterra Environmental Services / W. Sacramento, CA	none	Acceptable	Acceptable	Acceptable		Acceptable	
RI/FS Quarterly Progress Report, 1st quarter 1995, Surface Water & Sediment, Rhône-Poulenc (6/95) by Woodward-Clyde Consultants	WLCRPB95		Cat 1	Yes - no explicit reference to COC		SW846 M.6010	Metals	QA1	*Woodward-Clyde (6/95)*	3 Surface water samples from Doane Lake and 4 surface water samples from Willamette River	Quanterra Environmental Services / W. Sacramento, CA	none	Acceptable	Acceptable	Acceptable		Acceptable	

Attachment F2. Historical Water Chemical Data Quality Review.

Project Description	Survey CD	SedQual Survey Code	Comments	Recommend Category Revision (Y/N-comment)	Reason for Category 2 Designation	Analytical Method(s)	Parameter group	QA Review	DV Survey Code	Matrix	Laboratory	C-O-C	HT's	Method Blank(s)	MS/MSD's	LCS's	Replicates	Surrogate(s)
RI/FS Quarterly Progress Report, 1st quarter 1995, Surface Water & Sediment, Rhône-Poulenc (6/95) by Woodward-Clyde Consultants	WLCRPB95		Cat 1	Yes - no explicit reference to COC		SW846 M.9060	TOC	QA1	*Woodward-Clyde (6/95)*	3 Surface water samples from Doane Lake and 4 surface water samples from Willamette River	Quanterra Environmental Services / W. Sacramento, CA	none	Acceptable	Acceptable	Acceptable		Acceptable	
RI/FS Quarterly Progress Report, 1st quarter 1995, Surface Water & Sediment, Rhône-Poulenc (6/95) by Woodward-Clyde Consultants	WLCRPB95		Cat 1	Yes - no explicit reference to COC		SW846 M.8270	SVOCs	QA1	*Woodward-Clyde (6/95)*	3 Surface water samples from Doane Lake and 4 surface water samples from Willamette River	Quanterra Environmental Services / W. Sacramento, CA	none	Acceptable	Acceptable	Acceptable		Acceptable	Acceptable
McCormick & Baxter Superfund Site Bioavailable Contaminant Research Project September 2002 by Kim A. Anderson, Oregon State University	WLCMBI02		Cat 1			FSES 8003 for As III; EPA 6020 by NCA	Metals (As, As III, Cr, Cu, Zn)	QA1	*(Lab report - Integral review)*	20 grab surface water; 20 total - SPMD and DGT samplers	North Creek Analytical - Beaverton	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	
McCormick & Baxter Superfund Site Bioavailable Contaminant Research Project September 2002 by Kim A. Anderson, Oregon State University	WLCMBI02		Cat 1			PAHs - EPA 8270 SIM; SVOCs EPA 8270C	PAHs & pentachlorophenol; SVOCs	QA1	*(Lab report - Integral review)*	20 grab surface water; 20 total - SPMD and DGT samplers	North Creek Analytical - Beaverton	Accceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
McCormick & Baxter Superfund Site Bioavailable Contaminant Research Project September 2002 by Kim A. Anderson, Oregon State University	WLCMBI02		Cat 1			EPA 415.1; EPA 160.2	TOC, TSS	QA1	*(Lab report - Integral review)*	20 grab surface water; 20 total - SPMD and DGT samplers	North Creek Analytical - Beaverton	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	
McCormick & Baxter Superfund Site Bioavailable Contaminant Research Project September 2002 by Kim A. Anderson, Oregon State University	WLCMBI02		Cat 2		No precision or accuracy documentation	DEQ NW TPH-DX	Petroleum Hydrocarbons	QA1	*(Lab report - Integral review)*	20 grab surface water; 20 total - SPMD and DGT samplers	North Creek Analytical - Beaverton	Acceptable	Acceptable	Acceptable	Not Reported	Not Reported	Acceptable	Not Reported

Attachment F3. Historical Tissue Residue Data Quality Review.

Project Description	Survey CD	SedQual Survey Code	Comments	Recommended Category Revision (Y/N)	Reason for Category 2 Designation	Analytical Method(s)	Parameter group	QA Review	DV Survey Code	Matrix	Laboratory	C-O-C	HT's	Method Blank(s)	MS/MSD's	LCS's	Replicates	Surrogate(s)
Found in: EPA Region 10, Columbia River Basin Contaminant Aquatic Biota and Sediment Data - On-line Database (biota 1987-1993; sediment 1984-1994). Curtis et al. 1993/94.	CLBC8494		Cat2; no QC data	No	Laboratory unknown, no COC, holding time unknown, no precision and limited accuracy documentation	unkown (dioxins/furans & chlor. pest & PCBs), SW846 M.8270/M.3540 (PAHs)	chlorinated dioxins/furans, PCBs, chlor. pest. & PAHs	NA	*(none)*	wholebody & fillet (N. squawfish, cutthroat trout & carp)	(unknown - possibly OSU, Corvallis)	??	??	??	??	??	??	Variable - some acceptable
EPA Region 10, Columbia River Basin Contaminant Aquatic Biota and Sediment Data - On-line Database (biota 1987-1993; sediment 1984-1994). Sources include USFWS, Curtis et al. 1993, WR Toxics Study	CLBC8494		Cat2; no QC data	No	Method unknown, no COC, holding time unknown, no precision or accuracy documentation	??	butyltins, dioxins/furans, metals, PCBs, pesticies, and SVOCs	NA	*(none)*	biota and sediments	(unknown)							
Environmental Contaminants in Great Blue Herons (Ardea Herodias) from the Lower Columbia and Willamette Rivers, OR and WA	CLWLTC94		Cat2; no QC data	No	No COC, holding time unknown, no precision or accuracy documentation	GC/ECD	OCs and PCB congeners - 1994	NA	*(none)*	blue heron eggs 1 sample in 1994 and 1 sample in 1995	Texas A&M	none presented or referenced		??	??		??	
Environmental Contaminants in Great Blue Herons (Ardea Herodias) from the Lower Columbia and Willamette Rivers, OR and WA	CLWLTC94		Cat2; no QC data	No	No COC, holding time unknown, no precision or accuracy documentation	HRGC/HRMS Method 1613	dioxins/furans - 1994	NA	*(none)*	blue heron eggs 1 sample in 1994 and 1 sample in 1995	Texas A&M	none presented or referenced		??	??		??	
Environmental Contaminants in Great Blue Herons (Ardea Herodias) from the Lower Columbia and Willamette Rivers, OR and WA	CLWLTC94		Cat2; no QC data	No	No COC, holding time unknown, no precision or accuracy documentation	EPA/600/4-79-020, Method 245.5	Hg - 1994	NA	*(none)*	blue heron eggs 1 sample in 1994 and 1 sample in 1995	Texas A&M	none presented or referenced		??	??		??	
Environmental Contaminants in Great Blue Herons (Ardea Herodias) from the Lower Columbia and Willamette Rivers, OR and WA	CLWLTC94		Cat2; no QC data	No	No COC, holding time unknown, no precision or accuracy documentation	GC/ECD (OC), HRGC/HRMS, Schwartz et al. 1993, Peterman et al. 1996 PCBs	OCs and PCB congeners - 1995	NA	*(none)*	blue heron eggs 1 sample in 1994 and 1 sample in 1995	Midwest Science Center	none presented or referenced		??	??		??	
Environmental Contaminants in Great Blue Herons (Ardea Herodias) from the Lower Columbia and Willamette Rivers, OR and WA	CLWLTC94		Cat2; no QC data	No	No COC, holding time unknown, no precision or accuracy documentation	HRGC/HRMS, Peterman 1995	dioxins/furans - 1995	NA	*(none)*	blue heron eggs 1 sample in 1994 and 1 sample in 1995	Midwest Science Center	none presented or referenced		??	??		??	
Environmental Contaminants in Great Blue Herons (Ardea Herodias) from the Lower Columbia and Willamette Rivers, OR and WA	CLWLTC94		Cat2; no QC data	No	No COC, holding time unknown, no precision or accuracy documentation	EPA/600/4-79-020, Method 245.5	Hg - 1995	NA	*(none)*	blue heron eggs 1 sample in 1994 and 1 sample in 1995	Midwest Science Center	none presented or referenced		??	??		??	
DEQ Mercury Data; Foster 1/97	DEQWQP97		Cat2; no QC data	No	Method unknown, no COC, holding time unknown, no precision or accuracy documentation	??	mercury	NA	*(none)*	fish from 2 stations	ODEQ ??							
McCormick & Baxter Creosoting Company, Remedial Investigation Report, 9/92	MBCREOS2	MBCREOS2	Cat 1	Yes - COCs referenced multiple times in DV reports; Labs identified in Volume 1 of RI report		EPA M.1625C	Selected SVOCs	QA1 equiv.	PTI 9/92	40 crayfish & fish composites	ATI / Fort Collins, CO	referenced in report	Acceptable	Acceptable	Acceptable		Acceptable	Acceptable
McCormick & Baxter Creosoting Company, Remedial Investigation Report, 9/92	MBCREOS2	MBCREOS2	Cat2; very little QC data presented	No	No COC, holding time unknown, no precision or accuracy documentation	EPA CLP procedures	chlorinated pesticides & total PCBs	QA1 equiv.	PTI 9/92	?? crayfish & fish composites	ATI / Fort Collins, CO	none presented or referenced	no presentation	no presentation	no presentation			no presentation
McCormick & Baxter Creosoting Company, Remedial Investigation Report, 9/92	MBCREOS2	MBCREOS2	Cat 1	Yes - COCs referenced multiple times in DV reports; Labs identified in Volume 1 of RI		SW846 M.8290 (mod.)	chlorinated dioxins & furans	QA1 equiv.	PTI 9/92	12 crayfish & fish composites	Triangle Labs / Durham, NC	referenced in report	Acceptable	Elevated levels reported in MBs	Unknown - various modifications made to method		Acceptable	Acceptable
McCormick & Baxter Creosoting Company, Remedial Investigation Report, 9/92	MBCREOS2	MBCREOS2	Cat 1	Yes - COCs referenced multiple times in DV reports; Labs identified in Volume 1 of RI		EPA CLP procedures	metals	QA1 equiv.	PTI 9/92	24 crayfish & fish composites	CAS / Kelso	referenced in report	Acceptable	Acceptable	MS Acceptable, results qual. as estimates due to low	Acceptable	Variable - some not analyzed	

Attachment F3. Historical Tissue Residue Data Quality Review.

Project Description	Survey CD	SedQual Survey Code	Comments	Recommended Category Revision (Y/N)	Reason for Category 2 Designation	Analytical Method(s)	Parameter group	QA Review	DV Survey Code	Matrix	Laboratory	C-O-C	HT's	Method Blank(s)	MS/MSD's	LCS's	Replicates	Surrogate(s)
The Oregonian's "River of Risk" series December 17-20, 2000 (OSU data)	ORRORS00		Cat2; no QC data	No	Method unknown, no COC, holding time unknown, no precision or accuracy documentation	(unreferenced)	Chlorin. pest. & PCB congeners	NA	*(none)*	finfish from 6 sites	OSU ??	??	??	??	??	??	??	??
Remedial Action Plan, Station "L" Site, Willamette River Sediments, Hart Crowser, 2/88	PGERAP88		Cat2; no QC data	No	Method unknown, no COC, holding time unknown, no precision or accuracy documentation	(unreferenced)	total PCBs	NA	*(none)*	9 crayfish & 9 sculpin composites	(unknown)							
USGS Water-Resources Investigations Report 97-4082-D - Dioxins and Furans in Bed Sediment and Fish Tissue of the Willamette Basin, 1992-95	WBWRIR98		Cat2; lack of QC data	No	No COC, holding time unknown, no precision or accuracy documentation	SW846 M.8290	chlorinated dioxins & furans	NA	*(none)*	finfish from 8 stations	Quanterra Environmental Services / W. Sacramento, CA	??	??	??	??	??		
Willamette River Toxics Study, 1988/1991 - ODEQ 7/94	WRTOXS94		Cat2; lack of QC data	No	No COC, holding time unknown, no precision or accuracy documentation	"DEQ standard analytical techniques", EPA M.1613A & SW846 M.8270	chlor. pest., PCBs, dioxins/furans, PAHs & metals	NA	*(none)*	fish from 21 stations	ODEQ	??	??	??	??	??	??	??
Phase I & II Lower Willamette River Reference Area Study USACOE - Hart Crowser, Inc.	WLLRSI01		Cat 1	Yes - Validation report acceptable (previously DV report noted as very brief).		Freeze Dry	Total Solids	QA1	Appendix C review - SEA 04/02	5 tissue	Columbia Analytical Services	Missing analysis, not marked on COC	Acceptable	none	none	none	none	none
Phase I & II Lower Willamette River Reference Area Study USACOE - Hart Crowser, Inc.	WLLRSI01		Cat 1	Yes - Validation report acceptable (previously DV report noted as very brief).		SW846 M.200.8 & 7470 (Hg)	Metals (Sb, As, Cd, Cr, Cu, Ni, Ag, Zn, Hg)	QA1	Appendix C review - SEA 04/02	5 tissue	Columbia Analytical Services	Missing analysis, not marked on COC	Acceptable	MB: Cu>MRL all samples < MRL = "U" those > MRL = "J"	Acceptable	Acceptable	Acceptable	none
Phase I & II Lower Willamette River Reference Area Study USACOE - Hart Crowser, Inc.	WLLRSI01		Cat 1	Yes - Validation report acceptable (previously DV report noted as very brief).		SW846 M.8081A	Chlorin. Pesticides	QA1	Appendix C review - SEA 04/02	5 tissue	Columbia Analytical Services	Missing analysis, not marked on COC	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Phase I & II Lower Willamette River Reference Area Study USACOE - Hart Crowser, Inc.	WLLRSI01		Cat 1	Yes - Validation report acceptable (previously DV report noted as very brief).		SW846 M.8082	PCBs (Aroclors)	QA1	Appendix C review - SEA 04/02	5 tissue	Columbia Analytical Services	Missing analysis, not marked on COC	Acceptable	Acceptable MDLs based on EPA3540C samples prepped with EPA3541	none	Acceptable MDLs based on EPA3540C samples prepped with EPA3541	Acceptable MDLs based on EPA3540C samples prepped with EPA3541	Acceptable MDLs based on EPA3540C samples prepped with EPA3541
Phase I & II Lower Willamette River Reference Area Study USACOE - Hart Crowser, Inc.	WLLRSI01		Cat 1	Yes - Validation report acceptable (previously DV report noted as very brief).		SW846 M.8270C	SVOCs	QA1	Appendix C review - SEA 04/02	5 tissue	Columbia Analytical Services	Missing analysis, not marked on COC	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	sample 7650F surrogates out high
Phase I & II Lower Willamette River Reference Area Study USACOE - Hart Crowser, Inc.	WLLRSI01		Cat 1	Yes - Validation report acceptable (previously DV report noted as very brief).		Krone	TBT	QA1	Appendix C review - SEA 04/02	5 tissue	Columbia Analytical Services	Missing analysis, not marked on COC	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	sample 7648F surrogates out high
Phase I & II Lower Willamette River Reference Area Study USACOE - Hart Crowser, Inc.	WLLRSI01		Cat 1	Yes - Validation report acceptable (previously DV report noted as very brief).		PSEP	Lipids	QA1	Appendix C review - SEA 04/02	5 tissue	Columbia Analytical Services	Missing analysis, not marked on COC	Acceptable	none	none	none	none	none

ATTACHMENT F4: SEDIMENT CHEMISTRY SURVEY DESCRIPTIONS

Historical sediment chemistry data in the project database were compiled from over 70 surveys conducted by U.S. Environmental Protection Agency (EPA), Oregon Department of Environmental Quality (DEQ), U.S. Army Corps of Engineers (Corps), Port of Portland, and numerous private parties. Surveys completed prior to 1990 are summarized in Section 4.2.1 of the main text. For surveys completed in 1990 or after (over 60), specifics about each survey are provided in the following summaries. Each summary described herein includes information on the project objectives, sampling dates, sampling methods, sample types, and analyses for that survey. This information was obtained from the survey source document, and the reference is provided.

Summary results (maximum and minimum concentrations) for indicator chemicals in surface and/or subsurface sediments are also provided in each survey description. Minimum concentrations are reported as the lowest concentration or reporting limit. Maximum concentrations are reported as the highest detected concentration, or, if all concentrations are undetected, the highest reporting limit. Sampling locations for each survey can be found on Map 4-1 (surface sediments) and Map 4-2 (subsurface locations). As appropriate, the location of the maximum concentration is also provided. Locations of maximum concentrations were not provided when numerous samples were collected from immediately adjacent to a single facility (i.e., McCormick & Baxter) or when the sediment was dredged and samples generally represented sediment composited from several locations.

Each data set was reviewed to characterize the quality of the data prior to entry in the database and to ensure that the data were appropriate for use in the RI/FS. Additional information on the data and review process is provided in Section 4 of the Work Plan.

WLCOFH02. Source Control Pilot Project for the City of Portland Outfalls, Portland, OR. ***(Prepared by CH2M Hill, August 2002).***

The City of Portland initiated a pilot project to evaluate the impacts of stormwater discharge from City outfalls on sediment quality in the Willamette River. City outfalls M-1 and M-18 were selected as sediment sampling locations during the first phase of the pilot project. The purpose of the sampling was to determine if chemical concentrations in sediment discharged from City outfalls warrant source investigation, identification, and control. In addition, information from sample analytical results was to be used to identify constituents of concern at these outfalls, which may be investigated further in a subsequent phase of the study.

Outfall M-1 is located in the Swan Island/Mocks Bottom basin or 'lagoon.' Outfall M-18 is located in the Guilds Lake Industrial Area, at the site of Gunderson Rail Services. Nine surface (0-15 cm) sediment samples were collected at both outfalls from locations spread in an array upstream, adjacent to, and downstream of each outfall. The samples were collected from August 20-22, 2002, either from a shallow draft vessel (Boston Whaler) using a grab sampler or on foot in wading depths using hand tools. Analyses included the conventional parameters of percent moisture, total solids, total organic carbon (TOC), and grain size, and chemical parameters, including metals, semivolatile organic compounds (SVOCs), organochlorine pesticides, herbicides, polychlorinated biphenyls (PCBs), and total petroleum hydrocarbons (TPH).

The results for indicator chemicals are summarized in the following two tables. The first table summarizes results for samples collected off outfall M-1; the second table summarizes results for samples collected off outfall M-18. Results are reported on a dry-weight basis.

Summary Data for M-1 Surface Samples

Parameter	Minimum	Maximum
Arsenic (mg/kg)	2.81	8.98
Cadmium (mg/kg)	0.00927 U	1.89
Copper (mg/kg)	15 B	86.5 B
Lead (mg/kg)	5.45 B	57.6 B
Mercury (mg/kg)	0.0102 U	0.131
Zinc (mg/kg)	57 B	403 B
TBT (µg/kg)	na	na
bis(2-ethylhexyl)phthalate (µg/kg)	68.4 U	39,200 J
Total LPAH (µg/kg)	19.57 A	744 A
Total HPAH (µg/kg)	60.4 A	2,832 A
Total PCBs (µg/kg)	6.18 UA	338 A
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	0.635 UA	5.87 A
Dibenzofuran (µg/kg)	18.5 U	261 UJ

Parameter	Minimum	Maximum
4-methylphenol (µg/kg)	23.6 U	68 J
Diesel Fuels (mg/kg)	26.1 JV	777 V
Xylenes (µg/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
B - Analyte found in associated blank.
J - Estimated value.
U - Undetected at concentration shown.
V - In diesel range but doesn't match diesel standard.

Summary Data for M-18 Surface Samples

Parameter	Minimum	Maximum
Arsenic (mg/kg)	4.36	9.76
Cadmium (mg/kg)	0.0638 J	0.897
Copper (mg/kg)	41 B	98.9 B
Lead (mg/kg)	60.6 B	210 B
Mercury (mg/kg)	0.0103 U	0.453
Zinc (mg/kg)	119 B	272 B
TBT (µg/kg)	na	na
bis(2-ethylhexyl)phthalate (µg/kg)	62.7 U	2700
Total LPAH (µg/kg)	40.1 A	1,186 A
Total HPAH (µg/kg)	92.2 A	3,106 A
Total PCBs (µg/kg)	64.7 A	640 A
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	20.1 A	178.5 A
Dibenzofuran (µg/kg)	17.7 U	45 J
4-methylphenol (µg/kg)	22.6 U	72.4 J
Xylenes (µg/kg)	na	na
Diesel Fuels (mg/kg)	16.2 JV	369 V

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
B - Analyte found in associated blank.
J - Estimated value.
U - Undetected at concentration shown.
V - In diesel range but doesn't match diesel standard.

WLCMCB02. MarCom Expanded Preliminary Assessment, Portland, OR. *(Prepared by Parametrix, 2002).*

An Expanded Preliminary Assessment (XPA) was performed by Parametrix at the MarCom facility in Portland in 2002. The purpose of an XPA is to determine if a release has occurred or may occur at a site that could endanger human health or the environment. In addition to the collection of upland soil and groundwater samples, three sediment samples were collected in the nearshore area of the Willamette adjacent to the facility. The samples were collected 1) near the southern boundary of the site near a stormwater outfall (SED-1), 2) midway along the shoreline near a second stormwater outfall (SED-2), and 3) near the northern boundary of the site inshore of an active marine ways facility (SED-3).

The sediment sampling was conducted on February 8, 2002. The samples were collected from a surface interval of 0-15 cm using a Peterson-type clamshell sampler. Analyses included percent solids, total metals, organotins, and polycyclic aromatic hydrocarbons (PAHs). The results for indicator chemicals are summarized in the following table, reported on a dry-weight basis.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	7.39	105 (SED-2)
Cadmium (mg/kg)	0.397 U	0.5 U (SED-3)
Copper (mg/kg)	118	1150 (SED-2)
Lead (mg/kg)	35.2	577 (SED-1)
Mercury (mg/kg)	0.1 U	0.106 (SED-2)
Zinc (mg/kg)	225	2,010 (SED-2)
TBT (µg/kg)	43.7	819 (SED-2)
bis(2-ethylhexyl)phthalate (µg/kg)	na	na
Total LPAH (µg/kg)	239 A	668.7 A (SED-2)
Total HPAH (µg/kg)	2,224.3 A	5,090 A (SED-2)
Total PCBs (µg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	na	na
Dibenzofuran (µg/kg)	na	na
4-methylphenol (µg/kg)	na	na
Xylenes (µg/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Undetected at concentration shown.

WLLRSH01. Willamette River Reference Area Study – Phase I Results and Recommendations for Phase II Sampling Locations, Portland, OR. ***(Prepared by Hart Crowser, September 2001).***

This investigation was the initial phase to identify potential reference sediment locations in the Willamette River as part of the U.S. Army Corps of Engineers' plan to develop a Dredged Material Management Plan (DMMP) for the waterway. The objective was to identify three reference areas representing fine-, medium-, and coarse-grained sediment in the LWR that could be used in subsequent biological testing.

Ten potential locations were selected. The station IDs and approximate river mile (RM) descriptions are listed in the table below.

Station	Approximate Location Description
HC-1	RM 15.7, upstream of East Island
HC-2	RM 15.5, near Ross Island
HC-3	RM 16.5, near downstream boundary of Riverview Cemetery
HC-4	RM 17.2, west side of channel
HC-5	RM 17.8, west side of channel upstream of Riverdale, OR
HC-6	RM 18.75, no sample collected
HC-7	RM 18.9, west of Elk Rock Island
HC-8	RM 18.8, east of Elk Rock Island
HC-9	RM 23.1, downstream end of Cedar Island
HC-10	RM 23.4, inside Cedar Island Cove

Sampling took place on August 27, 2001. Surface (0-10 cm) grab samples were collected at each location and were wet-sieved in the field to identify general grain-size characteristics. Samples were then submitted for laboratory analyses of grain-size distribution, total volatile solids (TVS), total solids, TPHs, pesticides, and PCBs.

The results for indicator chemicals are summarized in the following table, reported on a dry-weight basis.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	na	na
Cadmium (mg/kg)	na	na
Copper (mg/kg)	na	na
Lead (mg/kg)	na	na
Mercury (mg/kg)	na	na
Zinc (mg/kg)	na	na
TBT (μg/kg)	na	na
bis(2-ethylhexyl)phthalate (μg/kg)	na	na
Total LPAH (μg/kg)	na	na
Total HPAH (μg/kg)	na	na

Parameter	Minimum	Maximum (Location)
Total PCBs (µg/kg)	26 UA	40 UA (HC-10)
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	1.3 UA	2 UA (HC-04, HC-10)
Dibenzofuran (µg/kg)	na	na
4-methylphenol (µg/kg)	na	na
Diesel Fuels (mg/kg)	13 U	56 Z (HC-04)
Xylenes (µg/kg)	na	na

na - Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Undetected at concentration shown.
Z - Fingerprint does not resemble petroleum product.

WLLRSI01. Lower Willamette River Reference Area Study, U.S. Army Corps of Engineers, Portland, OR. ***(Prepared by Hart Crowser, February 26, 2002).***

This investigation was the second phase in the effort to identify potential reference sediment locations in the Willamette River as part of the U.S. Army Corps of Engineers' effort to develop a DMMP for the waterway. The objective was to identify three reference areas representing fine-, medium-, and coarse-grained sediment in the LWR that could be used in biological testing.

This investigation consisted of comprehensive chemical and biological testing of three candidate reference sites:

Station	Approximate Location Description	Target Grain Size Range
HC-02	RM 15.5, near Ross Island	Coarse
HC-08	RM 18.8, east of Elk Rock Island	Fine
HC-10	RM 23.4, inside Cedar Island Cove	Medium

Surface sediment sampling was conducted on September 17, 2001, using an air-powered van Veen grab sampler. Sample intervals ranged from the surface to 30 cm. Samples were submitted for TOC, TVS, select VOCs, SVOCs, PAHs, phenols, phthalates, pesticides, PCBs, metals, and porewater butyltin analyses, as well as 10-day lethal and sublethal bioassays.

Five additional surface samples were collected from Cedar Island Cove to assess the range of grain sizes available at that location. These five samples were analyzed for grain size, TOC, and TVS only.

The grain sizes at the coarse, medium, and fine candidate locations consisted of fine sand, very sandy silt, and sandy silt, respectively. Organic content in these samples ranged from 0.42 to 1.77%. The results for indicator chemicals are summarized in the following table, reported on a dry-weight basis (except for porewater results).

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	2.7	4.3 (HC-08)
Cadmium (mg/kg)	0.07	0.18 (HC-08)
Copper (mg/kg)	15.4	50.9 (HC-08)
Lead (mg/kg)	5.24	12.6 (HC-08)
Mercury (mg/kg)	0.02	0.05 (HC-08)
Zinc (mg/kg)	49.7	96.8 (HC-08)
TBT (μg/L)	0.06	0.09 (HC-08)
bis(2-ethylhexyl)phthalate (μg/kg)	310 U	420 U (HC-08)
Total LPAH (μg/kg)	10.8 A	28.6 A (HC-10)
Total HPAH (μg/kg)	96.6 A	131 A (HC-10)
Total PCBs (μg/kg)	31 UA	42 UA (HC-08)
2,3,7,8-TCDD (ng/kg)	na	na

Parameter	Minimum	Maximum (Location)
Total DDT (µg/kg)	0.73 A	14.6 A (HC-10)
Dibenzofuran (µg/kg)	16 U	21 U (HC-08)
4-methylphenol (µg/kg)	7.3 J	16 U (HC-02)
Xylenes (µg/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Undetected at concentration shown.

WLCCIF01. Results of Sediment Sampling and Analysis, Cargill Irving Elevator Terminal, Portland, OR. ***(Prepared by Harding ESE, August 3, 2001).***

This investigation consisted of sediment sampling to characterize material to be removed during maintenance dredging at the Cargill, Inc. (Cargill) Irving Elevator Terminal in Portland (RM 11.5). The material was addressed as a single dredged material management unit (DMMU) located within the facility's berthing area.

Sediment sampling was conducted by Harding ESE on June 29, 2001. Four vibracores were collected within the DMMU: T01 (0-54 cm), T02 (0-109 cm), T03 (0-106 cm), and T04 (0-60 cm). Due to refusal, one of the cores did not achieve the entire proposed dredging depth, including the 2-foot overdredge interval. From each core, the material within the proposed dredge prism depth interval was split between two samples: one representing the individual core, and one composite of the four cores representing the entire DMMU. The amount of material contributed to the composite from each core was proportional to its total length. All the samples were analyzed for conventional parameters (total solids, TVS, TOC, total sulfide, and ammonia), grain-size distribution, SVOCs, organoclorine pesticides, PCBs, organotins, and metals. The composite sample was also analyzed for porewater organotins. Samples T01, T04, and the composite sample later underwent bioassay testing.

The individual samples were generally composed of sands with silt; the organic carbon contents ranged from 0.4 to 0.82%. The composite material was dominantly sand with silt, having an organic content of 0.67%. The results for indicator chemicals are summarized in the following table, reported on a dry-weight basis (except for porewater results).

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	2.1	3.1 (T02)
Cadmium (mg/kg)	0.21	0.32 (T02)
Copper (mg/kg)	20.2	26.4 (T02)
Lead (mg/kg)	14.4	35 (T04)
Mercury (mg/kg)	0.03	0.05 (T02)
Zinc (mg/kg)	68.3	79.3 (T04)
TBT(µg/kg)	13	220 (T04)
TBT(µg/L)	--	0.06 (composite)
bis(2-ethylhexyl)phthalate (µg/kg)	180 U	220 J (T01)
Total LPAH (µg/kg)	135 A	346 A (T01)
Total HPAH (µg/kg)	441 A	3,457 A (T01)
Total PCBs (µg/kg)	13.4 A	130 A (T04)
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	0.73 UA	2.42 A (T03)
Dibenzofuran (µg/kg)	4.2 J	12 J (T01)
4-Methylphenol (µg/kg)	16 J	54 (T02)
Xylenes (µg/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
J – Estimated value.
U - Undetected at concentration shown.

WLCT0F01. Dredged Material Characterization Study, Marine Terminal 2, Berths 203-206, Marine Terminal 5, Berth 501, Portland, OR. ***(Prepared by Hart Crowser, August 24, 2001).***

Hart Crowser conducted this study for the Port of Portland prior to maintenance dredging at three berthing areas at the Port's Marine Terminal 2 (Berths 204-206), and one berthing area at Marine Terminal 5 (Berth 501). Terminal 2 is located on the west side of the Willamette River at RM 10, and Terminal 5 is located along the east bank of the river at RM 1. The information gained from this investigation was to be used to determine the quality of the dredged material for management options, the quality of the effluent from dredged material dewatering, and the quality of the dredged material leachate that would percolate into the aquifer underlying the rehandling facility. No dredging was planned at Berth 203 at the time of this study, but the data were collected for use in evaluating future dredging options.

Subsurface sediment vibracores were collected at Terminal 2, Berths 203-206, on June 28-29, 2001, and at Terminal 5, Berth 501, on June 27-28, 2001. Ten cores were collected at Terminal 2, and nine cores were collected at Terminal 5. Recovered core depths ranged from 5.5 to 9 feet below the mudline. The cores were segregated into two DMMUs at both Terminal 2 (Berth 203 and Berths 204-205) and Terminal 5 (Berth 501-Barge , and Berth 501-Face). The cores in each DMMU were divided into three intervals and composited to form representative samples, as outlined in the following table.

Facility	DMMU	Composite Sample ID	Approximate Interval	Interval Description
Terminal 2	Berth 203	T2-01-1A	0-121 cm	Proposed dredging depth (including 2 feet overdredge)
		T2-01-1B	121-152 cm	1 foot below dredge prism
		T2-01-1C	152-182 cm	1-2 feet below dredge prism
	Berths 204-206	T2-01-2A	0-152 cm	Proposed dredging depth (including 2 feet overdredge)
		T2-01-2B	152-182 cm	1 foot below dredge prism
		T2-01-2C	182-210 cm	1-2 feet below dredge prism
Terminal 5	Berth 501-Barge	T5-01-1A	0-152 cm	Proposed dredging depth (including 2 feet overdredge)
		T5-01-1B	152-182 cm	1 foot below dredge prism
		T5-01-1C	182-210 cm	1-2 feet below dredge prism
	Berth 501-Face	T5-01-2A	0-182 cm	Proposed dredging depth (including 2 feet overdredge)
		T5-01-2B	182-210 cm	1 foot below dredge prism
		T5-01-2C	210-240 cm	1-2 feet below dredge prism

The 'A' samples from each DMMU were submitted for analysis of conventional parameters, SVOCs, chlorinated pesticides, PCBs, metals, and porewater TBT. Elutriate (dewatered fluid) from T2-01-2A was analyzed for total suspended solids (TSS),

turbidity, TBT, chlorinated pesticides, and PCBs. Initially, the 'B' and 'C' samples from each DMMU were frozen pending potential future analysis. Samples T2-01-1B and T2-01-1C were later analyzed for pesticides and PCBs based on elevated concentrations in T2-01-1A.

The Terminal 2 'A' composites were composed primarily of sandy silt, while the Terminal 5 'A' composites were composed of sand and silty sand. Organic carbon content ranged from 0.17 to 3.04%. The results for indicator chemicals in the sediment samples are summarized in the following table, reported (except porewater TBT) on a dry-weight basis.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	1.8	3 (T2-01-2A, T5-01-2A)
Cadmium (mg/kg)	0.09	0.51 (T5-01-2A)
Copper (mg/kg)	8.8	30.1 (T2-01-2A)
Lead (mg/kg)	3.38	19.8 (T5-01-2A)
Mercury (mg/kg)	0.02	0.14 (T2-01-1A)
Zinc (mg/kg)	37.9	112 (T2-01-1A)
TBT (µg/L)	0.02 U	0.07 (T5-01-2A)
bis(2-ethylhexyl)phthalate (µg/kg)	270 UJ	380 UJ (T2-01-2A)
Total LPAH (µg/kg)	73 A	308 A (T2-01-1A)
Total HPAH (µg/kg)	276 A	1,221 A (T2-01-1A)
Total PCBs (µg/kg)	27 UA	770 A (T2-01-1B)
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	1.4 UA	78 A (T2-01-1B)
Dibenzofuran (µg/kg)	14 UJ	19 UJ (T2-01-2A)
4-methylphenol (µg/kg)	na	na
Xylenes (µg/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
J – Estimated value.
U - Undetected at concentration shown.

WLCCPF01. Chevron Willbridge Terminal Dock Sediment Sampling, Portland, OR. ***(Prepared by PNG Environmental, 2001).***

PNG Environmental performed sediment sampling to characterize sediment prior to maintenance dredging in the vicinity of the Chevron Willbridge Terminal dock, located on the west side of the Willamette River at approximately RM 7.8.

Samples were collected at five stations on June 6-7, 2001: two in the slip north of the dock, and three in the slip south of the dock. The sample IDs and intervals at each of these stations are summarized in the table below. Only the uppermost interval collected at each station contained the sediment proposed for dredging.

Station (Location)	Sample ID	Sample Interval
SD0101 (Head of northern slip)	SD-1-S1C	91-183 cm
	SD-1-39-Foot	183-213 cm
	SD-1-41-Foot	213-244 cm
SD0102 (Northern slip)	SD-2-S1C	0-30 cm
	SD-2-39-Foot	30-61 cm
	SD-2-41-Foot	61-91 cm
SD0103 (Head of southern slip)	SD-3-S1C	0-152 cm
	SD-3-39-Foot	152-183 cm
	SD-3-41-Foot	183-213 cm
SD0104 (Southern slip)	SD-4-S1C	0-91 cm
	SD-4-39-Foot	91-122 cm
	SD-4-41-Foot	122-152 cm
SD0105 (Southern slip)	SD-5-SD1C	0-30 cm
	SD-5-39-Foot	30-61 cm
	SD-5-41-Foot	61-90 cm

The samples were analyzed for ammonia/nitrogen, sulfide, total solids, TVS, VOCs, SVOCs, PAHs, TPH-diesel, pesticides, PCBs, and total metals. Porewater from these samples was analyzed for butyltins. The results for indicator chemicals in surface and subsurface samples are summarized in the following tables. Except for porewater TBT, the results were reported on a dry-weight basis. In surface sediment samples, maximum concentrations of all chemicals were found in Sample SD-5-SD1C.

Summary Data for Surface Samples.

Parameter	Minimum	Maximum
Arsenic (mg/kg)	4.16	4.31
Cadmium (mg/kg)	0.4	0.73
Copper (mg/kg)	41.9	53
Lead (mg/kg)	14	43.2
Mercury (mg/kg)	0.2 U	0.26
Zinc (mg/kg)	98.8	236

Parameter	Minimum	Maximum
TBT(µg/L)	0.02 U	0.04 U
bis(2-ethylhexyl)phthalate (µg/kg)	149	248
Total LPAH (µg/kg)	18.7 A	458 A
Total HPAH (µg/kg)	234 A	1,057 A
Total PCBs (µg/kg)	12 UA	79.1 A
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	0.8 UA	0.8 UA
Dibenzofuran (µg/kg)	100 U	100 U
4-methylphenol (µg/kg)	na	na
Xylenes (µg/kg)	200 U	200 U

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Undetected at concentration shown.

Summary Data for Subsurface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	2.52	6.37 (SD-4-41-Foot)
Cadmium (mg/kg)	0.3 U	0.69 U (SD-1-S1C)
Copper (mg/kg)	18.1	58.2 (SD-2-39-Foot)
Lead (mg/kg)	5.23	47.8 (SD-3-41-Foot)
Mercury (mg/kg)	0.2 U	0.31 (SD-5-39-Foot)
Zinc (mg/kg)	60.7	172 (SD-3-41-Foot)
TBT(µg/kg)	0.02 U	0.06 U (SD-5-41-Foot)
bis(2-ethylhexyl)phthalate (µg/kg)	100 U	320 (SD-1-S1C)
Total LPAH (µg/kg)	6 UA	1,721 A (SD-1-41-Foot)
Total HPAH (µg/kg)	58.1 A	5,107 A (SD-1-S1C)
Total PCBs (µg/kg)	12 UA	205 A (SD-1-39-Foot)
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	0.8 UA	1.7 UA (SD-3-S1C)
Dibenzofuran (µg/kg)	100 U	212 U (SD-3-S1C)
4-methylphenol (µg/kg)	na	na
Xylenes (µg/kg)	200 U	425 U (SD-3-S1C)

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Undetected at concentration shown.

WLCT4K99. Terminal 4 – Slip 1 and Berth 401 Sediment Characterization Study, Portland, OR. ***(Prepared by Hart Crowser, May 2000).***

Hart Crowser conducted this study for the Port of Portland to characterize the quality of relatively finer-grained surface sediments in Slip 1 and Berth 401 at Terminal 4. Surface (0-10 cm) sediment samples were collected at 19 locations on November 18-19, 1999, to delineate the horizontal extent of contamination. Eighteen samples were located in or at the mouth of Slip 1, and one sample was located northwest of Berth 401. Sample collection methods were not specified in the report.

All 19 samples were analyzed for grain-size distribution. The majority of samples were composed primarily of fines, with sand fractions constituting approximately 4 to 48% of each sample. Ten of the finer-grained samples (all located within Slip 1) were selected for chemical analyses, including total metals (not including mercury), SVOCs, pesticides, PCBs, and TOC. The remaining samples were archived for potential future analysis.

Organic content ranged from 1.66 to 4.72% in the samples analyzed. Results for indicator chemicals are summarized in the following table.

Parameter	Minimum	Maximum
Arsenic (mg/kg)	3.4	6.3
Cadmium (mg/kg)	0.27 U	1.4
Copper (mg/kg)	28.7	49.7
Lead (mg/kg)	11.5	223
Mercury (mg/kg)	na	na
Zinc (mg/kg)	66.5	446
TBT(µg/kg)	na	na
bis(2-ethylhexyl)phthalate (µg/kg)	170	4,700
Total LPAH (µg/kg)	10 UA	9,568 A
Total HPAH (µg/kg)	894 A	117,300 A
Total PCBs (µg/kg)	11 A	135 A
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	7.3 A	28.4 A
Dibenzofuran (µg/kg)	10 U	290
4-methylphenol (µg/kg)	na	na
Xylenes (µg/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Undetected at concentration shown.

WLCGSD01. NW Natural "Gasco" Site, Draft Screening Level Nearshore Source Control Evaluation Results Report, Portland, OR. ***(Prepared by Anchor Environmental, L.L.C., July 2001).***

The purpose of this investigation was to characterize nearshore river conditions adjacent to the NW Natural "Gasco" site in order to validate groundwater model results and determine whether site groundwater was an ongoing source of river water and sediment contamination.

On April 10-11, 2001, nine sediment vibracores were collected from a research vessel along two transects that ran perpendicular from the Gasco site shoreline. Four cores were collected along the first transect located offshore of the tar pond area, and five cores were collected along the second transect located approximately 500 feet northwest of the first. Samples were collected from the cores at three depth intervals: 0-10 cm, 10-20 cm, and 30-40 cm. All samples were analyzed for TOC, total solids, six metals, cyanide, BTEX, PAHs, and sulfides.

Organic carbon content ranged from 0.18 to 8.76%. Results for indicator chemicals in surface and subsurface samples are summarized in the following tables. All results are reported in dry weight.

Summary Data for Surface Samples.

Parameter	Minimum	Maximum
Arsenic (mg/kg)	2.4	5.1
Cadmium (mg/kg)	na	na
Copper (mg/kg)	21	55.9
Lead (mg/kg)	4.3	56.8
Mercury (mg/kg)	na	na
Zinc (mg/kg)	56.1 J	281 J
TBT (µg/kg)	na	na
bis(2-ethylhexyl)phthalate (µg/kg)	na	na
Total LPAH (µg/kg)	351 A	771,800 A
Total HPAH (µg/kg)	1,238 A	1,057,400 A
Total PCBs (µg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	na	na
Dibenzofuran (µg/kg)	na	na
4-methylphenol (µg/kg)	na	na
Xylenes (µg/kg)	0.020 U	1.51

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
J - Estimated value.
U - Undetected at concentration shown.

Summary Data for Subsurface Samples.

Parameter	Minimum	Maximum
Arsenic (mg/kg)	1.1	5.1
Cadmium (mg/kg)	na	na
Copper (mg/kg)	14.5	57.6
Lead (mg/kg)	2.28	58.4
Mercury (mg/kg)	na	na
Zinc (mg/kg)	37 J	313 J
TBT (µg/kg)	na	na
bis(2-ethylhexyl)phthalate (µg/kg)	na	na
Total LPAH (µg/kg)	3 UA	4,299,000 A
Total HPAH (µg/kg)	3 UA	1,893,000 A
Total PCBs (µg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	na	na
Dibenzofuran (µg/kg)	na	na
4-methylphenol (µg/kg)	na	na
Xylenes (µg/kg)	0.020 U	9.1

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
J - Estimated value.
U - Undetected at concentration shown.

WLCWTI00. Revised 60-inch Storm Sewer Interim Remedial Actions Report, Tosco Willbridge Terminal, Portland, OR. ***(Prepared by KHM Environmental Management, Inc., May 2002).***

KHM Environmental Management performed subsurface investigations and interim remedial actions at the Tosco Willbridge Terminal facility, which is located on the west bank of the Willamette River at RM 8. These activities were performed to address the seepage of petroleum hydrocarbons from bedding/backfill materials associated with a 60-inch-diameter storm sewer. The storm sewer is owned by the City of Portland, but crosses the Tosco terminal between Front Avenue and the river. The primary goal of the interim remedial activities was to assess the extent of separate-phase hydrocarbons (SPH) in the vicinity of the storm sewer, and eliminate SPH seepage to the Willamette. Remedial goals also included removal of the impacted sediment adjacent to the outfall.

The investigation included the collection of groundwater and soil/sediment samples in the vicinity of the outfall as well as the installation of various engineering controls to contain and reduce the SPH seepage. Four sediment/soil samples were collected near the Willamette River low-water line on either side of the storm sewer outfall, using hand tools such as shovels or trowels. The samples were collected on September 21, 2000 within a 6-inch interval beginning at the sand/silt interface, which ranged from approximately 0.5 to 1 foot below the ground surface (bgs). On September 21-22, 2000, nine additional soil/sediment samples were collected from test pits excavated in the outfall area to determine the area of sediment impact and calculate the volume of material that would require removal. Test pit samples were collected directly from the excavator bucket at depth intervals ranging from 61 to 229 cm bgs.

All soil/sediment samples were analyzed for hydrocarbon identification and TPH as diesel and heavy oil. One test pit sample was also analyzed for VOCs and RCRA metals for disposal characterization. Results for indicator chemicals in LWR samples are summarized in the following table, reported on a dry-weight basis. Based on the analytical results of the soil/sediment samples in the vicinity of the outfall, a permit was requested from the U.S. Army Corps of Engineers for excavation of the impacted area.

Parameter	Minimum	Maximum
Arsenic (mg/kg)		1.69
Cadmium (mg/kg)		0.5 U
Copper (mg/kg)	na	na
Lead (mg/kg)	10 U	10 U
Mercury (mg/kg)		0.1 U
Zinc (mg/kg)	na	na
TBT(µg/kg)	na	na
bis(2-ethylhexyl)phthalate (µg/kg)	na	na
Total LPAH (µg/kg)	na	na
Total HPAH (µg/kg)	na	na

Parameter	Minimum	Maximum
Total PCBs (µg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	na	na
Dibenzofuran (µg/kg)	na	na
4-methylphenol (µg/kg)	na	na
Xylenes (µg/kg)		1,253

na – Not analyzed.
U - Undetected at concentration shown.

WLCAYH00. Expanded Preliminary Assessment Data Report, Union Pacific Railroad (UPRR) Albina Yard, Portland, OR. ***(Prepared by Jacobs Engineering, November 2000).***

Jacobs Engineering performed an XPA of the Union Pacific Railroad (UPRR) Albina Yard site in August 2000. The purpose of the XPA was to determine if a release had occurred or may occur at the site that could endanger human health or the environment per Oregon's Revised Statutes (ORS Chapter 465.200). The XPA included the collection of soil, groundwater, and surface water samples, as well as six sediment samples. Four of these samples were collected from the Willamette River, while the remaining two were collected from storm drains. The river sediment sampling station locations were described as follows:

Station	Location
SD-01	Upstream of Albina Yard, northwest of Fremont Bridge, sediment quality presumably unaffected by site activities (baseline sample)
SD-02	Near Outfall #2, draining stormwater runoff from the southeastern portion of UPRR site
SD-03	Near Outfall #1, draining stormwater runoff from the central portion of UPRR site
SD-04	Near Outfall #3, draining stormwater runoff from the northwestern portion of UPRR site

Both surface and subsurface sediment samples were collected. Surface samples were collected from the top 20 cm using a single grab with a 0.1-square-meter (m^2) van Veen sampler. Subsurface sediment samples were collected using a 2-inch-diameter gravity core configured with a 3-foot barrel. Sample recovery was difficult at most locations given the steeply sloped bottom and the amount of riprap and debris present. Three core samples were collected: SD-1D (30-60 cm), SD-2D (30-69 cm), and SD-4D (30-60 cm). Efforts to collect a subsurface core at station SD-3 were abandoned after several attempts failed to retrieve any sample volume.

Samples were analyzed for TPH, SVOCs, metals, TBT, PCB Aroclors, and TOC. Organic carbon content ranged from 0.93 to 2.60%. Results for indicator chemicals in surface and subsurface samples are summarized in the following tables. All results were reported in dry weight.

Summary Data for Surface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	2	3.8 (SD-01)
Cadmium (mg/kg)	0.15	0.67 (SD-04)
Copper (mg/kg)	23.3	45 (SD-03)
Lead (mg/kg)	9.88	61.3 (SD-04)
Mercury (mg/kg)	0.05	0.09 (SD-04)
Zinc (mg/kg)	65.1	122 (SD-04)

Parameter	Minimum	Maximum (Location)
TBT (µg/kg)	3	12 (SD-01)
bis(2-ethylhexyl)phthalate (µg/kg)	80 J	200 (SD-03)
Total LPAH (µg/kg)	39 A	174 A (SD-04)
Total HPAH (µg/kg)	174 A	793 A (SD-01)
Total PCBs (µg/kg)	7 A	550 A (SD-04)
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	na	na
Dibenzofuran (µg/kg)	0.9 J	5 J (SD-04)
4-methylphenol (µg/kg)	na	na
Xylenes (µg/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
J - Estimated value.

Summary Data for Subsurface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	2.7	4.4 (SD-04)
Cadmium (mg/kg)	0.15	0.38 (SD-04)
Copper (mg/kg)	30.4	33.4 (SD-04)
Lead (mg/kg)	5.91	28.5 (SD-02)
Mercury (mg/kg)	0.06	0.13 (SD-02)
Zinc (mg/kg)	54	113 (SD-04)
TBT (µg/kg)	1 U	13 (SD-04)
bis(2-ethylhexyl)phthalate (µg/kg)	20 J	200 J (SD-04)
Total LPAH (µg/kg)	10.9 A	108 A (SD-04)
Total HPAH (µg/kg)	17 A	660 A (SD-02)
Total PCBs (µg/kg)	12 A	15 A (SD-04)
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	na	na
Dibenzofuran (µg/kg)	3 J	3 J (SD-02, -04)
4-methylphenol (µg/kg)	na	na
Xylenes (µg/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
J - Estimated value.
U - Undetected at concentration shown.

WLCMFH00. Expanded Preliminary Assessment Data Report, Marine Finance Site, Portland, OR. ***(Prepared by Jacobs Engineering, November 2000).***

Jacobs Engineering performed an XPA of the Marine Finance Site from August 7-10, 2000, under DEQ's Orphan Site Account. The purpose of the XPA was to determine if a release had occurred or may occur at the site that could endanger human health or the environment per Oregon's Revised Statutes (ORS Chapter 465.200).

In addition to soil sample collection, sediment samples were collected from six locations as part of the XPA. Stations were identified as SD-1 through SD-6 and were situated as follows:

Station	Location
SD-1	Seep pool in northern portion of site northwest of Mark Even Construction
SD-2	Northwest and downstream of Mark Even Construction dock near area of known runoff
SD-3	North and downstream of the middle dock
SD-4	North and downstream of Hendren Towboat
SD-5	Adjacent to Hendren Towboat site
SD-6	100 feet upstream of Hendren Towboat as a "baseline" sample

Both surface (S sample suffix) and subsurface (D sample suffix) sediment samples were collected. Surface samples were collected from the top 20 cm using a single grab at all six locations. Subsurface sediment samples were collected using a 2-inch-diameter gravity core configured with a 3-foot barrel. Sample recovery was difficult at most locations given the steeply sloped bottom and the amount of riprap and debris present. Only 3 core samples were collected: SD-4D (30-54 cm), SD-5D (30-54 cm), and SD-6D (30-66 cm).

Samples were analyzed for TPH, SVOCs, metals, TBT, PCB Aroclors, and TOC. Organic carbon content ranged from 0.92 to 4.37%. Results for indicator chemicals are presented in the following table. All results were reported in dry weight.

Summary Data for Surface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	3.7	11.1 (SD-3)
Cadmium (mg/kg)	0.21	0.38 (SD-1)
Copper (mg/kg)	34.6	98.5 (SD-3)
Lead (mg/kg)	13.6	232 (SD-5)
Mercury (mg/kg)	0.02	0.11 (SD-5)
Zinc (mg/kg)	87.8	273 (SD-3)
TBT (µg/kg)	0.7 J	130 (SD-3)
LPAH (µg/kg)	214 A	19,320 A (SD-5)
HPAH (µg/kg)	970 A	78,600 A (SD-5)

Parameter	Minimum	Maximum (Location)
Total PCBs (µg/kg)	8 A	19 A (SD-5)
Total DDTs (µg/kg)	na	Na
Bis(2-ethylhexyl)phthalate (µg/kg)	50 J	300 J (SD-3)
Dibenzofuran (µg/kg)	6 J	200 J (SD-5)
4-Methylphenol (µg/kg)	na	na
Xylene (µg/kg)	na	na
Diesel Fuel (mg/kg)	92	720 (SD-5)
2,3,7,8-TCDD (ng/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
J - Estimated value.

Summary Data for Subsurface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	3.6	3.8 (SD-4)
Cadmium (mg/kg)	0.15	0.43 (SD-5)
Copper (mg/kg)	26.3	36.5 (SD-5)
Lead (mg/kg)	10.9	46 (SD-5)
Mercury (mg/kg)	0.07	0.18 (SD-5)
Zinc (mg/kg)	65.1	121 (SD-5)
TBT (µg/kg)	1 J	5 (SD-6)
LPAH (µg/kg)	130 A	180,800 A (SD-5)
HPAH (µg/kg)	1,570 A	402,800 A (SD-5)
Total PCBs (µg/kg)	10 A	76 A (SD-5)
Total DDTs (µg/kg)	na	na
Bis(2-ethylhexyl)phthalate (µg/kg)	20 J	3,000 J (SD-5)
Dibenzofuran (µg/kg)	2 J	1,500 (SD-5)
4-Methylphenol (µg/kg)	na	na
Xylene (µg/kg)	na	na
Diesel Fuel (mg/kg)	97	2800 (SD-5)
2,3,7,8-TCDD (ng/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
J - Estimated value.

WLCT1F00. Marine Terminal 1 Baseline Investigation Final Report, Port of Portland, Portland, OR. ***(Prepared by Striplin Environmental Associates, August 2000).***

SEA conducted a study to establish baseline sediment quality conditions in the vicinity of the Port of Portland's Marine Terminal 1 South between RM 10 and 11. Sampling was conducted on June 23, 2000.

Surface (0 to 10 cm) sediments from nine stations were sampled using a 0.1-m^2 double van Veen grab sampler deployed from a 28-foot sampling vessel. Each sample represented two replicate grabs that were necessary to collect adequate volume. Seven stations (T1S-02 through T1S-08) were located offshore of berths 104, 105, and 106, and the remaining two were located upstream (T1S-09) and downstream (T1S-01) of the berth areas to assess impacts stemming from potential sources beyond the Terminal 1 property boundaries.

The samples were analyzed for TOC, grain-size distribution, VOCs, total sulfides, SVOCs, pesticides, PCBs, and metals, and porewater was analyzed for tri-n-butyl tin. The samples were generally fine-grained; fines content ranged from approximately 27 to 66%. Organic content ranged from 1.4 to 2.65%. The results for indicator chemicals are summarized in the following table.

Parameter	Minimum	Maximum
Arsenic (mg/kg)	3.3	5.5 (T1S-06)
Cadmium (mg/kg)	0.16	0.26 (T1S-03)
Copper (mg/kg)	30.1 N	57.2 N (T1S-01)
Lead (mg/kg)	10.7	20.8 (T1S-01)
Mercury (mg/kg)	0.04	0.56 (T1S-09)
Zinc (mg/kg)	75.5 N	114 N (T1S-01)
TBT(µg/L)	0.05 UX	0.05 UX
bis(2-ethylhexyl)phthalate (µg/kg)	140	310 (T1S-08)
Total LPAH (µg/kg)	20 UA	157 A (T1S-09)
Total HPAH (µg/kg)	20 UA	410 A (T1S-09)
Total PCBs (µg/kg)	14 A	41 A (T1S-01)
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	1.8 A	6.7 A (T1S-09)
Dibenzofuran (µg/kg)	20 U	20 U
4-methylphenol (µg/kg)	120 U	120 (U)
Xylenes (µg/kg)	2 U	10 U (T1S-06)

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
N – For metals, the matrix spike sample recovery was not within control limits. See case narrative.
U - Undetected at concentration shown.
X – See case narrative.

WLCGAF00. Dredging Sampling Results, Goldendale Alumina Unloading Facility, Phase I Sampling, Portland, OR. ***(Prepared by CH2M Hill, March 2001).***

Phase I of this investigation consisted of sampling to characterize sediments proposed for removal during maintenance dredging at the Goldendale Alumina Company (GAC) Portland Unloading Facility dock (RM 11). The results of previous sampling of the material conducted in 1999 by CH2M Hill had indicated that chemical concentrations in the material were below screening levels for aquatic disposal, but DEQ requested additional sampling to be done to characterize the material for disposal at Ross Island.

Five surface (0-30 cm) sediment samples were collected on June 12, 2000 from the proposed dredging area near the facility's dock. The sampling was performed by David Evans and Associates using a ponar clamshell sampler deployed from a boat. The samples were analyzed for grain-size distribution, conventional parameters (ammonia as nitrogen, total sulfide, TOC), VOCs, SVOCs, organochlorine pesticides, PCBs, butyltins, and metals. Three of the samples were selected by GAC and DEQ for bioassays.

The samples were primarily composed of silt with very fine sand. Organic content ranged from 1.91 to 2.47%. The results for indicator chemicals are summarized in the following table. The results (except porewater TBT) are reported on a dry-weight basis.

Parameter	Minimum	Maximum
Arsenic (mg/kg)	2.9	3.8
Cadmium (mg/kg)	0.16	0.17
Copper (mg/kg)	31.6	34
Lead (mg/kg)	11.5	13.3
Mercury (mg/kg)	0.2 U	0.2 U
Zinc (mg/kg)	68.5	73.1
TBT (µg/L)	6.3	36
bis(2-ethylhexyl)phthalate (µg/kg)	95	2,700
Total LPAH (µg/kg)	12 A	2,948 A
Total HPAH (µg/kg)	95	9,585 A
Total PCBs (µg/kg)	20 UA	20 UA
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	1.9 A	4.7 A
Dibenzofuran (µg/kg)	3 J	64
4-methylphenol (µg/kg)	25 U	25 U
Xylenes (µg/kg)	20 U	24 U

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
J - Estimated value.
U - Undetected at concentration shown.

LWCGAL00. Preliminary Assessment and Dredging Sampling Results, Goldendale Alumina Unloading Facility, Phase II Sampling, Portland, OR. ***(Prepared by CH2M Hill, March 2001).***

Following maintenance dredging at the GAC dock in October 2000, sediment sampling was conducted as part of a preliminary assessment (PA) of the GAC facility. The PA was performed by GAC, as requested in DEQ's strategy recommendation for the site.

Three surface (0-30 cm) sediment samples were collected on December 21, 2000 and analyzed for PAHs. Two of the samples ('Post Dredge 1' and 'Post Dredge 2') were collected from within the dredged area and one ('UP Outfall') was collected near a stormwater outfall. A stormwater sample was subsequently collected in January 2001 to assess whether stormwater near the site was contributing to PAHs detected in sediments near the dock. No PAHs or oil and grease constituents were detected in the stormwater.

The analytical results of indicator chemicals in the three Phase II sediment samples are summarized in the following table. The maximum concentrations were all detected in sample 'Post Dredge 2.' All results are reported on a dry-weight basis.

Parameter	Minimum	Maximum
Arsenic (mg/kg)	na	na
Cadmium (mg/kg)	na	na
Copper (mg/kg)	na	na
Lead (mg/kg)	na	na
Mercury (mg/kg)	na	na
Zinc (mg/kg)	na	na
TBT (µg/L)	na	na
bis(2-ethylhexyl)phthalate (µg/kg)	na	na
Total LPAH (µg/kg)	193 A	5,530 A
Total HPAH (µg/kg)	1,357 A	40,280 A
Total PCBs (µg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	na	na
Dibenzofuran (µg/kg)	9.6	280
4-methylphenol (µg/kg)	na	na
Xylenes (µg/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.

WLCGPE00. Expanded Preliminary Assessment for the Linnton Site, Portland, OR. ***(Prepared by CH2M Hill, August 2000).***

This report interpreted data gathered during investigations in the Willamette River adjacent to the Linnton property (RM 4), which was formerly owned by Georgia-Pacific West, Inc. The river investigations were performed as part of an XPA, as requested in DEQ's strategy recommendation for the property. The purpose of the XPA was to determine whether contamination in adjacent river sediments could be associated with a hazardous substance release or past operations at the site.

Sediment sampling was performed on May 16-17, 2000. A gravity corer was used to collect two 12-inch cores at each of 13 sampling stations. The two cores at each station were composited to form one representative sample. The samples were analyzed for grain-size distribution, TOC, PAHs, phenols, diesel-range TPHs, and metals.

The samples were dominantly fine-grained; fines content ranged from approximately 60 to 96%. Organic content ranged from 1 to 6%. The results for indicator chemicals are summarized in the following table.

Parameter	Minimum	Maximum
Arsenic (mg/kg)	8.8	21.6
Cadmium (mg/kg)	0.72 U	1.3
Copper (mg/kg)	32.3	47.9
Lead (mg/kg)	7.7	28.7
Mercury (mg/kg)	0.08	0.36
Zinc (mg/kg)	88.1	151
TBT(µg/L)	na	na
bis(2-ethylhexyl)phthalate (µg/kg)	na	na
Total LPAH (µg/kg)	25.2 A	4,785 A
Total HPAH (µg/kg)	99.4 A	18,489 A
Total PCBs (µg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	na	na
Dibenzofuran (µg/kg)	na	na
4-methylphenol (µg/kg)	16 U	76
Xylenes (µg/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Undetected at concentration shown.

WLCT5K99. Sediment Characterization at Marine Terminal 5, Barge Berth 501 and Berth 503, Portland, OR. ***(Prepared by Hart Crowser, 1999).***

The purpose of this investigation was to characterize sediment to be dredged for navigational maintenance at Port of Portland's Terminal 5, located between RM 1 and RM 2. Three DMMUs were defined for this project: DMMU T501-Face (located along the offshore side of Berth 501); DMMU T501-Barge (the barge berth area inshore of Berth 501); and DMMU T503 (along Berth 503).

Vibracores were collected on November 18, 1999 from five locations: two within DMMU T501-Face, one from DMMU T501-Barge, and two from DMMU T503. Whole cores from DMMU T501-Face and DMMU T503 were homogenized to form one representative sample for each respective unit. Sampled intervals ranged up to 182 cm (approximately 6 feet) below the mudline. The samples were submitted for the analysis of particle size, total solids, TVS, TOC, ammonia, metals (including mercury), SVOCs, pesticides, PCBs, total sulfides, and biological assays. Porewater was analyzed for TBT.

The results for indicator chemicals are summarized in the following table. Sediment analytical results are reported in dry weight. The maximum concentrations for all analytes except TBT were detected in the composite sample from Berth 503. The maximum TBT concentration was detected in the composite sample from Berth 501. The DMMUs associated with these analytical results have since been dredged.

Parameter	Minimum	Maximum
Arsenic (mg/kg)	2	5.1
Cadmium (mg/kg)	0.08	0.67
Copper (mg/kg)	8.31	97.9
Lead (mg/kg)	3.21	16.5
Mercury (mg/kg)	0.1	0.5
Zinc (mg/kg)	34.2	122
TBT (µg/L)	0.03	3.5
bis(2-ethylhexyl)phthalate (µg/kg)	35 U	97
Total LPAH (µg/kg)	6 UA	51 A
Total HPAH (µg/kg)	10 UA	400 A
Total PCBs (µg/kg)	20 UA	20 UA
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	5 UA	5 UA
Dibenzofuran (µg/kg)	6 U	6 U
4-methylphenol (µg/kg)	10 U	10 U
Xylenes (µg/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Undetected at concentration shown.

WLCMBJ99. Sediment Remedial Design Final Sampling Data Summary Report, McCormick & Baxter Creosoting Company, Portland, OR. ***(Prepared by Ecology and Environment, Inc., February 2001).***

Ecology and Environment conducted sediment sampling on behalf of DEQ to support the remedial design for contaminated sediment at the McCormick & Baxter Creosoting Company's Portland facility, located at approximately RM 7.

Phase I of the remedial design sampling was conducted in October 1999 and included surface water and sediment sampling. Thirty-nine sediment samples were collected within approximately 300-400 feet of the facility shoreline, from a mudline depth interval of 0-6 inches. Four reference samples were collected at approximately RMs 18, 22, 23, and 24. Samples were collected using a ponar grab sampler deployed from a sampling platform or vessel. Samples were composited from three replicate grabs on average, although up to 12 grabs were required at one location to acquire sufficient sample volume. The samples were submitted for grain-size distribution, arsenic, pentachlorophenol, PAHs, and toxicity analyses. Selected samples were analyzed for dioxins/furans.

The sediment samples were composed primarily of sands, which ranged from 72.67 to 100% of sample material. Results for indicator chemicals are summarized in the following table. All results were reported in dry weight.

Parameter	Minimum	Maximum
Arsenic (mg/kg)	2.9	11.7
Cadmium (mg/kg)	na	na
Copper (mg/kg)	na	na
Lead (mg/kg)	na	na
Mercury (mg/kg)	na	na
Zinc (mg/kg)	na	na
TBT(µg/L)	na	na
bis(2-ethylhexyl)phthalate (µg/kg)	na	na
Total LPAH (µg/kg)	10 UA	282,830 A
Total HPAH (µg/kg)	10 UA	102,460 A
Total PCBs (µg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	1 U	4
Total DDT (µg/kg)	na	na
Dibenzofuran (µg/kg)	na	na
4-methylphenol (µg/kg)	na	na
Xylenes (µg/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Undetected at concentration shown.

WLCMBA01. Sediment Remedial Design Final Sampling Data Summary Report, McCormick & Baxter Creosoting Company, Portland, OR. ***(Prepared by Ecology and Environment, Inc., February 2001).***

Ecology and Environment (E&E) conducted sediment sampling on behalf of DEQ to support the remedial design for contaminated sediment at the McCormick & Baxter Creosoting Company's Portland facility, located at approximately RM 7. Phase I of the remedial design sampling was conducted in October 1999. Phase II sampling was performed in January and February 2001 to address data gaps identified during Phase I, including the delineation of the lateral extent of contamination and parameters necessary for permeation modeling.

On January 5 and 8, 2001, surface sediment samples were collected at 29 locations offshore of the McCormick & Baxter facility, and one sample was collected at an upstream reference location at RM 24. The samples were collected from a sampling interval of 0-15 inches using a PVC plastic sampling tube deployed by divers. Two replicates were required at each station: one was submitted for grain-size distribution and PAH analyses, and the other was submitted for toxicity testing.

Subsurface sediment samples were collected on February 5, 2001 at three locations offshore of the facility. The samples were obtained from cores collected from 0 to 10 feet using a Shelby tube and piston sampler. Porewater samples from the sediment cores were submitted for dissolved organic carbon and SVOC analyses. Sediment from the cores was collected for non-aqueous phase liquid (NAPL) extraction to be used in the physical testing required for sediment cap permeation modeling. Samples of light NAPL, dense NAPL, and river water were also collected to provide data for cap permeation modeling.

The surface sediment samples displayed a range of grain sizes, but were generally finer than the Phase I samples. Fines in Phase II samples ranged from 0 to 93%. The results for indicator chemicals in the surface samples are summarized in the following table. All results were reported in dry weight. The results of the sediment porewater analyses from this investigation were not available at the time of the E&E report.

Parameter	Minimum	Maximum
Arsenic (mg/kg)	na	na
Cadmium (mg/kg)	na	na
Copper (mg/kg)	na	na
Lead (mg/kg)	na	na
Mercury (mg/kg)	na	na
Zinc (mg/kg)	na	na
TBT(µg/L)	na	na
bis(2-ethylhexyl)phthalate (µg/kg)	na	na
Total LPAH (µg/kg)	13.4 UA	173,569 A
Total HPAH (µg/kg)	13.4 UA	82,097 A

Parameter	Minimum	Maximum
Total PCBs (µg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	na	na
Dibenzofuran (µg/kg)	na	na
4-methylphenol (µg/kg)	na	na
Xylenes (µg/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Undetected at concentration shown.

WLCOSJ00. Pre-remedial Investigation Field Activities Data Report, Oregon Steel Mills, Inc. (OSM), Portland, OR. ***(Prepared by Exponent, February 2001).***

Exponent performed this pre-remedial investigation at the OSM Portland mill in October 2000. The facility is located at approximately RM 3. Field activities included upland subsurface soil and groundwater sampling near a former oil sump, and sediment sampling in the vicinity of stormwater outfalls along the Willamette River.

Sediment sampling was conducted on October 10-11, 2000. Surface (0-10 cm) samples were collected from four stations in the vicinity of each of two outfalls (Outfalls 001 and 003) that drain the property. In addition, two surface samples were collected 100 feet apart near both the upstream and downstream property boundaries. Deeper samples were obtained at two additional stations near Outfall 003 using a coring device or a shovel. Deeper samples could not be obtained near Outfall 001 due to refusal. The sample locations, IDs, and intervals are summarized in the table below:

Location	Sample ID	Interval
Near northern property boundary	SD0001	0-10 cm
	SD0002	0-10 cm
Outfall 003	SD0003	0-10 cm
	SD0004	0-10 cm
	SD0005	0-10 cm
	SD0006	0-10 cm
	SD0007 (dup of SD0006)	0-10 cm
	SD0014	0-30 cm
	SD0015	0-30 cm
	SD0016	0-60 cm
Outfall 001	SD0008	0-10 cm
	SD0009	0-10 cm
	SD0010	0-10 cm
	SD0011	0-10 cm
	SD0014	0-10 cm
	SD0015	0-10 cm
	SD0016	0-10 cm
Near southern property boundary	SD0012	0-10 cm
	SD0013	0-10 cm

All sediment samples were analyzed for priority pollutant metals, SVOCs, PCBs, TOC, and grain size. Samples SD0015 and SD0016 were also analyzed for TPH.

The sediment samples were composed primarily of sands and gravels. Fines content in the samples ranged from approximately 3 to 8%. Organic content ranged from less than 0.05 to 1.91%. The results for indicator chemicals in the sediment samples are summarized in the following table. All results were reported in dry weight.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	1.8	132 (SD0009)
Cadmium (mg/kg)	1 U	2.1 (SD0009)
Copper (mg/kg)	111	148 (SD0015)
Lead (mg/kg)	19.8 U	166 (SD0010)
Mercury (mg/kg)	0.02 U	0.07 (SD0005)
Zinc (mg/kg)	43.1	823 (SD0009)
TBT(µg/L)	na	na
bis(2-ethylhexyl)phthalate (µg/kg)	180 U	2,000 U (SD0009)
Total LPAH (µg/kg)	8.9 UA	14,093 A (SD0004)
Total HPAH (µg/kg)	19 UA	39,000 (SD0004)
Total PCBs (µg/kg)	140 A	2,790 A (SD0005)
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	na	na
Dibenzofuran (µg/kg)	8.9 U	1,000 (SD0004)
4-methylphenol (µg/kg)	na	na
Xylenes (µg/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Undetected at concentration shown.

WLCRIL99. Site Investigation Report, Port of Portland Confined Dredged Material Disposal, Ross Island Facility, Portland, Oregon. ***(Prepared by Hart Crowser, November 30, 2000).***

Hart Crowser conducted a site investigation at the Ross Island Confined Dredged Material Disposal Facility to determine if dredged material from Port facilities, which were placed at Ross Island, posed a risk to human health or the environment. In addition to groundwater and surface water sampling, Hart Crowser collected samples of lagoon sediment.

Surface (0-10 cm) sediment samples were collected at 34 locations during November 16-19,1999. These included 29 locations within the lagoon, Holgate Slough, and the adjacent Willamette River (Samples HC-SS01 through HC-SS31); two upstream background samples (HC-SS32 and HC-SS33); and three reference samples in the Columbia River (HC-REF1, HC-REF2, HC-REF3). Surface samples were collected using a van Veen grab.

Subsurface sediment samples were collected at 19 locations within Ross Island Lagoon (seven in disposal cells and 12 near the cells to assess slope stability) during November and December 1999. Borings ranged from 18 to 94.5 feet below mudline; sampling intervals ranged from approximately 4.4-26 feet to 15.5-59 feet. Subsurface samples were collected using a hollow-stem auger, split-spoon sampler, Gus sampler, and Hart sampler.

Samples were analyzed for TOC, grain size, metals, SVOCs, VOCs, PCBs, DDT, and TPH. Some samples were also analyzed for porewater TBT. Organic carbon in surface sediments ranged from 0.12 to 1.9%. Results for surface sediment samples and subsurface samples are provided below in separate tables. Results are reported in dry weight.

Summary Data for Surface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	2.27U	7.7 (HC-G06A)
Cadmium (mg/kg)	0.27UJ	0.3 (HC-SS15)
Copper (mg/kg)	14.4U	52.3J (HC-G06A)
Lead (mg/kg)	4.56	27.8 (HC-G06A)
Mercury (mg/kg)	0.12U	0.8 (HC-SS22)
Zinc (mg/kg)	33.2	191J (HC-G06A)
TBT (µg/kg)	na	na
TBT (µg/L)	0.02UJ	0.08 (HC-SS17)
Bis(2-ethylhexyl)phthalate (µg/kg)	100U	420 (HC-SS03)
Total HPAH (µg/kg)	50UA	2080A (HC-SS03)
Total LPAH (µg/kg)	50UA	160A (HC-SS03)

Parameter	Minimum	Maximum (Location)
Total PCBs (µg/kg)	11A	130A (HC-SS20)
2,3,7,8-TCDD (ng/kg)	na	na
Total DDTs (µg/kg)	2.6A	2.6A (HC-SS11)
Dibenzofuran (µg/kg)	50U	50U
4-Methylphenol (µg/kg)	na	na
Xylenes (µg/kg)	na	na

na – Not analyzed.
U - Undetected at concentration shown.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
UA - All summed analytes undetected, high detection shown.
J - Estimated value.

Summary Data for Subsurface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	2.18U	24.4 (HC-G07)
Cadmium (mg/kg)	0.3U	1.7 (HC-G05)
Copper (mg/kg)	15.5	1340 (HC-G07
Lead (mg/kg)	6.3	409 (HC-G05)
Mercury (mg/kg)	0.1U	1.43 (HC-G07)
Zinc (mg/kg)	40.5J	960 (HC-G07)
TBT (µg/kg)	na	na
TBT (µg/L)	0.23	27 (HC-G07)
Bis(2-ethylhexyl)phthalate (µg/kg)	100U	3600 (HC-G07)
Total HPAH (µg/kg)	50UA	726000A (HC-G08)
Total LPAH (µg/kg)	50UA	90600A (HC-G08)
Total PCBs (µg/kg)	20UA	2900A (HC-G07)
2,3,7,8-TCDD (ng/kg)	na	na
Total DDTs (µg/kg)	2.6A	754.7A (HC-G07)
Dibenzofuran (µg/kg)	50U	1700 (HC-G08)
4-Methylphenol (µg/kg)	na	na
Xylenes (µg/kg)	na	na

na – Not analyzed.
U - Undetected at concentration shown.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
UA - All summed analytes undetected, high detection shown.
J - Estimated value.

WLCRIJ99. Baseline Sediment Characterization, In-Water Clear Zone Sampling Results, Ross Island Lagoon. (*Prepared by Landau Associates, January 24, 2000).*

Landau conducted an investigation to evaluate sediment quality in the in-water clear zone of a mined area prior to reclamation.

Eight locations in the in-water clear zone (CZ01 to CZ08) were sampled for surface (0-10 cm) sediments. Porewater samples from four of the eight locations were also analyzed. In addition, three surface sediment samples were collected in the vicinity of a previously sampled location (SVS-18, located in a 1998 breach area) to verify previously reported concentrations. Stations SVS-18-R1 and SVS-18-R2 were near the original station SVS-18; three grab samples from along the toe of the slope were composited into one sample for analysis (SVS-18-COMP). All samples were collected October 26-28, 1999, using an Ekman grab sampler.

Sediment samples were analyzed for TOC, grain size, metals, SVOCs, pesticides, PCBs, and organotins. Porewater samples were analyzed for organotins. Organic carbon ranged from 1.01 to 1.58%. Sediments were composed predominantly of silt and clay. Results for indicator chemicals in surface sediments are presented in the following table. All results were reported in dry weight.

Parameter	Minimum	Maximum
Arsenic (mg/kg)	2.7	6.6 (CZ06)
Cadmium (mg/kg)	0.09	0.7 (SVS18R2)
Copper (mg/kg)	25.5	56.9 (CZ07)
Lead (mg/kg)	9.18	23.6 (CZ04)
Mercury (mg/kg)	0.05	0.18 (SVS18R1)
Zinc (mg/kg)	52.7	130 (SVS18R2)
TBT (µg/kg)	15	117 (SVS18R1)
TBT (µg/L)	0.006J	0.01J (CZ07)
Bis(2-ethylhexyl)phthalate (µg/kg)	40JB	160J (SVS18R1)
Total HPAH (µg/kg)	104A	1592A (SVS18R2)
Total LPAH (µg/kg)	13A	184A (SVS18R2)
Total PCBs (µg/kg)	20UA	11A (CZ03)
2,3,7,8-TCDD (ng/kg)	na	na
Total DDTs (µg/kg)	0.8A	2.7A (CZ03)
Dibenzofuran (µg/kg)	2J	7 (SVS18R2)
4-Methylphenol (µg/kg)	200U	200U
Xylenes (µg/kg)	na	na

na – Not analyzed.
U - Undetected at concentration shown.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
J - Estimated value.
B - Analyte found in associated blank.

WLCGXV99. Environmental Site Assessment, GATX Terminals Corporation Linnton Terminal. ***(Prepared by KHM Environmental Management, December 1999).***

KHM Environmental Management conducted an investigation to provide baseline petroleum hydrocarbon data in subsurface soils at the Linnton Terminal and sediments in the adjacent Willamette River.

A total of eight sediment samples were collected at four locations on October 8, 1999. Stations S-1 and S-2 were located near sump outfalls. Stations S-3 and S-4 were located in the river adjacent to the facility. One surface (0-10 cm) and one subsurface (30-40 cm) sample were collected at each location. Samples were collected using a core-type sampler.

Samples were analyzed for TOC, grain size, ammonia, metals, SVOCs, VOCs, pesticides, and PCBs. Organic carbon ranged from 0.2 to 1.5%. Results for surface sediment samples and subsurface samples are provided below in separate tables. Results are reported in dry weight.

Summary Data for Surface Samples.

Parameter	Minimum	Maximum
Arsenic (mg/kg)	2.6	4.32 (S-1)
Cadmium (mg/kg)	0.5U	1.02U (S-3)
Copper (mg/kg)	22.4	28.3 (S-3)
Lead (mg/kg)	16.5	29.4 (S-4)
Mercury (mg/kg)	0.1U	0.112 (S-4)
Zinc (mg/kg)	68.8	126 (S-4)
TBT (µg/kg)	na	na
Bis(2-ethylhexyl)phthalate (µg/kg)	2000U	20400U (S-3)
Total HPAH (µg/kg)	330UA	8670A (S-2)
Total LPAH (µg/kg)	330UA	2250A (S-2)
Total PCBs (µg/kg)	134UA	274UA (S-3)
2,3,7,8-TCDD (ng/kg)	na	na
Total DDTs (µg/kg)	6.7UA	29.2A (S-4)
Dibenzofuran (µg/kg)	330U	3370U (S-3)
4-Methylphenol (µg/kg)	na	na
Xylenes (µg/kg)	na	na

na – Not analyzed.
U - Undetected at concentration shown.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
UA - All summed analytes undetected, high detection shown.

Summary Data for Subsurface Samples.

Parameter	Minimum	Maximum
Arsenic (mg/kg)	3.61	6.62 (S-2)

Parameter	Minimum	Maximum
Cadmium (mg/kg)	0.5U	1.08U (S-2)
Copper (mg/kg)	26.8	34.4 (S-2)
Lead (mg/kg)	17.8	47 (S-2)
Mercury (mg/kg)	0.149	0.333 (S-1)
Zinc (mg/kg)	69.8	164 (S-2)
TBT (µg/kg)	na	na
Bis(2-ethylhexyl)phthalate (µg/kg)	2000U	21500U (S-2)
Total HPAH (µg/kg)	330UA	2750A (S-4)
Total LPAH (µg/kg)	330UA	1670A (S-3)
Total PCBs (µg/kg)	85.9A	194A (S-4)
2,3,7,8-TCDD (ng/kg)	na	Na
Total DDTs (µg/kg)	6.7UA	33.1A (S-4)
Dibenzofuran (µg/kg)	330U	3550U (S-2)
4-Methylphenol (µg/kg)	na	na
Xylenes (µg/kg)	na	na

na – Not analyzed.
U - Undetected at concentration shown.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
UA - All summed analytes undetected, high detection shown.

WLCRIV99. Phase I Remedial Investigation, Ross Island Sand & Gravel Co.
(Prepared by Landau Associates, September 20, 2000).

Landau collected sediment samples to provide supplemental data for a remedial investigation (RI) of the Ross Sand & Gravel site. The overall objective of the RI was to collect data in conjunction with other site investigations to provide an indication of the nature and extent of contamination at the site and to focus subsequent RI study components.

Four surface sediment samples were collected in October 1999. Two samples (PA01 and PA02) were collected within Ross Island lagoon, and two samples (PA03 and PA04) were collected within Holgate Slough. These surface samples were collected from the top 10 cm of sediment. In addition, 41 subsurface sediment samples from 15 borings within the lagoon were collected during November and December 1999. These included two samples from the 0-1 cm depth interval. The subsurface samples were collected in conjunction with a Port of Portland investigation (see WLCRIL99). Sampling methods were not reported in the Phase I RI report (Landau 2000), but the Port reported that subsurface samples were collected using a hollow-stem auger, split-spoon sampler, Gus sampler, and Hart sampler.

Surface samples were analyzed for TOC, grain size, metals, SVOCs, VOCs, pesticides, PCBs, and organotins. Organic carbon in surface sediments ranged from 1.44 to 1.69%. Results for indicator chemicals in surface sediments are presented in the following table. All results were reported in dry weight.

Summary Data for Surface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	3	7.7 (G06A)
Cadmium (mg/kg)	0.08U	0.234 (PA01)
Copper (mg/kg)	24.8	55.6 (PA01)
Lead (mg/kg)	11.8	27.8 (G06A)
Mercury (mg/kg)	0.04	0.18 (PA01, PA02)
Zinc (mg/kg)	72.5	191J (G06A)
TBT (µg/kg)	0.4J	11 (PA01)
Bis(2-ethylhexyl)phthalate (µg/kg)	100U	180 (G06A)
Total HPAH (µg/kg)	77A	442A (G05)
Total LPAH (µg/kg)	11A	55A (G06A, PA02)
Total PCBs (µg/kg)	5A	8A(PA03)
2,3,7,8-TCDD (ng/kg)	na	na
Total DDTs (µg/kg)	0.9A	2.3A (PA03)
Dibenzofuran (µg/kg)	1J	3J (PA02)
4-Methylphenol (µg/kg)	200U	200U
Xylenes (µg/kg)	na	Na

na – Not analyzed.
U - Undetected at concentration shown.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
J - Estimated value.

Subsurface samples were analyzed for conventionals, metals, SVOCs, pesticides, PCBs, hydrocarbons, and organotins. Organic carbon in subsurface sediments ranged from 0.06 to 7.35%. Results for indicator chemicals in subsurface sediments are presented in the following table.

Summary Data for Subsurface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	0.2UJ	24.4 (G07)
Cadmium (mg/kg)	0.03U	1.7 (G05)
Copper (mg/kg)	10.5	1340 (G07)
Lead (mg/kg)	2	409 (G05)
Mercury (mg/kg)	0.01J	1.43 (G07)
Zinc (mg/kg)	21.9	960 (G07)
TBT (µg/kg)	0.2J	2000 (G07)
Bis(2-ethylhexyl)phthalate (µg/kg)	100J	3600 (G07)
Total HPAH (µg/kg)	50UA	726000A (G08)
Total LPAH (µg/kg)	50UA	90600A (G08)
Total PCBs (µg/kg)	4A	2900A (G07)
2,3,7,8-TCDD (ng/kg)	na	na
Total DDTs (µg/kg)	0.2A	6500A (G05)
Dibenzofuran (µg/kg)	50U	1700 (G08)
4-Methylphenol (µg/kg)	na	na
Xylenes (µg/kg)	na	na

na – Not analyzed.
U - Undetected at concentration shown.
UA - All summed analytes undetected, high detection shown.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
J - Estimated value.

WLCARI99. Forensic Geochemical Assessment of Near Shore Sediments, Remedial Investigation Work Plan, Atlantic Richfield/BP Terminal 22T. ***(Prepared by SECOR, October 3, 2002).***

SECOR collected sediment samples at the ARCO/BP Terminal 22T to gain a greater understanding of sediment conditions in the immediate vicinity of the terminal and to assess potential sources of PAH mixtures found in the sediments.

A total of 16 locations were sampled for surface sediments on September 1, 1999. Sampling stations were located on five transects (numbered 22T, 37, 38, 39, and 41) running perpendicular to the shoreline at the site; three samples (identified as A, B, or C) were collected on each transect. An additional sample was collected in the vicinity of Station SD039C where an oil sheen was visible on the sediment surface. Surface samples were collected from the top 10 cm of sediment using a hand trowel or small box-core sampler.

Samples were analyzed for conventionals, metals, PAHs, and BTEX. Organic carbon ranged from 0.1 to 3.4%. Results for indicator chemicals are presented in the following table. All results were reported in dry weight.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	2	7 (SD039C)
Cadmium (mg/kg)	1U	1U
Copper (mg/kg)	23	131 (SD037B)
Lead (mg/kg)	9	73 (SD039C)
Mercury (mg/kg)	0.2U	0.5 (SD039C)
Zinc (mg/kg)	81	483 (SD039C)
TBT (µg/kg)	na	na
Bis(2-ethylhexyl)phthalate (µg/kg)	na	na
Total HPAH (µg/kg)	186A	27650A (SD039C)
Total LPAH (µg/kg)	7A	2859A (SHEEN)
Total PCBs (µg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na
Total DDTs (µg/kg)	na	na
Dibenzofuran (µg/kg)	5U	130 (SHEEN)
4-Methylphenol (µg/kg)	na	na
Xylenes (µg/kg)	100U	200U (SD041B)

na – Not analyzed.
U - Undetected at concentration shown.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.

WLR0499; WLR1199. Willamette River Sediment Sampling Evaluation. ***(Prepared by U.S. Army Corps of Engineers, June 1999 and March 2000).***

The U.S. Army Corps of Engineers collected sediment cores during two sampling surveys in the Willamette River to characterize sediments prior to maintenance dredging to determine if sediments were suitable for open, in-water disposal.

In the first survey, a total of nine sediment cores representing three dredged material management units (DMMUs) were collected on April 29, 1999. The sediment represented by the April samples exceeded the Dredged Material Evaluation Framework screening levels and required additional chemical and biological testing. Therefore, a second survey was conducted. Five additional sediment cores were collected on November 29, 1999, from five of the nine locations sampled in April. In addition, a fourth DMMU was added and three additional cores collected from a shoal at RM 11.

DMMU	RM	Location	Station (WLR0449, April)	Station (WLR1199, November)
1	2+10	East edge of navigation channel off Oregon Steel Mill dock	WR-VC01A WR-VC02A	WR-VC02N
2	9 to 9+35	Shoal on west edge of navigation channel	WR-VC03A WR-VC04A	WR-VC05N
3	8+30 to 8+50	Navigation channel in front of Texaco dock	WR-VC05A WR-VC06A WR-VC07A WR-VC08A	WR-VC03N WR-VC04N
4	11	Shoal in navigation channel.	Not sampled	WR-VC06N WR-VC07N WR-VC08N

The depth interval for all samples was 0-8 feet. At stations WR-VC08 (April), WR-VC06 (November), and WR-VC07 (November), the bottom interval (approximately 8-12 feet) was also analyzed. Cores were collected using a vibracorer.

The subsurface samples were analyzed for conventionals, metals, SVOCs, PCBs, pesticides, and herbicides. Some samples were also analyzed for dioxin/furans and porewater organotins. Organic carbon ranged from 0.37 to 2.4%. Results for indicator chemicals are presented in the following table. All results were reported in dry weight.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	2.4J	5 (WR-VC06N)
Cadmium (mg/kg)	0.17J	0.41J (WR-VC02N)
Copper (mg/kg)	30	44 (WR-VC04N)

Parameter	Minimum	Maximum (Location)
Lead (mg/kg)	15	42 (WR-VC06N)
Mercury (mg/kg)	0.079J	0.35 (WR-VC06N)
Zinc (mg/kg)	83	230 (WR-VC07N)
TBT (µg/kg)	na	na
TBT (µg/L)	0.02U	0.13 (WR-VC07N)
Bis(2-ethylhexyl)phthalate (µg/kg)	11JB	210B (WR-VC07N)
Total HPAH (µg/kg)	8.9A	699A (WR-VC01A)
Total LPAH (µg/kg)	3.2UA	322A (WR-VC01A)
Total PCBs (µg/kg)	26UA	32UA (WR-VC06A)
2,3,7,8-TCDD (ng/kg)	0.68U	0.76U (WR-VC05N)
Total DDTs (µg/kg)	2.9A	15.4A (WR-VC07N)
Dibenzofuran (µg/kg)	3.6J	16 (WR-VC07N)
4-Methylphenol (µg/kg)	na	na
Xylenes (µg/kg)	na	na

na – Not analyzed.
U - Undetected at concentration shown.
UA - All summed analytes undetected, high detection shown.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
J - Estimated value.
B - Analyte found in associated blank.

TOSCO99. January 1999 Sediment Sampling Results for Tosco Portland Terminal. ***(Prepared by Exponent, April 29, 1999).***

Exponent conducted a sediment investigation at the Tosco Portland Terminal to determine if sediments proposed for dredging were acceptable for unconfined, open-water disposal.

Sediment cores were collected on January 20-22, 1999, at six locations in the dredged area adjacent to the facility. Cores were composited into two samples for analysis. Core sample intervals ranged from 0-4 to 0-6.8 feet in DMMU 1, and from 0-8 to 0-11 feet in DMMU 2. Cores were collected using a 4-inch-diameter vibracorer with polyethylene (i.e., LEXAN®) core liners.

Samples were analyzed for conventionals, metals, SVOCs, PCBs, and pesticides. Organic carbon ranged from 1.97 to 2.24%, and samples contained greater than 80% fine-grained material. Results for indicator chemicals are presented in the following table. All results were reported in dry weight.

Parameter	Minimum	Maximum
Arsenic (mg/kg)	4G	5G (DMMU 1)
Cadmium (mg/kg)	1U	1U (DMMU 1 & 2)
Copper (mg/kg)	44	46 (DMMU 1)
Lead (mg/kg)	21	29 (DMMU 1)
Mercury (mg/kg)	0.2U	0.2 (DMMU 2)
Zinc (mg/kg)	144	164 (DMMU 1)
TBT (µg/kg)	na	na
Bis(2-ethylhexyl)phthalate (µg/kg)	140	370 (DMMU 1)
Total HPAH (µg/kg)	1133A	2309A (DMMU 1)
Total LPAH (µg/kg)	400A	962A (DMMU 1)
Total PCBs (µg/kg)	74A	240A (DMMU 1)
2,3,7,8-TCDD (ng/kg)	na	na
Total DDTs (µg/kg)	19A	52A (DMMU 2)
Dibenzofuran (µg/kg)	13	46 (DMMU 1)
4-Methylphenol (µg/kg)	48	63 (DMMU 2)
Xylenes (µg/kg)	na	na

na – Not analyzed.
U - Undetected at concentration shown.
G - Estimate is greater than value shown.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.

WLRWTF98. Remedial Investigation Report, Willbridge Facility. ***(Prepared by KHM Environmental Management, December 2000).***

KHM Environmental Management conducted an RI of the Willbridge Facility. The purpose of the RI was to determine the need for remedial action. Information was collected to interpret subsurface conditions, evaluate potential human health and ecological risk, and to evaluate characteristics relevant to identifying potential hot spots of contamination. Soil, groundwater, surface water and sediment samples were collected.

A total of 13 river sediment locations were sampled on December 17-18, 1998. Nine stations were located along the site-river interface, two stations were located upstream outside the dock embayment, and two stations were located downstream outside the dock embayment. The draft RI report stated that surface samples were collected from the top 24 inches of sediment at all 13 locations. Sediment was collected using a stainless-steel sediment corer with 3-inch-diameter barrel and slide hammer.

Samples were analyzed for BTEX, PAHs, and metals. Some samples were also analyzed for SVOCs, VOCs, and organopesticides. Results for indicator chemicals are presented in the following table. All results were reported in dry weight.

Parameter	Minimum	Maximum
Arsenic (mg/kg)	1.22	6.53G (TOS-SD5)
Cadmium (mg/kg)	0.651	5.79 (TOS-SD5)
Copper (mg/kg)	11.3	47.9 (TOS-SD3)
Lead (mg/kg)	10G	49.3 (GATX-SD2)
Mercury (mg/kg)	0.05U	0.12U (TOS-SD3)
Zinc (mg/kg)	17.3G	73.7G (CHEV-SD1)
TBT (µg/kg)	na	na
Bis(2-ethylhexyl)phthalate (µg/kg)	2000UG	4800UG (TOS-SD3)
Total HPAH (µg/kg)	6.7UA	1496A (TOS-SD3)
Total LPAH (µg/kg)	6.7UA	341A (TOS-SD3)
Total PCBs (µg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na
Total DDTs (µg/kg)	3.35UA	10.6A (GATX-SD3)
Dibenzofuran (µg/kg)	500UG	1200UG (TOS-SD3)
4-Methylphenol (µg/kg)	500UG	1200UG (TOS-SD3)
Xylenes (µg/kg)	50U	120UG (TOS-SD3)

na – Not analyzed.
U - Undetected at concentration shown.
UA - All summed analytes undetected, high detection shown.
G - Estimate is greater than value shown.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.

WLRELF99. Elf Atochem Acid Plant Area Remedial Investigation Interim Data Report. ***(Prepared by Exponent, June 1999).***

The purpose of this investigation was to identify and delineate the nature and extent of chemicals of interest in soil, groundwater, and sediments related to the former DDT manufacturing facility. Sediments were collected from six riverbank ("RB") and six offshore ("OS") stations adjacent to the Elf Atochem site.

Riverbank samples were collected on November 23-24, 1998. Riverbank sediment samples were collected from 0-10 cm using a stainless-steel spoon, and from >10 cm using a titanium drive corer. Coring depths to the 90-cm target depth could be achieved at only one station (RB-6). Subsurface refusal limited penetration to 35 cm or less at stations RB-1, RB-2, RB-3, RB-4, and RB-5. Surface sediments and sediment core samples were analyzed for SVOCs, VOCs, TOC, and grain size.

Offshore sediment samples were collected on January 19-20, 1999. Offshore sediments were collected with either a Livingston® gravity corer or with a vibracorer. Sediment cores were sampled for a surface interval (0-10 cm) and a deeper interval (either one 20-cm interval, or, at two stations, an entire 10- to 90-cm interval). Sediment samples were analyzed for SVOCs, VOCs, organochlorine pesticides, TOC, and grain size.

Results for indicator chemicals in surface and subsurface samples are presented in the following tables. All results were reported in dry weight.

Summary Data for Surface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	na	na
Cadmium (mg/kg)	na	na
Copper (mg/kg)	na	na
Lead (mg/kg)	na	na
Mercury (mg/kg)	na	na
Zinc (mg/kg)	na	na
TBT (µg/kg)	na	na
4-methylphenol (µg/kg)	na	na
Total xylenes (µg/kg)	na	na
Bis(2-ethylhexyl) phthalate (µg/kg)	20 UG	1800 (OSS006)
Dibenzofuran (µg/kg)	5 U	76 (OSS004)
Total LPAH (µg/kg)	10 UA	2246 A (OSS004)
Total HPAH (µg/kg)	25.5 A	69700 A (OSS004)
Total PCBs (µg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	57 A	84909 A (OSS002)

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U- Undetected at concentration shown.
G - Estimate is greater than the value shown.

Summary Data for Subsurface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	na	na
Cadmium (mg/kg)	na	na
Copper (mg/kg)	na	na
Lead (mg/kg)	na	na
Mercury (mg/kg)	na	na
Zinc (mg/kg)	na	na
TBT (µg/kg)	na	na
4-methylphenol (µg/kg)	na	na
Total xylenes (µg/kg)	na	na
Bis(2-ethylhexyl) phthalate (µg/kg)	20 U	4200 (OSS006)
Dibenzofuran (µg/kg)	5 U	360 (OSS004)
Total LPAH (µg/kg)	10 UA	16780 A (OSS004)
Total HPAH (µg/kg)	14 A	118400 A (OSS004)
Total PCBs (µg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	122 A	22556 A (OSS002)

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Undetected at concentration shown.

WLCT4J98. Remedial Investigation Report Terminal 4, Slip 3 Sediments, Port of Portland. ***(Prepared by Hart Crowser, April 2000).***

Hart Crowser conducted an RI of Terminal 4, Slip 3 sediments for the Port of Portland. The RI study area consisted of sediments located upriver at Pier 5 Willamette River Dock, Slip 3, and Wheeler Bay immediately downriver and adjacent to Slip 3. The purpose was to delineate the extent of contamination and to evaluate potential risks to the Willamette River environment and to human health posed by contaminants in river sediments. Sub-tidal surface sediments (0-10 cm) were collected at 44 offshore stations. Nine subsurface samples were collocated with surface sampling stations.

Surface sediment samples were collected on October 12-15, 1998, using a hydraulic grab sampler, and sub-sampled using stainless-steel instruments. Surface sediments were analyzed for pencil pitch, diesel, metals, SVOCs, VOCs, pesticides (on a limited subset of samples), TOC, and grain size.

Subsurface sediment samples were collected on October 12, 1998, using a vibracorer. Sediment cores were sampled for a top layer (0-2 feet), a bottom layer (-2 to -4 feet), and a deeper layer (-4 to -6 feet). Subsurface sediment samples were analyzed for pencil pitch, diesel, metals, SVOCs, VOCs, pesticides (on a limited subset of samples), TOC, and grain size.

Results for indicator chemicals in surface and subsurface samples are presented in the following tables. All results were reported in dry weight.

Summary Data for Surface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	3	14 G (HC-S-02)
Cadmium (mg/kg)	0.2	6.6 G (HC-S-25)
Copper (mg/kg)	15.3	90.1 (HC-S-02)
Lead (mg/kg)	15.2 E	1160 E (HC-S-19)
Mercury (mg/kg)	0.02 E	0.34 E (HC-S-25)
Zinc (mg/kg)	82 G	1330 G (HC-S-25)
TBT (µg/kg)	na	na
4-methylphenol (µg/kg)	20 U	130 (HC-S-19)
Total xylenes (µg/kg)	na	NA
Bis(2-ethylhexyl) phthalate (µg/kg)	50	550 (HC-S-43)
Dibenzofuran (µg/kg)	20 UG	860 (HC-S-38)
Diesel fuels (mg/kg)	25 U	2100 (HC-S-01)
Total LPAH (µg/kg)	233 A	114000 A (HC-S-02)
Total HPAH (µg/kg)	2068 A	765000 A (HC-S-01)
Total PCBs (µg/kg)	na	na

Parameter	Minimum	Maximum (Location)
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	5 A	39 A (HC-S-16)

na - Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Undetected at concentration shown.
G - Estimate is greater than the value shown.
E - Estimated because of the presence of interference

Summary Data for Subsurface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	2 G	15 G (HC-S-07)
Cadmium (mg/kg)	0.1 UG	3.3 G (HC-S-07)
Copper (mg/kg)	13.3	83.2 (HC-S-07)
Lead (mg/kg)	3	576 (HC-S-07)
Mercury (mg/kg)	0.02	0.18 (HC-S-07)
Zinc (mg/kg)	37 G	656 G (HC-S-11)
TBT (µg/kg)	na	na
4-methylphenol (µg/kg)	20 U	4000 U
Total xylenes (µg/kg)	na	na
Bis(2-ethylhexyl) phthalate (µg/kg)	20 U	180 G (HC-S-39)
Dibenzofuran (µg/kg)	20 U	4000 U
Diesel fuels (mg/kg)	25 U	100 U
Total LPAH (µg/kg)	20 UA	10000 A (HC-S-42)
Total HPAH (µg/kg)	20 UA	198000 A (HC-S-42)
Total PCBs (µg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	na	na

na - Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Undetected at concentration shown.

PPTLDT24. Sediment Characterization Study Marine Terminal 2, Berths 203-206, Port of Portland. ***(Prepared by Hart Crowser, March 1999).***

Hart Crowser conducted a pre-maintenance dredging sediment characterization at Terminal 2 on the Willamette River for the Port of Portland. Maintenance dredging was proposed at Berths 203, 204, 205, and 206 to remove sediment that had accumulated above navigational depths. Sub-tidal sediment cores (5.5 to 6 feet in depth) were collected at five offshore stations to characterize two DMMUs. Two cores in Berth 203 (HC-VC-04 and HC-VC-05) were composited to characterize one DMMU, and three cores from Berths 204-206 (HC-VC-01, HC-VC-02, and HC-VC-03) were composited to characterize a second DMMU.

Subsurface sediment samples were collected on September 15, 1998. The method by which the cores were collected was not described in the report. Sediment cores were sectioned and composited from 0 to -3 feet. Sediment samples were analyzed for metals, SVOCs, VOCs, TBT, pesticides, PCBs, TOC, ammonia, sulfides, TVS, TS, and grain size.

Results for indicator chemicals in surface and subsurface samples are presented in the following tables. All results were reported in dry weight.

Summary Data for Subsurface Samples.

Parameter	Minimum	Maximum
Arsenic (mg/kg)	1.4 G	2 G
Cadmium (mg/kg)	0.13 G	0.17 G
Copper (mg/kg)	17.2 G	22.5 G
Lead (mg/kg)	11.6	14.4
Mercury (mg/kg)	0.05	0.06
Zinc (mg/kg)	55.9 G	85.7 G
TBT (µg/kg)	0.02 UG	0.04 U
4-methylphenol (µg/kg)	na	na
Total xylenes (µg/kg)	na	na
Bis(2-ethylhexyl) phthalate (µg/kg)	na	na
Dibenzofuran (µg/kg)	20 U	20 U
Diesel fuels (mg/kg)	na	na
Total LPAH (µg/kg)	26 A	117 A
Total HPAH (µg/kg)	510 A	1105 A
Total PCBs (µg/kg)	10 UA	26 A
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	2 UA	103 A

na - Not analyzed.

A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Undetected at concentration shown.
G - Estimate is greater than the value shown.

WLCT0I98. Sediment Characterization Study of Local Sponsors' Berths, Columbia and Willamette River Navigation Channel Deepening, Longview and Kalama, Washington and Portland, Oregon. ***(Prepared by Hart Crowser, February 1999).***

The purpose of this investigation was to provide preliminary dredge prism characterization for the dredging of the Columbia and Willamette navigation channels. Two sub-tidal sediment cores were collected at each DMMU identified in the project area. Cores were collected for the proposed dredge prisms at Berth 501, Terminal 6, Berth 401, and the Irving Street Terminal at the Port of Portland; the Harvest States Grain Terminal and the Peavey Grain Terminal at the Port of Kalama; and the Longview Grain Terminal at the Port of Longview. Twelve surface grab samples were also collected from deeper water locations in the Willamette River.

Subsurface sediment cores were collected using a vibracorer on September 14-17, 1998. Sediment cores were sectioned and composited from 0 to -3 feet and -3 to -5 feet. Sediment samples were analyzed for metals, SVOCs, VOCs, TBT, pesticides, PCBs, TOC, ammonia, sulfides, TVS, and TS.

Surface sediment samples were collected on September 14-15, 1998. The report does not specifically describe the method by which the samples were collected, other than to say they were "grab samples." In addition, no description of the grab sub-sampling scheme was presented. Surface sediment samples were analyzed for metals, SVOCs, VOCs, TBT, pesticides, PCBs, TOC, ammonia, sulfides, TVS, and TS.

Organic carbon content ranged in the core composites from 0.05 to 1.63%, and in the grab samples from 0.65 to 2.27%. Results for indicator chemicals in surface and subsurface samples are presented in the following tables. All results were reported in dry weight.

Summary Data for Surface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	0.7	2.4 G (Grab 09)
Cadmium (mg/kg)	0.09 B	0.27 J (Grab 01)
Copper (mg/kg)	12.3	48 (Grab 08)
Lead (mg/kg)	4.64	17.7 (Grab 01)
Mercury (mg/kg)	0.02 U	0.07 (multiple)
Zinc (mg/kg)	38.6	73.9 (Grab 08)
TBT (µg/kg)	0.02 UG	0.12 G (Grab 08)
4-methylphenol (µg/kg)	20 U	10000 U
Total xylenes (µg/kg)	na	na
Bis(2-ethylhexyl) phthalate (µg/kg)	100 U	1000 (Grab 12)
Dibenzofuran (µg/kg)	20 U	10000 U

Parameter	Minimum	Maximum (Location)
Diesel fuels (mg/kg)	na	na
Total LPAH (µg/kg)	20 A	155000 A (Grab 05)
Total HPAH (µg/kg)	212 A	452000 A (Grab 05)
Total PCBs (µg/kg)	10 UA	14 A (Grabs 10 & 12)
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	2 UA	65.9 A (Grab 04)

na - Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Undetected at concentration shown.
B - Analyte found in associated blank.
G - Estimate is greater than the value shown.
J - Estimated value.

Summary Data for Subsurface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	1	2.6 (B501-C1)
Cadmium (mg/kg)	0.14 J	0.85 (B501-C1)
Copper (mg/kg)	14.4	21.8 (B401-C1(
Lead (mg/kg)	9.8	367 (IS-C2)
Mercury (mg/kg)	0.05	0.21 (B401-C1)
Zinc (mg/kg)	53.4	115 G (IS-C2)
TBT (µg/kg)	0.03 G	0.05 G (IS-C1)
4-methylphenol (µg/kg)	20 U	77 (B501-C1)
Total xylenes (µg/kg)	na	na
Bis(2-ethylhexyl) phthalate (µg/kg)	20 U	220 (IS-C1)
Dibenzofuran (µg/kg)	20 U	27 (IS-C1)
Diesel fuels (mg/kg)	na	na
Total LPAH (µg/kg)	45 A	9654 A (IS-C1)
Total HPAH (µg/kg)	438 A	74460 A (IS-C1)
Total PCBs (µg/kg)	12 A	7100 A (IS-C1)
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	2 UA	479.8 A (B401-C1)

na - Not analyzed
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Undetected at concentration shown.
G - Estimate is greater than the value shown.
J - Estimated value.

PSYSEA98. Portland Shipyard Sediment Investigation Data Report. ***(Prepared by Striplin Environmental Associates, Inc., November 1998).***

The purpose of this investigation was to characterize surface and subsurface sediment quality in the vicinity of the Portland Shipyard, develop site-specific sediment quality criteria, and to identify potential sources of contamination.

Sub-tidal sediments were collected at 52 surface and 23 subsurface locations. Surface samples were collected from the top 10 cm of the sediment. Subsurface core samples represented sediments composited over approximate 4-foot intervals (0 to -4 feet, -4 to -8 feet, and -8 to -12 feet). All sediments were collected over a 3-week period beginning on March 31, 1998.

Surface sediment samples were collected from March 31 through April 7, and on April 16, 1998, using a hydraulic grab sampler, and sub-sampled using stainless-steel instruments. Surface sediments were analyzed for selected metals, SVOCs, TOC, TS, and grain size. All but five samples were analyzed for porewater TBT and ammonia. Selected stations were analyzed for pesticides, VOCs, and TPHs.

Subsurface sediment samples were collected from April 14-16, 1998, using a vibracorer. Subsurface sediment samples for 15 cores were analyzed in 4-foot intervals for metals, SVOCs, PCBs, TOC, and grain size. Additionally, two cores were analyzed at 1-foot intervals for selected total metals, bulk TBT, and grain size.

Results for indicator chemicals in surface and subsurface samples are presented in the following tables. All results were reported in dry weight.

Summary Data for Surface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	2	17 (PSY27)
Cadmium (mg/kg)	0.1 U	23 (PSY08)
Copper (mg/kg)	15.6	655 (PSY27)
Lead (mg/kg)	10.2	96.6 (PSY21)
Mercury (mg/kg)	0.05 U	0.54 (PSY49)
Zinc (mg/kg)	66	683 E (PSY10)
TBT (µg/kg)	0.025 U	11 (PSY27)
4-methylphenol (µg/kg)	100 U	760 (PSY77)
Total xylenes (µg/kg)	5 U	25 U
Bis(2-ethylhexyl) phthalate (µg/kg)	94 B	7590 J (PSY08)
Dibenzofuran (µg/kg)	10 U	204 (PSY10)
Diesel fuels (mg/kg)	na	na
Total LPAH (µg/kg)	10 A	2467 A (PSY12)

Parameter	Minimum	Maximum (Location)
Total HPAH (µg/kg)	10 A	17268 A (PSY12)
Total PCBs (µg/kg)	10 UA	2500 A (PSY14)
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	2 UA	153 A(PSY27)

na - Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Undetected at concentration shown.
B - Analyte found in associated blank.
J - Estimated value.
E - Estimated because of the presence of interference.

Summary Data for Subsurface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	2 U	21 (PSY30C, 36C)
Cadmium (mg/kg)	0.1 U	1.6 (PSY30C)
Copper (mg/kg)	10.5	1580 (PSY30C)
Lead (mg/kg)	2.1	146 (PSY30C)
Mercury (mg/kg)	0.02	0.72 (PSY27C)
Zinc (mg/kg)	24	1340 (PSY30C)
TBT (µg/kg)	1 U	90000 (PSY30C)
4-methylphenol (µg/kg)	100 UG	157 G (PSY01C)
Total xylenes (µg/kg)	na	na
Bis(2-ethylhexyl) phthalate (µg/kg)	100 U	16000 G (PSY36C)
Dibenzofuran (µg/kg)	10 U	266 G (PSY36C)
Diesel fuels (mg/kg)	na	na
Total LPAH (µg/kg)	10 UA	5780 A (PSY36C)
Total HPAH (µg/kg)	10 UA	13420 A (PSY36C)
Total PCBs (µg/kg)	10 A	2290 A (PSY20C)
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	na	na

na - Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Undetected at concentration shown.
G - Estimate is greater than the value shown.

WLCT4J97. Sediment Characterization Study Terminal 4, Berth 416, Port of Portland. ***(Prepared by Hart Crowser, March 1998).***

The purpose of this investigation was to characterize sediment in the proposed maintenance dredging area in Terminal 4, Berth 416 in order to assess the quality of the proposed dredge prism and to determine appropriate dredged sediment disposal options. The dredge prism was divided into two separate DMMUs. Two sub-tidal sediment cores were collected within the prism for each DMMU. Two separate samples from cores HC-VC-102 and HC-VC-103 were submitted to characterize one DMMU, and a composite of cores HC-VC-104 and HC-VC-105 was submitted to characterize a second DMMU.

The methods by which the cores were collected, processed, and sub-sampled were not described in the report. Sediment from throughout the entire length of the cores was homogenized for each sample. Subsurface sediment samples were analyzed for metals, SVOCs, pesticides, PCBs, TBT, TOC, ammonia, sulfides, TVS, and TS.

Organic carbon content ranged from 1.28 to 3.14% sediments. Results for indicator chemicals in subsurface samples are presented in the following tables. All results were reported in dry weight.

Summary Data for Subsurface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	3.38 J	4.66 J (C104105)
Cadmium (mg/kg)	0.5 U	0.5 U
Copper (mg/kg)	15.5	34.2 (HC-VC-103)
Lead (mg/kg)	9.53	17.7 (HC-VC-103)
Mercury (mg/kg)	0.0717	0.254 (HC-VC-103)
Zinc (mg/kg)	74.4	123 (C104105)
TBT (µg/L)	0.0089 U	0.012 (HC-VC-102)
4-methylphenol (µg/kg)	40 U	69.1 (HC-VC-103)
Total xylenes (µg/kg)	na	na
Bis(2-ethylhexyl) phthalate (µg/kg)	500 U	500 U
Dibenzofuran (µg/kg)	31.8	93.8 (C104105)
Diesel fuels (mg/kg)	na	na
Total LPAH (µg/kg)	455.7 A	1804.3 A (C104105)
Total HPAH (µg/kg)	1225.6 A	4807.7 A (C104105)
Total PCBs (µg/kg)	20 UA	20.6 A (C104105)
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	1 UA	14.35 A (C104105)

na - Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.

U - Undetected at concentration shown.
J - Estimated value.

WLR0797. Results of July 1997 Willamette River Sediment Study. ***(Prepared by U.S. Army Corps of Engineers, Portland District).***

This Willamette River sediment study for a proposed channel deepening project is composed of laboratory data sheets for the U.S. Army Corps of Engineers, Portland District. No project narrative, including objectives, methods, sampling interval(s), or sampling locations, is provided. However, sediment chemistry data are provided for 18 surface sediment samples (including three composites and two field duplicates) and 34 subsurface sediment core samples (eight of which are field duplicates).

Surface sediment samples were collected on July 24-25, 1997, from the 0- to 10-inch depth interval. Surface sediments were analyzed for metals, SVOCs, TBT, DDT, PCBs, TVS, TS, TOC, and grain size.

Subsurface sediment samples were collected from July 22-25, 1997. Core depths ranged from 6 to 20 feet. Sediment cores were sampled for layers of varying thickness. Subsurface sediment samples were also analyzed for the same parameters as for surface sediment.

Results for indicator chemicals in surface and subsurface samples are presented in the following tables. All results were reported in dry weight.

Summary Data for Surface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	0.6	4 (WR-BC-10)
Cadmium (mg/kg)	0.05	0.93 (WR-BC-07)
Copper (mg/kg)	8	39 (WR-BC-15)
Lead (mg/kg)	3.9	32.2 (WR-BC-36)
Mercury (mg/kg)	0.01	0.17 (C16/17)
Zinc (mg/kg)	45.2	171 (WR-BC-36)
TBT (µg/kg)	0.01 J	0.42 (WR-BC-23)
4-methylphenol (µg/kg)	na	na
Total xylenes (µg/kg)	na	na
Bis(2-ethylhexyl) phthalate (µg/kg)	na	na
Dibenzofuran (µg/kg)	0.9 G	2100 G (WR-BC-22)
Diesel fuels (mg/kg)	na	NA
Total LPAH (µg/kg)	2.5 A	395500 A (WR-BC-22)
Total HPAH (µg/kg)	2 A	1024100 A (WR-BC-22)
Total PCBs (µg/kg)	4 A	105 A (WR-BC-36)
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	0.2 A	17.3 A (WR-BC-21)

na - Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
G - Estimate is greater than the value shown.
J - Estimated value.

Summary Data for Subsurface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	0.5 U	19.7 (WR-CD-43)
Cadmium (mg/kg)	0.03	2.12 (WR-CD-43)
Copper (mg/kg)	8.9	70.1 (WR-CD-43)
Lead (mg/kg)	1.2	489 (WR-CD-43)
Mercury (mg/kg)	0.01 E	0.87 E (WR-CD-42)
Zinc (mg/kg)	10.8	190 (WR-GC-39)
TBT (µg/kg)	0.5 U	0.5 U
4-methylphenol (µg/kg)	na	na
Total xylenes (µg/kg)	na	na
Bis(2-ethylhexyl) phthalate (µg/kg)	na	na
Dibenzofuran (µg/kg)	0.5 G	85 G (WR-GC-18)
Diesel fuels (mg/kg)	na	na
Total LPAH (µg/kg)	1.4 A	1484 A (WR-GC-11)
Total HPAH (µg/kg)	2 A	5654 A (WR-GC-11)
Total PCBs (µg/kg)	5 A	246 A (WR-CD-42)
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	0.3 A	198 (WR-GC-24)

na - Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Undetected at concentration shown.
G - Estimate is greater than the value shown.
E - Estimated because of the presence of interference.

WRD&M98. Results of Sediment Investigation to Identify Chemicals in the Vicinity of the Portland Shipyard. ***(Prepared by Dames & Moore, 1998).***

In January 1998, Dames & Moore collected surface sediment samples from 12 stations in the vicinity of the Portland Shipyard. No project narrative, including objectives, methods, or sampling gear, is provided.

Stations were identified as DM-A through DM-L. All stations were located along the eastern shore between RM 7 and RM 11. Stations DM-A, DM-B and DM-C were located at RM 10.7; stations DM-D, DM-E, and DM-F were located at RM 9.9; DM-G was located at RM 9; DM-H was located at RM 8.3, DM-I and DM-J were located off Triangle Park at RM 7.7; and DM-K and DM-L were located off the McCormick & Baxter Site at RM 7. Surface samples were collected from the top 10 cm. All samples were analyzed for heavy metals, SVOCs, PCBs and TOC.

Results for indicator chemicals in surface samples are presented in the following tables. All results were reported in dry weight.

Summary Data for Surface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	2.88	5.86 (DM-B)
Cadmium (mg/kg)	0.5 UE	2.13 E (DM-B)
Copper (mg/kg)	24.4	46.7 (DM-J)
Lead (mg/kg)	10 U	31.4 (DM-F)
Mercury (mg/kg)	0.05 U	1.06 (DM-C)
Zinc (mg/kg)	60.6	119 (DM-B)
TBT (µg/kg)	2	36 (DM-I)
4-methylphenol (µg/kg)	na	na
Total xylenes (µg/kg)	na	na
Bis(2-ethylhexyl) phthalate (µg/kg)	435 B	7330 B (DM-I)
Dibenzofuran (µg/kg)	na	na
Diesel fuels (mg/kg)	na	na
Total LPAH (µg/kg)	14 A	856.2 A (DM-B)
Total HPAH (µg/kg)	153.3 A	7905 A (DM-B)
Total PCBs (µg/kg)	40 UA	109 A (DM-F)
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	na	na

na - Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Undetected at concentration shown.
E - Estimated because of the presence of interference

PSYD&M97. Results of Sediment Investigation to Identify Chemicals in the Vicinity of the Portland Shipyard. ***(Prepared by Dames & Moore, 1998).***

In November 1997 and January 1998, Dames & Moore collected three subsurface (DM-20 and DM-24C1 and DM-24C2) and five surface (DM-1, DM-9, DM-16, DM-18, and DM-22) sediment samples in the Portland Shipyard area. Stations DM-12, DM-16, and DM-21 were located in Swan Island Lagoon. Surface samples were collected from the top 10 cm. Subsurface sample cores ranged from 106 to 198 cm in depth. The remaining stations were located within the drydock area of the shipyard. No project narrative, including objectives, methods, or sampling gear, is provided. All samples were analyzed for heavy metals, SVOCs, PCBs, and TOC.

Results for indicator chemicals in surface samples are presented in the following tables. All results were reported in dry weight.

Summary Data for Surface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	4.49	7.18 (DM-16)
Cadmium (mg/kg)	0.5 U	1.53 (DM-16)
Copper (mg/kg)	38.1	146 (DM-9)
Lead (mg/kg)	12.3	53.5 (DM-16)
Mercury (mg/kg)	0.09	0.27 (DM-22)
Zinc (mg/kg)	71.3	397 (DM-16)
TBT (µg/kg)	92	1158 (DM-18)
4-methylphenol (µg/kg)	na	na
Total xylenes (µg/kg)	50 U	50 U
Bis(2-ethylhexyl) phthalate (µg/kg)	779	1920 B (DM-22)
Dibenzofuran (µg/kg)	na	na
Diesel fuels (mg/kg)	na	na
Total LPAH (µg/kg)	29.4 A	342.8 A (DM-16)
Total HPAH (µg/kg)	314.4 A	2256.3 A (DM-16)
Total PCBs (µg/kg)	40 UA	168 A (DM-1)
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	na	na

na - Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Undetected at concentration shown.
B - Analyte found in associated blank.

Summary Data for Subsurface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	3.16	4.6 (DM-20)
Cadmium (mg/kg)	1.29 E	1.98 E (DM-20)
Copper (mg/kg)	27.8	55.8 (DM-20)
Lead (mg/kg)	10 U	28.9 (DM-20)
Mercury (mg/kg)	0.05 U	0.73 (DM-24C2)
Zinc (mg/kg)	69.2	141 (DM-20)
TBT (µg/kg)	na	na
4-methylphenol (µg/kg)	na	na
Total xylenes (µg/kg)	na	na
Bis(2-ethylhexyl) phthalate (µg/kg)	13 UB	425 (DM-20)
Dibenzofuran (µg/kg)	na	na
Diesel fuels (mg/kg)	na	na
Total LPAH (µg/kg)	6.7 UA	318 A (DM-20)
Total HPAH (µg/kg)	6.7 UA	1700.8 A (DM-20)
Total PCBs (µg/kg)	40 UA	150 A (DM-20)
2,3,7,8-TCDD (ng/kg)	na	na
Total DDT (µg/kg)	na	na

na - Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Undetected at concentration shown.
B - Analyte found in associated blank.
E - Estimated because of the presence of interference.

WRWSI98. Portland Harbor Sediment Investigation, Multnomah County, Oregon. ***(Prepared by Roy F. Weston, Inc., May 1998).***

This Portland Harbor sediment investigation was performed for EPA as part of a site inspection. The EPA site inspection process evaluates actual and potential environmental hazards for purposes of identifying remedial action priorities. The Portland Harbor sediment investigation was conducted between RMs 3.5 and 9.5. The purpose of the investigation was to provide a screening level evaluation of sediment contamination within this portion of the lower Willamette River.

The following surface sediment, subsurface sediment, and porewater samples were collected and evaluated:

- 150 surface (0-10 cm) sediment samples
- 28 sediment porewater samples
- 37 subsurface sediment cores.

Surface sediment samples were collected using a stainless-steel, modified 0.1-m^2 van Veen grab sampler. Between one and four grabs were retrieved at each station to provide adequate volumes of sediment for testing. Subsurface samples were collected with a 5-foot gravity core (3-inch diameter). Core lengths ranged from 1.8 to 4.6 feet and averaged 3.2 feet. Stations SD001-SD151 were located in nearshore areas along both the west and east shores. Samples with the suffix "PW" were porewater samples. Subsurface sediment sample identifiers used the "A" suffix.

Sediment samples were generally analyzed for grain size, TOC, metals, and SVOCs. A subset of sediment samples was also analyzed for pesticides and PCBs, titanium, herbicides, organotins, and dioxins/furans. Porewater samples were analyzed for metals and butyltins. Results for surface and subsurface sediment samples are provided below in separate tables. Sediment chemistry results are reported in dry weight. Porewater results are reported in mg/L (wet weight).

Summary Data for Surface Sediment Samples and Porewater.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	3 U	16 (SD133 RM 8.1)
Cadmium (mg/kg)	0.2 U	2.2 (SD23 RM 4.2)
Copper (mg/kg)	15.3	543 (SD133 RM 8.1)
Lead (mg/kg)	5	262 (SD32 RM 4.5)
Mercury (mg/kg)	0.01 U	0.86 (SD128 RM 8.1)
Zinc (mg/kg)	64.6	539 (SD133 RM 8.1)
Arsenic (mg/L)	0.001 U	0.009 (SD64 RM 6.2)
Cadmium (mg/L)	0.002U	0.002 U
Copper (mg/L)	0.002 U	0.134 (SD128 RM8.1)
Lead (mg/L)	0.001 U	0.047 (SD128 RM 8.1)

Parameter	Minimum	Maximum (Location)
Mercury (mg/L)	0.0001 U	0.0001 (SD128 RM 8.1)
Zinc (mg/L)	0.004 U	0.179 (SD128 RM 8.1)
TBT (µg/kg)	5.7 U	47,000 (SD12 RM 3.8)
TBT (µg/L)	0.02 U	0.5 J (SD128 RM 8.1)
LPAH (µg/kg)	19 UA	402,400 A (SD64 RM 6.2)
HPAH (µg/kg)	45 A	690,000 A (SD33 RM4.5)
Total PCBs (µg/kg)	20 UA	580 A (SD133 RM 8.1)
Total DDTs (µg/kg)	1.2 A	3,740 A (SD97 RM 7.5)
Bis(2-ethylhexyl)phthalate (µg/kg)	21	2,100 (SD136 Swan Is.)
Dibenzofuran (µg/kg)	19 U	3,700 (SD64 RM 6.2)
4-Methylphenol (µg/kg)	19 U	1,400 (SD139 Swan Is.)
Xylene (µg/kg)	na	na
Diesel Fuel (mg/kg)	na	na
2,3,7,8-TCDD (nkg)	0.51	1.1 (SD86 RM 7.1)

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U – Undetected at the concentration shown.

Summary Data for Subsurface Sediment Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	4 U	14 (SD133 RM8.1)
Cadmium (mg/kg)	0.3	5.3 (SD143 RM 8.8)
Copper (mg/kg)	36.8	729 (SD133 RM 8.1)
Lead (mg/kg)	13	1,080 (SD143 RM 8.8)
Mercury (mg/kg)	0.04	0.80 (SD133 RM 8.1)
Zinc (mg/kg)	91.3	598 (SD133 RM 8.1)
TBT (µg/kg)	5.7 U	15,000 (SD133 RM 8.1)
TBT (µg/L)	na	na
LPAH (µg/kg)	34 A	69,410 A (SD55C RM 5.7)
HPAH (µg/kg)	135 A	152,700 A (SD35 4.7)
Total PCBs (µg/kg)	15 A	2,379 A (SD133 RM 8.1)
Total DDTs (µg/kg)	2.7 UA	51,000 A (SD92 RM 7.2)
Bis(2-ethylhexyl)phthalate (µg/kg)	31 U	5,000 (SD143 RM 8.8)
Dibenzofuran (µg/kg)	19 U	3,600 (SD72 RM6.6)
4-Methylphenol (µg/kg)	19 U	450 (SD01 RM 3.3)
Xylene (µg/kg)	na	na
Diesel Fuel (mg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	0.76 U	1.2 (SD72 RM 6.6)

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U – Undetected at the concentration shown.

WLR1196. Columbia and Lower Willamette River Project, Lower Willamette River, Portland Harbor Sediment Evaluation. ***(Prepared by the U. S. Army Corps of Engineers, November 1996).***

The lower Willamette River deep-draft channel is maintained at an authorized depth of 40 feet from the mouth of the Willamette River to the Broadway Bridge. The purpose of the Corps' 1996 sediment evaluation was to characterize channel sediments for maintenance dredging. Results of the sediment chemical characterization were used to determine acceptable disposal alternatives.

A recurring shoal on the west side of the channel between RMs 8.3 and 10.1 was targeted for characterization. Sediments had accumulated in this area since maintenance dredging in 1992. Six samples were collected from the proposed dredge prism. Four sediment cores (WR-VC-1, WR-VC-4 through WR-VC-6) and two surface grabs (WR-VC-2, WR-VC-3) were collected from the shoaled areas to characterize the material for dredged material disposal. Cores were collected using a Benthos gravity corer, and surface samples were collected with a Ponar grab. Sediments were collected on November 13-14, 1996. Sample collection information is as follows:

Core	Location	Sample Depth
WR-VC-1	RM 8.3 west side of channel	244 cm
WR-VC-2	RM 8.8 west side of channel	0-13 cm (grab)
WR-VC-3	RM 9 west side of channel	0-13 cm (grab)
WR-VC-4	RM 9.4 west side of channel at bend in channel	244 cm
WR-VC-5	RM 10 west side of channel	244 cm
WR-VC-6	RM 10.1 west side of channel	244 cm

Sediment samples were analyzed for grain size, TOC, acid volatile sulfides, metals, butyltins, pesticides and PCBs, and limited SVOCs (phenols and PAHs). Sediments were predominantly silt with some clay and a small amount of sand. Results for surface sediment samples and subsurface samples are provided below in separate tables. Results are reported in dry weight.

Based on the outcome of the chemical testing, shoaled sediments were recommended for unconfined, open-water disposal.

Summary Data for Surface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	2.1	3 (WR-VC-3)
Cadmium (mg/kg)	0.12	0.15 (WR-VC-3)
Copper (mg/kg)	26.2	35.6 (WR-VC-3)
Lead (mg/kg)	10.1	12.7 (WR-VC-3)
Mercury (mg/kg)	0.06 J	0.07 J (WR-VC-2)

Parameter	Minimum	Maximum (Location)
Zinc (mg/kg)	59	67.4 (WR-VC-3)
TBT (µg/kg)	3 B	5 B (WR-VC-2)
LPAH (µg/kg)	21 A	31 A (WR-VC-3)
HPAH (µg/kg)	135 A	185 A (WR-VC-3)
Total PCBs (µg/kg)	3 A	4 A (WR-VC-3)
Total DDTs (µg/kg)	1.4 A	3.5 A (WR-VC-3)
Bis(2-ethylhexyl)phthalate (µg/kg)	na	na
Dibenzofuran (µg/kg)	2 J	3 J (WR-VC-3)
4-Methylphenol (µg/kg)	na	na
Xylene (µg/kg)	na	na
Diesel Fuel (mg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
B - Analyte detected in blank.
J - Estimated value.

Summary Data for Subsurface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	2.2	4.8 (WR-VC-6)
Cadmium (mg/kg)	0.12	0.18 (WR-VC-5)
Copper (mg/kg)	25.7	46 (WR-VC-6)
Lead (mg/kg)	10.3	17.4 (WR-VC-6)
Mercury (mg/kg)	0.06 J	0.08 J (WR-VC-5)
Zinc (mg/kg)	61.8	90.1 (WR-VC-6)
TBT (µg/kg)	2 B	12 (WR-VC-6)
LPAH (µg/kg)	42 A	105 A (WR-VC-4)
HPAH (µg/kg)	243 A	451 A (WR-VC-5)
Total PCBs (µg/kg)	4 A	10 A (WR-VC-4)
Total DDTs (µg/kg)	2.4 A	3.6 A (WR-VC-6)
Bis(2-ethylhexyl)phthalate (µg/kg)	na	na
Dibenzofuran (µg/kg)	2 J	9 (WR-VC-5)
4-Methylphenol (µg/kg)	na	na
Xylene (µg/kg)	na	na
Diesel Fuel (mg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
B - Analyte detected in blank.
J - Estimated value.

WLCT0K96. Sediment Characterization Study, River Terminals 1,2, and 5, Willamette River. ***(Prepared by Hart Crowser, January 14, 1997).***

In November 1996, the Port of Portland performed sediment characterizations at Terminals 1, 2, and 5 to support routine maintenance dredging.

Sediments were collected using a 6-foot gravity core (4-inch-diameter barrel) except for one location. HC-SS-9 at Terminal 5 was collected with a Ponar grab sampler due to the compact, coarse-grained sediments encountered there. Collected sediments were composited into seven samples. The station and sample composite information for each terminal is as follows:

Coring Station	Core Length (feet)	Composite Name
Terminal 1 – Berth 104		
HC-GC-01 – north end of berth	5.5	HC-T1-01
HC-GC-02 – south end of berth	5	HC-T1-02
Terminal 2		
HC-GC-03 – Berth 204	2	HC-T2-01
HC-GC-04 – Berth 204	2	
HC-GC-05 – Berth 205	4	HC-T2-02
HC-GC-06 – Berth 205	4	
HC-GC-07 – Berth 206	4	HC-T2-03
HC-GC-08 – Berth 206	4	
Terminal 5 – Berth 501		
HC-SS-09 (grab) – center of berth	0.5	HC-T5-02
HC-GC-10 – south end of berth	2	HC-T5-01

Sediment samples were analyzed for grain size, conventional variables, metals, butyltins, pesticides and PCBs, and limited SVOCs (PAHs and phenols). Results for surface sediment samples and subsurface samples are provided below in separate tables. Results are reported in dry weight.

Hart Crowser concluded that Terminal 1 and Terminal 2 sediments were suitable for unconfined, open-water disposal. The suitability of Terminal 5 sediments for unconfined, open-water disposal was questionable due to somewhat elevated TBT concentrations.

Summary Data for Surface Samples.

Parameter	Minimum	Maximum
Arsenic (mg/kg)	3 *	--
Cadmium (mg/kg)	0.17 *	--
Copper (mg/kg)	10.2 *	--
Lead (mg/kg)	4.8 *	--
Mercury (mg/kg)	0.05 UJ*	--

Parameter	Minimum	Maximum
Zinc (mg/kg)	63.7 *	--
TBT (µg/kg)	190 *	--
LPAH (µg/kg)	10 UA*	--
HPAH (µg/kg)	10 UA*	--
Total PCBs (µg/kg)	10 UA*	--
Total DDTs (µg/kg)	2 UA*	--
Bis(2-ethylhexyl)phthalate (µg/kg)	na	--
Dibenzofuran (µg/kg)	na	--
4-Methylphenol (µg/kg)	na	--
Xylene (µg/kg)	na	--
Diesel Fuel (mg/kg)	na	--
2,3,7,8-TCDD (ng/kg)	na	--

*Only one surface sample analyzed.
na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
J - Estimated value.
U - Not detected at detection limit shown.

Summary Data for Subsurface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	3	4 (several samples)
Cadmium (mg/kg)	0.16	0.18 (HC-T1-01)
Copper (mg/kg)	18.9	34.5 (HC-T1-01)
Lead (mg/kg)	6.37	31.9 (HC-T2-03)
Mercury (mg/kg)	0.05 UJ	0.12 J (HC-T2-03)
Zinc (mg/kg)	60.5	81.3 (HC-T1-02)
TBT (µg/kg)	8	35 (HC-T2-03)
LPAH (µg/kg)	13 A	338 A (HC-T2-03)
HPAH (µg/kg)	198 UA	736 A (HC-T2-03)
Total PCBs (µg/kg)	10 UA	99 A (HC-T2-03)
Total DDTs (µg/kg)	2 UA	2 UA
Bis(2-ethylhexyl)phthalate (µg/kg)	na	na
Dibenzofuran (µg/kg)	na	na
4-Methylphenol (µg/kg)	na	na
Xylene (µg/kg)	na	na
Diesel Fuel (mg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
J - Estimated value.
U - Not detected at detection limit shown.

RIEDEL96. Soil and Sediment Testing Supporting Triangle Park's Purchase of the Former Zidell Property. (CAS laboratory report, dated September 23, 1996). ***(Prepared by Maul Foster & Associates, August 30, 1996).***

RIEDEL97. Baseline Sediment Assessment. ***(Prepared by Maul Foster & Associates, November 20, 1997).***

Maul Foster & Associates completed two phases of work supporting Triangle Park's purchase of the former Zidell property, located immediately south of the McCormick & Baxter site. The first phase of work had no supporting data report, only a summary table and associated laboratory report. Data with the survey code, RIEDEL96, were collected in this first phase of work on August 30, 1996. The second phase of work, RIEDEL97. is reported in the Baseline Sediment Assessment, dated November 20, 1997.

In the first phase of work, divers collected seven cores (SED-1 through SED-7) by pushing 2.5-foot-long Shelby tubes into the sediment. Core lengths ranged from 0.6 to 1.6 feet. Stations were located nearshore, extending from the southern property boundary (SED-1) to the northern property boundary (SED-7). Samples were analyzed for metals, PCBs, and butyltins. Indicator chemical results (dry weight) are summarized below.

RIEDEL96 Summary Data for Surface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	4	35 (SED-4)
Cadmium (mg/kg)	1 U	1 U
Copper (mg/kg)	na	na
Lead (mg/kg)	20 U	60 (SED-4)
Mercury (mg/kg)	na	na
Zinc (mg/kg)	na	na
TBT (µg/kg)	3 U	32,000 (SED-4)
LPAH (µg/kg)	na	na
HPAH (µg/kg)	na	na
Total PCBs (µg/kg)	100 UA	200 UA (several samples)
Total DDTs (µg/kg)	na	na
Bis(2-ethylhexyl)phthalate (µg/kg)	na	na
Dibenzofuran (µg/kg)	na	na
4-Methylphenol (µg/kg)	na	na
Xylene (µg/kg)	na	na
Diesel Fuel (mg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Not detected at detection limit shown.

In the second phase of work, Maul Foster & Associates collected eight cores using an impact corer and generally split the cores into surface (0-15 cm) and from 1 to 5 subsurface samples of various lengths. The longest core length was approximately 15 feet (up to 460 cm). Stations were distributed around the dock and pilings. Phase II sediment samples were analyzed for limited metals, limited SVOCs (including PAHs), and butyltins. Results for surface sediment samples and subsurface samples are provided below in separate tables. Results are reported in dry weight.

RIEDEL97 Summary Data for Surface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	3	6 (SED-10)
Cadmium (mg/kg)	na	na
Copper (mg/kg)	38	56 (SED-10)
Lead (mg/kg)	20 U	28 (SED-13)
Mercury (mg/kg)	na	na
Zinc (mg/kg)	na	na
TBT (µg/kg)	3	380 (SED-10)
LPAH (µg/kg)	64 A	169 A (SED-10)
HPAH (µg/kg)	338 A	1,095 A (SED-10)
Total PCBs (µg/kg)	na	na
Total DDTs (µg/kg)	na	na
Bis(2-ethylhexyl)phthalate (µg/kg)	na	na
Dibenzofuran (µg/kg)	5 U	10 (SED-10)
4-Methylphenol (µg/kg)	na	na
Xylene (µg/kg)	na	na
Diesel Fuel (mg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Not detected at detection limit shown.

RIEDEL97 Summary Data for Subsurface Sediment Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	1 U	32 (SED-10)
Cadmium (mg/kg)	na	na
Copper (mg/kg)	12	218 (SED-10)
Lead (mg/kg)	20 U	204 (SED-15)
Mercury (mg/kg)	na	na
Zinc (mg/kg)	na	na
TBT (µg/kg)	1 UH	24,000 (SED-10)
LPAH (µg/kg)	5 UA	3,223 A (SED-16)
HPAH (µg/kg)	5 UA	6,665 A (SED-16)
Total PCBs (µg/kg)	na	na

Parameter	Minimum	Maximum (Location)
Total DDTs (µg/kg)	na	na
Bis(2-ethylhexyl)phthalate (µg/kg)	na	na
Dibenzofuran (µg/kg)	5 U	52 GH (SED-10)
4-Methylphenol (µg/kg)	na	na
Xylene (µg/kg)	na	na
Diesel Fuel (mg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
G – Estimate is greater than value shown.
H – Holding time exceedance.
U - Not detected at detection limit shown.

WLFL0496. Willamette River Clackamas Co., OR, Willamette Falls Locks Preliminary Assessment – Sediment Quality of 1996 Flood Deposits. ***(Prepared by the U.S. Army Corps of Engineers, Portland District, May 10, 1996).***

Flooding in February 1996 resulted in the accumulation of 6 feet of sediment in the downstream Willamette Falls lock entrance along the west side of the channel. Sediments were collected from three areas of the accumulated material approximately 20 feet from the western dock edge. The Corps used a standard clamshell bucket to collect samples. Three samples were collected: WR-CS-15, WR-CS-25, and WR-CS-35.

The deposit was unstratified silty sand having a medium-strength sewage odor. The sampled sediments contained woody debris, unspecified rubbish, plastic fragments, cloth, and fibrous material. The three individual samples were analyzed for grain size, but a single composite of sediments from the three locations was analyzed for TOC, metals, pesticides and PCBs, and SVOCs. Results of indicator chemicals are reported in dry weight below.

The Corps recommended confined in-water or upland disposal of this material based on the outcome of the chemical testing and the presence of solid debris.

Parameter	Minimum	Maximum
Arsenic (mg/kg)	3.9 J*	--
Cadmium (mg/kg)	0.8 J*	--
Copper (mg/kg)	24.8*	--
Lead (mg/kg)	9.5*	--
Mercury (mg/kg)	0.28 U*	--
Zinc (mg/kg)	77*	--
TBT (µg/kg)	na	--
LPAH (µg/kg)	20 JA*	--
HPAH (µg/kg)	234 A*	--
Total PCBs (µg/kg)	67 UA*	--
Total DDTs (µg/kg)	Data sheet not available	--
Bis(2-ethylhexyl)phthalate (µg/kg)	91.9 J*	--
Dibenzofuran (µg/kg)	463 U*	--
4-Methylphenol (µg/kg)	463 U*	--
Xylene (µg/kg)	na	--
Diesel Fuel (mg/kg)	na	--
2,3,7,8-TCDD (ng/kg)	na	--

* Only one sample analyzed.
na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
J – Estimated value.
U - Not detected at detection limit shown.

WLCGSA96. Phase I Remedial Investigation Summary Report and Preliminary Analysis of Soil Data. Volumes I and II. ***(Prepared by Hahn and Associates, Inc., October 9, 1998).***

As part of the remedial investigation of the Gasco site, 11 sediment core samples (SD-4 through SD-14) were collected by Northwest Natural in January 1996. The Gasco site is approximately 47 acres in size in the North Doane Lake area of Portland. Station locations were as follows:

Station	Location Description
SD-4	Northern boundary with U.S. Moorings property
SD-5	Midpoint between northern boundary and Northwest Natural dock
SD-6	Behind Northwest Natural dock
SD-7	Southern half of Northwest Natural Property
SD-8	Southern half of Northwest Natural Property
SD-9	Southern boundary with Wacker Siltronic Corp. property
SD-10	Southern end of Wacker Siltronic Corp. property
SD-11	Southern boundary of Wacker Siltronic Corp. property
SD-12	Northern boundary of Atofina property
SD-13	Northern end of Atofina property
SD-14	Northern end of Atofina property

Sediment cores were collected using a vibracorer and were generally split into two sections, the top 15 cm and the bottom of the core. However, only surface sediment (top 15 cm) was collected at SD-13. Core lengths ranged from 2 to 9.5 feet. Sediment samples were analyzed for TOC, lead, VOCs, petroleum products, and PAHs. Results for surface sediment samples and subsurface samples are provided below in separate tables. Results are reported in dry weight.

Summary Data for Surface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	na	na
Cadmium (mg/kg)	na	na
Copper (mg/kg)	na	na
Lead (mg/kg)	2.8	47 (SD-8)
Mercury (mg/kg)	na	na
Zinc (mg/kg)	na	na
TBT (µg/kg)	na	na
LPAH (µg/kg)	50 UA	14,140,000 A (SD-7)
HPAH (µg/kg)	354 A	12,268,000 A (SD-7)
Total PCBs (µg/kg)	na	na
Total DDTs (µg/kg)	na	na
Bis(2-ethylhexyl)phthalate (µg/kg)	na	na
Dibenzofuran (µg/kg)	na	na

Parameter	Minimum	Maximum (Location)
4-Methylphenol (µg/kg)	na	na
Xylene (µg/kg)	300 U	18,000 (SD-7)
Diesel Fuel (mg/kg)	50 U	50 G (several samples)
2,3,7,8-TCDD (ng/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
G – Estimate is greater than value shown.
U - Not detected at detection limit shown.

Summary Data for Subsurface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	na	na
Cadmium (mg/kg)	na	na
Copper (mg/kg)	na	na
Lead (mg/kg)	2.3	26 (SD-8)
Mercury (mg/kg)	na	na
Zinc (mg/kg)	na	na
TBT (µg/kg)	na	na
LPAH (µg/kg)	50 UA	3,408,000 A (SD-9)
HPAH (µg/kg)	50 UA	2,063,000 A (SD-9)
Total PCBs (µg/kg)	na	na
Total DDTs (µg/kg)	na	na
Bis(2-ethylhexyl)phthalate (µg/kg)	na	na
Dibenzofuran (µg/kg)	na	na
4-Methylphenol (µg/kg)	na	na
Xylene (µg/kg)	300 U	6,000 (SD-9)
Diesel Fuel (mg/kg)	50 U	50 G (SD-10)
2,3,7,8-TCDD (ng/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
G – Estimate is greater than value shown.
U - Not detected at detection limit shown.

WLCWCJ95. Supplemental Environmental Site Assessment, St. Johns Riverfront Property. ***(Prepared by EMCON, January 9, 1996).***

EMCON performed a supplemental environmental site assessment (SESA) and a qualitative risk assessment (QRA) of the St. Johns Riverfront Property in October 1995. The St. Johns Riverfront Property is located on Willamette Cove adjacent to the McCormick & Baxter site. The work was completed for the Trust for Public Land. The purpose of the study was to expand on the information previously collected in 1988. The primary objectives of the SESA were to provide new and additional shallow soil, groundwater, and sediment analytical data for use in the QRA.

Surface sediments (0-15 cm) were collected using an Ekman dredge from 17 locations within Willamette Cove. The sediment samples were composited into three samples (A1-SD-1, A2-SD-2, and A3-SD-3). The compositing scheme is not provided in the referenced report; however, composite samples were collected from three designated areas (i.e., A1 through A3 referenced in sample numbers), corresponding with the following past upland industrial uses:

- A1 – plywood mill
- A2 – dry docks and repair shops
- A3 – barrel and vat manufacturer.

Sediment samples were analyzed for metals, SVOCs, PCBs, and VOCs. Results for indicator chemicals (dry weight) are presented in the table below.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	4 E	4 E
Cadmium (mg/kg)	1 U	1 U
Copper (mg/kg)	26	84 (A3)
Lead (mg/kg)	24	53 (A3)
Mercury (mg/kg)	0.20 U	0.2 (A3)
Zinc (mg/kg)	103	178 (A3)
TBT (µg/kg)	187 G	187 G (A2)
LPAH (µg/kg)	360 A	1,580 A (A1)
HPAH (µg/kg)	1,060 A	15,550 A (A1)
Total PCBs (µg/kg)	100 UA	200 UA (A2 & A3)
Total DDTs (µg/kg)	na	na
Bis(2-ethylhexyl)phthalate (µg/kg)	300 U	900 U (A2 & A3)
Dibenzofuran (µg/kg)	300 U	900 U (A2 & A3)
4-Methylphenol (µg/kg)	300 UG	900 U (A2 & A3)
Xylene (µg/kg)	5 U	15 U (A3)
Diesel Fuel (mg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na

na – Not analyzed.

A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
E – Estimated value.
G – Estimate is greater than value shown.
U - Not detected at detection limit shown.

MOOR0595. Results of U.S. Moorings May 1995 Sediment Study. ***(Prepared by U.S. Army Corps of Engineers, March 1996).***

The Corps' 1995 investigation of U.S. Moorings was performed to provide additional information related to the nature and extent of sediment contamination at this site. Previous investigations noted elevated levels of heavy metals, several pesticides, and PAHs in subsurface sediment samples, particularly along Dock A.

The 1995 investigation involved the collection of twelve 4-inch-diameter sediment cores in the vicinity of Docks A and B. Sediment was collected using an impact corer. Cores "1" through "4" and core "12" were collected on the downstream side of docks A and B. Cores "5" through "7" were collected between docks A and B, and cores "8" through "11" were collected on the riverside of Dock A. Each core was subsampled into one sample representing the thickness of the dredge prism, and up to 5 subsamples were taken at 1-foot intervals below the dredge prism depth. Core collection depths ranged from 3.1 to 10.2 feet.

Thirteen representative samples were analyzed for grain-size distribution and TVS. Thirty-eight samples (excluding replicates) were analyzed for lead, pesticides, and PAHs, and six samples were analyzed for butyltins and dioxin/furans. Results for indicator chemicals (dry weight) are presented in the table below.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	na	na
Cadmium (mg/kg)	na	na
Copper (mg/kg)	na	na
Lead (mg/kg)	17	416 (Core 8)
Mercury (mg/kg)	na	na
Zinc (mg/kg)	na	na
TBT (µg/kg)	3 UH	3 UH
LPAH (µg/kg)	2,240 A	456,000 A (Core 9)
HPAH (µg/kg)	8,410 A	549,570 A (Core 7)
Total PCBs (µg/kg)	na	na
Total DDTs (µg/kg)	20 A	2,190 A (Core 12)
Bis(2-ethylhexyl)phthalate (µg/kg)	na	na
Dibenzofuran (µg/kg)	300 U	4,850 (Core 9)
4-Methylphenol (µg/kg)	na	na
Xylene (µg/kg)	na	na
Diesel Fuel (mg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	0.64 U	1.2 (Core 6)

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
H - Holding time exceeded.
U - Not detected at detection limit shown.

WLCRFE95. Sediment Sampling and Analysis Report, Rose Festival Fleet Moorage, Front Avenue Seawall: Hawthorne to Steel Bridges, City of Portland, Oregon. ***(Prepared by AGI Technologies, July 11, 1995).***

AGI Technologies characterized sediments from the Rose Festival Fleet Moorage along the Front Avenue Seawall for dredging. Sediment test data was required to secure the necessary dredging permits.

Divers collected surface sediment (0-15 cm) from 14 stations (1 through 14) on May 11, 1995. Sediments were composited to yield five samples (15RF through 19RF). Sample 19RF was a field duplicate of 18RF. Station location information and the sample compositing scheme were as follows:

Station	Bollard No.	Composite	Station	Bollard No.	Composite
1	37 & 38	15RF	8	24	16RF
2	37	15RF	9	21	17RF
3	41	15RF	10	18	17RF
4	33	15RF	11	16	17RF
5	30	16RF	12	11	18RF/19RF
6	27	16RF	13	6	18RF/19RF
7	24	16RF	14	2	18RF/19RF

Samples were analyzed for grain-size distribution, TOC, metals, butyltins, PAHs, and pesticides and PCBs. Sediments were generally sand and gravel with a trace of silt. Divers described the surface substrate as predominantly gravel with pockets of silt and sand. Results for indicator chemicals (dry weight) are presented in the table below.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	3.1	12.7 (15RF)
Cadmium (mg/kg)	0.21	0.41 (16RF)
Copper (mg/kg)	22.6	45.4 (18RF)
Lead (mg/kg)	47	168 (18RF)
Mercury (mg/kg)	0.20 U	0.40 (18RF)
Zinc (mg/kg)	85.9	363 (16RF)
TBT (µg/kg)	3	270 (15RF)
LPAH (µg/kg)	50 A	310 A (18RF)
HPAH (µg/kg)	140 A	1,430 A (17RF)
Total PCBs (µg/kg)	20 UA	720 A (17RF)
Total DDTs (µg/kg)	2 UA	20 UA (17RF)
Bis(2-ethylhexyl)phthalate (µg/kg)	na	na
Dibenzofuran (µg/kg)	na	na
4-Methylphenol (µg/kg)	na	na
Xylene (µg/kg)	na	na
Diesel Fuel (mg/kg)	na	na

Parameter	Minimum	Maximum (Location)
2,3,7,8-TCDD (ng/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Not detected at detection limit shown.

WLCRPB95. Quarterly Progress Report, 1st Quarter 1995 Surface Water and Sediment. Rhône-Poulenc AG Company, St. Helens Road Facility. (*Prepared by Woodward-Clyde Consultants, June 20, 1995).*

Woodward-Clyde collected surface sediment samples from four locations as part of their RI quarterly monitoring program. Samples were collected on February 1, 1995. Stations were identified as "WR-1" through "WR-4" and were situated as follows:

Station	Location Description
WR-1	Downstream dock at ATOFINA
WR-2	Approximately 100 ft downstream of Rhône-Poulenc NPDES outfall
WR-3	Front Ave. stormwater discharge location
WR-4	Approximately 400 ft downstream of Rhône-Poulenc NPDES outfall

A fifth sample, WR-5, was a duplicate of WR-3. Surface sediments were collected from the top 15 cm using an Ekman dredge. Samples were analyzed for grain-size distribution, TOC, pH, specific gravity, metals, dioxins/furans, herbicides, pesticides, SVOCs, and VOCs. Results for indicator chemicals (dry weight) are presented in the table below.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	2.2 J	9.7 J (WR-3)
Cadmium (mg/kg)	0.081	1.7 (WR-3)
Copper (mg/kg)	na	na
Lead (mg/kg)	7.3	76.2 (WR-3)
Mercury (mg/kg)	0.1 U	0.36 (WR-3)
Zinc (mg/kg)	50.1	422 (WR-3)
TBT (µg/kg)	na	na
LPAH (µg/kg)	330 UA	330 UA
HPAH (µg/kg)	330 UA	330 UA
Total PCBs (µg/kg)	na	na
Total DDTs (µg/kg)	8.2 A	1,230 A (WR-2)
Bis(2-ethylhexyl)phthalate (µg/kg)	330 U	330 U
Dibenzofuran (µg/kg)	330 U	330 U
4-Methylphenol (µg/kg)	na	na
Xylene (µg/kg)	2 U	2 U
Diesel Fuel (mg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	0.24 U	3.4 (WR-3)

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Not detected at detection limit shown.
J – Estimated value.

MOOR1294. U.S. Moorings Facility Preliminary Assessment. ***(Prepared by U.S. Army Corps of Engineers, Portland District, February 28, 1995).***

Responding to EPA's request to perform a preliminary assessment of the U.S. Moorings site, the Corps collected nine upland soil samples and nine sediment samples to document existing soil and sediment conditions. The LWG's database does not contain the soil data.

Sediment sampling locations were identified as "M10" through "M18." Stations were located approximately 10-15 feet from the shoreline in water depths of 7-10 feet. Station M10 was the most upstream sampling location, and the remaining stations were evenly spaced to the site's downstream property line (approximately 550 feet away). Sediments were collected from the top 15 cm using a Ponar grab sampler. Station M12 was a duplicate of sample M11.

Samples were analyzed for total metals. The results (dry weight) are presented in the table below.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	3.2	60 (M10)
Cadmium (mg/kg)	2.6 U	4.8 U (M13 & M14)
Copper (mg/kg)	29	140 (M10)
Lead (mg/kg)	18	100 (M10)
Mercury (mg/kg)	0.1 U	0.2 U (several samples)
Zinc (mg/kg)	86	638 (M10)
TBT (µg/kg)	na	na
LPAH (µg/kg)	na	na
HPAH (µg/kg)	na	na
Total PCBs (µg/kg)	na	na
Total DDTs (µg/kg)	na	na
Bis(2-ethylhexyl)phthalate (µg/kg)	na	na
Dibenzofuran (µg/kg)	na	na
4-Methylphenol (µg/kg)	na	na
Xylene (µg/kg)	na	na
Diesel Fuel (mg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na

na – Not analyzed.
U - Not detected at detection limit shown.

PSYDD3. Sediment Testing at Portland Shipyard Dry Dock #3, Post Dredging. (Laboratory data package provided in the report, *Summary of Sediment Quality Information for Portland Shipyard). (Prepared by Hartman Associates, Inc., March 15, 1995).*

Pre-dredging sediment testing of Dry Dock #3 was conducted early in 1994 to secure federal and state dredging permits. Approximately 22,000 cubic yards of material were dredged from below Dry Dock #3 in November and December 1994. Most of the material consisted of sand blast grit.

The LWG's database contains sediment chemistry data from the post-dredging sediment investigation of Dry Dock #3, which was performed in December 1994. The post-dredging sediment sampling consisted of the collection of six surface samples (0-12 cm) using a Ponar surface grab. Surface sediment samples were named "S1" through "S6." Stations S1, S2, and S6 were located at the offshore end of the dry dock. Stations S3 and S5 were located nearshore, and S4 was located nearest the shoreline. In addition, three sediment cores ("C1" through "C3") were collected in a row extending down the center of the dry dock. Cores were collected with a gravity core and split into surface and bottom samples. Only the bottom samples were analyzed. Bottom sample intervals were 30-50 cm (C1B), 15-45 cm (C2B), and 25-33 cm (C3B).

Surface sediment samples were analyzed for grain-size distribution, metals, SVOCs, pesticides and PCBs, VOCs, and TBT. Subsurface samples were analyzed for grain-size distribution, metals, and SVOCs. Samples varied from fine- to coarse-grained material. S1, S2, C1B, and C3B were largely coarse-grained (>71% sand) in texture. S3, S6, and S5 were fine-grained (>70% fines), and the remaining samples (S4 and C2B) were roughly equal in percent fines and sand. Results for surface sediment samples and subsurface samples are provided below in separate tables. Results are reported in dry weight.

Summary Data for Surface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	18	98 (S4)
Cadmium (mg/kg)	0.32	0.90 (S4)
Copper (mg/kg)	610	2,000 (S4)
Lead (mg/kg)	52 G	200 G (S4)
Mercury (mg/kg)	0.24	1.5 (S6)
Zinc (mg/kg)	360 L	2,700 L (S4)
TBT (µg/kg)	4,300	9,600 (S3 & S6)
LPAH (µg/kg)	960 A	2,440 A (S6)
HPAH (µg/kg)	2,990 A	6,558 A (S6)
Total PCBs (µg/kg)	520 A	1,370 A (S6)
Total DDTs (µg/kg)	3 UA	3 UA
Bis(2-ethylhexyl)phthalate (µg/kg)	670	1,500 G (S4)

Parameter	Minimum	Maximum (Location)
Dibenzofuran (µg/kg)	66	150 G (S6)
4-Methylphenol (µg/kg)	50 U	51 (S6)
Xylene (µg/kg)	22	3,200 (S1)
Diesel Fuel (mg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
G – Estimate is greater than value shown.
L – Value is less than maximum shown.
U - Not detected at detection limit shown.

Summary Data for Subsurface Samples.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	52	140 (C1)
Cadmium (mg/kg)	0.92	1.2 (C1)
Copper (mg/kg)	1,500	2,200 (C3)
Lead (mg/kg)	97 G	330 G (C3)
Mercury (mg/kg)	0.22	2.1 (C2)
Zinc (mg/kg)	1,400 L	1,500 L (C1 & C2)
TBT (µg/kg)	na	na
LPAH (µg/kg)	352 A	4,490 A (C3)
HPAH (µg/kg)	2,810 A	12,400 A (C3)
Total PCBs (µg/kg)	na	na
Total DDTs (µg/kg)	na	na
Bis(2-ethylhexyl)phthalate (µg/kg)	1,100	1,900 G (C3)
Dibenzofuran (µg/kg)	71	360 G (C3)
4-Methylphenol (µg/kg)	50 U	97 (C2)
Xylene (µg/kg)	na	na
Diesel Fuel (mg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
G – Estimate is greater than value shown.
L – Value is less than maximum shown.
U - Not detected at detection limit shown.

WRSTRM94. Chemical Characterization of Sediments Adjacent to Storm Water Discharges in the Willamette River Near Portland. ***(Prepared by Hartman & Associates, Inc. and Fishman Environmental Services, 1995).***

The Port of Portland sponsored the characterization of stormwater discharges in the lower Willamette River in 1994. The purpose of this study was to provide preliminary sediment chemical data collected adjacent to five stormwater discharges located within the city limits of Portland. The preliminary data was intended to provide an understanding of pathways of contamination entering the river.

Samples were collected from the top 10 cm using a 2-inch core tube when sampling above water level or either a gravity corer or Ponar grab sampler when sampling below the water surface. At each of the five stations, up to five samples were collected in approximately 12-foot intervals, one upstream and four downstream of the discharge point. If sediment was present in the pipe, a sample was taken in lieu of the sample located farthest away from the discharge point. Station locations and sample information were as follows:

Station Number/City Designation	Description of Location	Outfall Diameter (inches)	Sample Notes
1/WW0300	West bank between Riverplace and Hawthorne Bridge	54	One collected from inside pipe, only 3 samples collected near discharge point.
2/WW0200	West bank, Front Ave. south of Fremont Bridge	42	One collected from inside pipe and 5 collected near discharge.
3/BC0116	West bank, Front Ave. north of Fire Bureau dock	72	Samples split into top 2 cm and 2-10 cm; one collected from inside pipe and no upstream sample.
4/SJ10M1	East bank, Swan Island Lagoon	60	Samples split into top 2 cm and 2-10 cm; no inside sample.
5/SJ16PP	East bank, St. Johns, Terminal 4 north of Pier 2	36	No inside sample.

Samples were analyzed for metals, SVOCs, pesticides and PCBs, and VOCs. Results for indicator chemicals (dry weight) are presented in the following table.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	2	5 (SJ16PP-A)
Cadmium (mg/kg)	1U	4 (SJ16PP-A)
Copper (mg/kg)	15	1,640 (WW0200-C)
Lead (mg/kg)	20 U	405 (WW0300-A)
Mercury (mg/kg)	0.2 U	0.2 (SJ16PP-A)
Zinc (mg/kg)	63	1,750 (BC0116-C)
TBT (µg/kg)	na	na
LPAH (µg/kg)	300 UA	12,000A(SJ16PP-A)
HPAH (µg/kg)	300 UA	166,000A(SJ16PP-A)
Total PCBs (µg/kg)	100 UA	7,000 A (SJ16PP-I)
Total DDTs (µg/kg)	10 UA	70 UA (BC0116-I)
Bis(2-ethylhexyl)phthalate (µg/kg)	300 UH	38,000 (SJ16PP-A)
Dibenzofuran (µg/kg)	300 UH	6,000 U (BC0116-C)
4-Methylphenol (µg/kg)	300 U	6,000 U (BC0116-C)
Xylene (µg/kg)	5 U	190 (SJ16PP-A)
Diesel Fuel (mg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Not detected at detection limit shown.

MOOR0694. Results of U.S. Moorings Sediment Study. ***(Prepared by U.S. Army Corps of Engineers, Portland District, June 14, 1994).***

On June 14, 1994, the Corps characterized sediments in the vicinity of a proposed small boat moorage at the U.S. Moorings facility. The purpose of the study was to determine if significant sediment contamination existed in the area where piles were to be driven for the proposed project. Previous investigations of U.S. Moorings sediments indicated the presence of metals, PAHs, and pesticides in the sediment.

Surface (0-13 cm) sediment samples were collected from 21 locations. Stations were named "M-P-1" through "M-P-21." Sediment samples from 12 locations were composited into six samples. The remaining nine samples were not composited and were submitted to the laboratory as individual samples. A total of 15 samples were analyzed for grain-size distribution, TOC, TBT, acid volatile sulfides, metals, PAHs, phenols, phthalates, and pesticides and PCBs. Dioxin/furan analyses were performed on four samples.

Sediments from this site were clayey, sandy silt high in organic carbon content. Results for indicator chemicals (dry weight) are presented in the following table.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	2.7	6.7 (MP03)
Cadmium (mg/kg)	0.27	0.55 (MP10/12)
Copper (mg/kg)	43	97.8 (MP03)
Lead (mg/kg)	23.7	86.9 (MP03)
Mercury (mg/kg)	0.09	0.13 (MP03)
Zinc (mg/kg)	97.4	175 (MP03)
TBT (µg/kg)	52 G	410 G (MP03)
LPAH (µg/kg)	1,073 A	10,239 A (MP15)
HPAH (µg/kg)	7,301 A	51,730 A (MP03)
Total PCBs (µg/kg)	40 UA	300 UA (MP01-MP03)
Total DDTs (µg/kg)	28 A	235 A (MP6)
Bis(2-ethylhexyl)phthalate (µg/kg)	280 G	520 (MP01)
Dibenzofuran (µg/kg)	50 U	180 (MP03)
4-Methylphenol (µg/kg)	100 U	100 U
Xylene (µg/kg)	na	na
Diesel Fuel (mg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	0.82	2 (MP04)

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
G – Estimate is greater than value shown.
U - Not detected at detection limit shown.

WLRPT294. 1994 Sediment Characterization Results, Terminal 2, Berth 203. (CAS laboratory report, dated April 8, 1994).

The Port of Portland characterized sediment off Berth 203 in 1994 in support of a maintenance dredging project. Four cores labeled "GC1" through "GC4" of unknown sampling depth were collected. The sample collection method is presumed to be by gravity core. Three of the four cores were split into surface and bottom portions and composited into two samples: "GC 1,2, &3 surface" and "GC 1,2, &3 bottom." Sample GC4 was submitted as a separate sample and analyzed for grain-size distribution and VOCs. The composited samples were analyzed for metals, SVOCs, pesticides and PCBs, and butyltins.

Sediments were silty sands. Results for surface sediment samples and subsurface samples are provided below in separate tables. Results are reported in dry weight.

Summary Data for Surface Samples.

Parameter	Minimum	Maximum
Arsenic (mg/kg)	2.8*	--
Cadmium (mg/kg)	0.33*	--
Copper (mg/kg)	38*	--
Lead (mg/kg)	29.3*	--
Mercury (mg/kg)	0.15*	--
Zinc (mg/kg)	316*	--
TBT (µg/kg)	75*	--
LPAH (µg/kg)	190 A*	--
HPAH (µg/kg)	2,270 A*	--
Total PCBs (µg/kg)	180 A*	--
Total DDTs (µg/kg)	2 UA*	--
Bis(2-ethylhexyl)phthalate (µg/kg)	2600*	--
Dibenzofuran (µg/kg)	20*	--
4-Methylphenol (µg/kg)	74 U*	--
Xylene (µg/kg)	10 U*	--
Diesel Fuel (mg/kg)	na	--
2,3,7,8-TCDD (ng/kg)	na	--

*Only one sample analyzed for this analyte.
na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Not detected at detection limit shown.

Summary Data for Subsurface Samples.

Parameter	Minimum	Maximum
Arsenic (mg/kg)	0.02 U*	--
Cadmium (mg/kg)	0.11*	--
Copper (mg/kg)	23*	--

Parameter	Minimum	Maximum
Lead (mg/kg)	9.08*	--
Mercury (mg/kg)	0.06*	--
Zinc (mg/kg)	115*	--
TBT (µg/kg)	10 U*	--
LPAH (µg/kg)	34 A*	--
HPAH (µg/kg)	135 A*	--
Total PCBs (µg/kg)	10 A*	--
Total DDTs (µg/kg)	2 UA*	--
Bis(2-ethylhexyl)phthalate (µg/kg)	120*	--
Dibenzofuran (µg/kg)	20 U*	--
4-Methylphenol (µg/kg)	53 U*	--
Xylene (µg/kg)	na	--
Diesel Fuel (mg/kg)	na	--
2,3,7,8-TCDD (ng/kg)	na	--

*Only one sample analyzed for this analyte.
na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Not detected at detection limit shown.

WLCT4L93. Terminal 4 Berth 408 Dredging Sediment Quality. ***(Prepared by the Port of Portland, 1994).***

The Port of Portland performed a dredged material characterization study at Terminal 4 (Slip 1) Berth 408 in December 1993. Approximately 1,500 cubic yards of sediment was characterized. Three cores approximately 26 inches (66 cm) in length were collected and submitted to the laboratory as three distinct samples (T408-1, T408-2, and T408-3). No information on collection methods was provided.

Samples were analyzed for grain-size distribution, metals, pesticides and PCBs, VOCs, phenols, phthalates, PAHs, and butyltins (bulk). Sediments were fine-grained, consisting of silt with clay. Results for indicator chemicals (dry weight) are presented in the following table. The Port of Portland later dredged this characterized sediment for upland disposal.

Parameter	Minimum	Maximum
Arsenic (mg/kg)	4.1	6.5
Cadmium (mg/kg)	0.53	1.56
Copper (mg/kg)	44	62
Lead (mg/kg)	55.3	147
Mercury (mg/kg)	0.10	0.21
Zinc (mg/kg)	163	416
TBT (µg/kg)	170	570
LPAH (µg/kg)	660 A	3540 A
HPAH (µg/kg)	6710 A	33,620 A
Total PCBs (µg/kg)	180 A	220 A
Total DDTs (µg/kg)	10 UA	30 UA
Bis(2-ethylhexyl)phthalate (µg/kg)	340	680
Dibenzofuran (µg/kg)	200 U	400 U
4-Methylphenol (µg/kg)	20 U	20 U
Xylene (µg/kg)	10 U	35
Diesel Fuel (mg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Not detected at detection limit shown.

PSYDD4. Sediment Testing at Portland Shipyard Dry Dock #4, Post Dredging. 1992. (Laboratory data package provided in the report, *Summary of Sediment Quality Information for Portland Shipyard). (Prepared by Hartman Associates, Inc., March 15, 1995).*

Pre-dredging sediment testing of Dry Dock #4 was conducted early in 1991 and 1992 to secure federal and state dredging permits. Approximately 95,000 cubic yards of material were dredged from under Dry Dock #4 in November and December 1992. The LWG's database contains sediment chemistry data from the post-dredging sediment investigation of Dry Dock #4 in December 1992. The post-dredging sediment sampling investigation consisted of the collection of eight surface (0-15 cm) samples. Collection methods were not indicated in the report. Stations 1 and 3 were located on the west side of the dry dock; stations 2 and 4 were located on the east side of the dry dock, and stations 5 through 8 were spaced equally down the center length of the dry dock, with station 8 located at the mouth.

Samples were analyzed for grain-size distribution, TVS, metals, SVOCs, pesticides and PCBs, VOCs, and TBT. Percent fines (silt+sand) ranged from 49 to 83%. Results for indicator chemicals (dry weight) are presented in the following table.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	3.7	11.7 (2)
Cadmium (mg/kg)	0.21	0.36 (2)
Copper (mg/kg)	91.6	506 (2)
Lead (mg/kg)	24.7	49.5 (8)
Mercury (mg/kg)	0.06	0.13 (8)
Zinc (mg/kg)	131	369 (2)
TBT (µg/kg)	7,340	42,900 (2)
LPAH (µg/kg)	361 A	3,090 A (2)
HPAH (µg/kg)	1,690 A	9,450 A (2)
Total PCBs (µg/kg)	100 UA	100 UA
Total DDTs (µg/kg)	3 UA	9 UA (8)
Bis(2-ethylhexyl)phthalate (µg/kg)	1,500 B	3,900 B (1)
Dibenzofuran (µg/kg)	64 U	160 (2)
4-Methylphenol (µg/kg)	20 U	58 (2)
Xylene (µg/kg)	13	390 (2)
Diesel Fuel (mg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
B - analyte found in associated blank.
U - Not detected at detection limit shown.

WLR0692. Lower Willamette River Sediment Evaluation – Portland Harbor.
(Prepared by the U.S. Army Corps of Engineers, Portland District, 1992).

The lower Willamette River deep-draft channel is maintained at an authorized depth of 40 feet from the mouth of the Willamette River to the Broadway Bridge. The purpose of the Corps' 1992 sediment evaluation was to characterize channel sediments for maintenance dredging. Results of the sediment chemical characterization were used to determine acceptable disposal alternatives.

Large shoals that had accumulated since the 1988 maintenance dredging were targeted for characterization. These included a shoal on the west side of the channel between RMs 8.0 and 10.4 and a smaller shoal between RMs 9.8 and 11.0 on the east side of the channel. Five sediment cores (WR-GC-1 through WR-GC-5) were collected from the shoaled areas to characterize the material for dredged material disposal. Cores were collected on June 3, 1992, using a Benthos gravity corer. Core collection locations and lengths are as follows:

Core	Location	Core Length (in.)
WR-GC-1	RM 10.1 east side of channel	25
WR-GC-2	RM 9.8 west side of channel	Top 0-6, Bottom 6-19
WR-GC-3	RM 9.2 west side of channel	53
WR-GC-4	RM 8.5 west side of channel at bend in channel	42
WR-GC-5	RM 8.8 west side of channel	53

One core, WR-GC-2, was divided into two sections, top and bottom, due to the presence of two distinct layers. All other cores were provided as one sample. Samples were analyzed for physical properties, grain-size distribution, TOC, acid volatile solids, metals, pesticides and PCBs, and PAHs. With the exception of the bottom portion of WR-GC-2, which was composed of sand, core samples were largely composed of silt with a minor amount of sand. TOC ranged from 0.10% (WR-GC-2 Bottom) to 2.88% (WR-GC-5). Results of indicator chemicals (dry weight) are presented in the following table.

The Corps determined that the sediment on the west side of the river between RM 8 and RM 10.2 was acceptable for unconfined, in-water disposal. Sediments from the shoal at RM 10.3 on the east side of the channel, however, were not dredged because sediments were not suitable for unconfined, in-water disposal.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	2	4 (WR-GC-5)
Cadmium (mg/kg)	0.1 U	0.4 (WR-GC-1)
Copper (mg/kg)	16	47 (WR-GC-4)
Lead (mg/kg)	3 J	29 J (WR-GC-1)
Mercury (mg/kg)	0.02 U	0.13 J (WR-GC-1)
Zinc (mg/kg)	46	196 (WR-GC-1)

Parameter	Minimum	Maximum (Location)
TBT (µg/kg)	na	na
LPAH (µg/kg)	20 UA	150 A (WR-GC-1)
HPAH (µg/kg)	40 UA	680 A (WR-GC-1)
Total PCBs (µg/kg)	10 UA	10 UA
Total DDTs (µg/kg)	2 UA	7 A (WR-GC-2 & -4)
Bis(2-ethylhexyl)phthalate (µg/kg)	na	na
Dibenzofuran (µg/kg)	20 U	75 U (WR-GC-4)
4-Methylphenol (µg/kg)	na	na
Xylene (µg/kg)	na	na
Diesel Fuels (mg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
J – Estimated value.
U - Not detected at detection limit shown.

WBWRIR98. Dioxins and Furans in Bed Sediment and Fish Tissue of the Willamette Basin, Oregon, 1992-1995. ***(Prepared by USGS, Water-Resources Investigations Report 97-4082-D).***

The Oregon District of the U.S. Geological Survey (USGS) began an investigation of dioxins and furans in sediments and tissues in 1992 with funding provided by the Willamette River Technical Advisory Steering Committee. The USGS continued this work between 1993 and 1995 as part of the Willamette Basin National Water-Quality Assessment. The purpose of the study was to assess the distribution and occurrence of dioxin and furan congeners in the Willamette River, Sandy River, and associated tributaries.

Sediment samples were collected from 22 sites, and fish tissue samples were collected from eight sites. In the lower Willamette River, sediment samples were collected from two locations, RM 5 and RM 13. Surface sediments (0-2 cm) were collected using an Ekman dredge.

Samples were analyzed for 10 tetra- through octa-dioxin and furan homolog totals, seventeen 2,3,7,8-substituted congeners, and organic content. 2,3,7,8-TCDD was not detected at 0.85 ng/kg (RM 5) and 0.80 ng/kg (RM 13).

WLCT1L91. 1992 Sediment Characterization Results, Terminal 1, Berth 104. (CAS laboratory report provided in Terminal 1 Preliminary Assessment Appendix). ***(Prepared by Port of Portland, January 14, 1992).***

The Port of Portland characterized sediment off Berth 104 in 1992 to support a maintenance dredging project. Two samples of unknown sampling depth were collected: 911217-2 and 911217-3. No sample collection methods were provided. Samples were analyzed for grain-size distribution, TVS, pesticides and PCBs, PAHs, phenols, and VOCs.

Sediments were largely composed of silt with a minor fraction of sand. Total volatile solids were 9.3% (911217-2) and 11.3% (911217-3). VOCs were not detected. Results for indicator chemicals (dry weight) are presented in the following table.

Parameter	Minimum	Maximum
Arsenic (mg/kg)	na	na
Cadmium (mg/kg)	na	na
Copper (mg/kg)	na	na
Lead (mg/kg)	na	na
Mercury (mg/kg)	na	na
Zinc (mg/kg)	na	na
TBT (µg/kg)	na	na
LPAH (µg/kg)	80 UA	90 UA
HPAH (µg/kg)	160 UA	180 UA
Total PCBs (µg/kg)	50 UA	50 UA
Total DDTs (µg/kg)	10 UA	10 UA
Bis(2-ethylhexyl)phthalate (µg/kg)	830	910
Dibenzofuran (µg/kg)	80 U	90 U
4-Methylphenol (µg/kg)	140	150
Xylene (µg/kg)	5 U	5 U
Diesel Fuel (mg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Not detected at detection limit shown.

MBCREOS1. McCormick & Baxter Creosoting Company Remedial Investigation Report. (Volumes I-IV). ***(Prepared by PTI Environmental Services, 1992).***

The remedial investigation of the McCormick & Baxter site was conducted in two phases, from September 1990 to March 1992. Phase I investigations focused on the onsite areas and provided preliminary data on offsite contaminant migration to the river and upland areas. Phase II focused on the migration of creosote offsite and in newly discovered source areas onsite. Surface sediment data were collected to characterize sediment contamination and reference concentrations and to identify source areas. Sediment cores were collected to determine the sources and lateral and vertical extent of subsurface sediment contamination.

Sediment quality data stored under the survey code, MBCREOS1, corresponds with Phase I activities. During Phase I, both surface and subsurface sediment samples were collected. Most samples were collected adjacent to and offshore of the facility and in Willamette Cove; however, one natural background sample, one upriver and one downriver reference, and six surface composite samples (in cross-river transects) located upstream and downstream of the site were also collected.

With the exception of the upriver reference sediment sample (RM39), which was collected using an Ekman grab, surface sediment samples (0-6 cm) were collected from 40 stations using a van Veen grab sampler. The majority of samples were composited from two grab samples collected from each location; however, six grab samples were taken at each of four stations extending in the six cross-river transects (i.e., samples with "TR" prefix). Five beach samples from four locations were also collected with a spoon. Forty-eight surface sediment samples were analyzed for grain size, TOC, and site-specific contaminants of concern (selected metals, pentachlorophenol, and PAHs). Seventeen samples were analyzed for grain-size distribution, TOC, and a broad range of organic and inorganic analyses. Eight samples were also analyzed for dioxins/furans.

Thirty-two cores were collected in Phase I using an impact corer 12-18 feet in length. Cores were cut into 3- to 4-foot sections. Of the 32 cores, seven were selected for subsampling, and a total of 11 samples (not including replicates) were analyzed. Core subsampling intervals varied depending on the station. The deepest core sample interval was 478 to 509 cm below mudline. Samples were analyzed for grain-size distribution, TOC, site-specific contaminants of concern, and dioxins/furans.

Results for surface sediment samples and subsurface samples are provided below in separate tables. Results are reported in dry weight.

Summary Data for Surface Samples.

Parameter	Minimum	Maximum
Arsenic (mg/kg)	2.4 M	18 J
Cadmium (mg/kg)	0.47 U	0.88 U
Copper (mg/kg)	1	330

Parameter	Minimum	Maximum
Lead (mg/kg)	5 J	44
Mercury (mg/kg)	0.01	0.2
Zinc (mg/kg)	35 JM	350
TBT	na	na
LPAH (µg/kg)	270 A	6,907,000A
HPAH (µg/kg)	910 A	2,169,000 A
Total PCBs (µg/kg)	4U J	980,000 Q
Total DDTs (µg/kg)	7 UA	900 A
Bis(2-ethylhexyl)phthalate (µg/kg)	15 U	88,000 J
Dibenzofuran (µg/kg)	15 U	620,000
4-Methylphenol (µg/kg)	300 U	90,000 U
Xylene (µg/kg)	na	na
Diesel Fuel (mg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	3 U	100

na - Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
J - Estimated value.
M - Mean value.
Q - Questionable value.
U - Not detected at detection limit shown.

Summary Data for Subsurface Samples.

Parameter	Minimum	Maximum
Arsenic (mg/kg)	2.1	11 M
Cadmium (mg/kg)	0.7 U*	--
Copper (mg/kg)	13	62
Lead (mg/kg)	41*	--
Mercury (mg/kg)	0.11	--
Zinc (mg/kg)	41	340
TBT	na	na
LPAH (µg/kg)	16 A	8,230,000 A
HPAH (µg/kg)	37 A	1,866,000 A
Total PCBs (µg/kg)	34 UJ*	--
Total DDTs (µg/kg)	3.4 UA*	--
Bis(2-ethylhexyl)phthalate (µg/kg)	1,700 M*	--
Dibenzofuran (µg/kg)	32,000 JM*	--
4-Methylphenol (µg/kg)	1,400 U*	--
Xylene (µg/kg)	na	na
Diesel Fuel (mg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	3 J	3

*Only one sample analyzed for this parameter.
na – Not analyzed.

A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
J - Estimated value.
M - Mean value.
U - Not detected at detection limit shown.

MBCREOS2. McCormick & Baxter Creosoting Company Remedial Investigation Report (Volumes I-IV). ***(Prepared by PTI Environmental Services, 1992).***

The RI of the McCormick & Baxter site was conducted in two phases from September 1990 to March 1992. Phase II focused on the migration of creosote offsite and in newly discovered source areas onsite.

Sediment quality data stored under the survey code, MBCREOS2, corresponds with Phase II activities. During Phase II, both surface and subsurface sediment samples were collected. Seven surface sediment samples were collected using a van Veen grab sampler in conjunction with Microtox testing. Sediment cores were collected from six locations along the estimated boundaries of subsurface contamination and in areas where the entire length of the Phase I cores were contaminated. Subsurface sediments were collected with a hollow-stem auger mounted on an anchored barge. Samples were collected at 3-foot intervals using a split-spoon sampler. Core subsampling intervals varied depending on the station. The deepest core sample interval was 2,331 to 2,377 cm below mudline. Three samples from each core (18 total) were selected for analysis. For both surface and subsurface samples, samples were analyzed for site-specific chemicals of concern. In addition, four heavily contaminated core samples were analyzed for dioxins/furans.

Results for surface sediment samples and subsurface samples are provided below in separate tables. Results are reported in dry weight.

Summary Data for Surface Samples.

Parameter	Minimum	Maximum
Arsenic (mg/kg)	4	14
Cadmium (mg/kg)	na	na
Copper (mg/kg)	36	150
Lead (mg/kg)	na	na
Mercury (mg/kg)	na	na
Zinc (mg/kg)	140	490
TBT	na	na
LPAH (µg/kg)	1,180	1,452,000
HPAH (µg/kg)	6,300	558,000
Total PCBs (µg/kg)	na	na
Total DDTs (µg/kg)	na	na
Bis(2-ethylhexyl)phthalate (µg/kg)	na	na
Dibenzofuran (µg/kg)	na	na
4-Methylphenol (µg/kg)	na	na
Xylene (µg/kg)	na	na
Diesel Fuel (mg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na

na – Not analyzed.

Summary Data for Subsurface Samples.

Parameter	Minimum	Maximum
Arsenic (mg/kg)	1.8	5.2
Cadmium (mg/kg)	na	na
Copper (mg/kg)	25	100
Lead (mg/kg)	na	na
Mercury (mg/kg)	na	na
Zinc (mg/kg)	69 J	450 J
TBT	na	na
LPAH (µg/kg)	20 A	396,000 A
HPAH (µg/kg)	62 UA	166, 000 A
Total PCBs (µg/kg)	na	na
Total DDTs (µg/kg)	na	na
Bis(2-ethylhexyl)phthalate (µg/kg)	na	na
Dibenzofuran (µg/kg)	na	na
4-Methylphenol (µg/kg)	na	na
Xylene (µg/kg)	na	na
Diesel Fuel (mg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	0.1 U	4.3

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
J - Estimated value.
U - Not detected at detection limit shown.

PSBTH311. Laboratory Report for Port of Portland PSRY Berth 311 Sediment Characterization. ***(Prepared by Port of Portland, 1990).***

On September 9, 1990, sediment samples were collected from seven locations off Berth 311 for characterization prior to dredging. The Port of Portland's Berth 311 is located on the eastern side of Swan Island Lagoon near the southeast corner. Stations 1 through 6 were situated within the proposed dredge prism, while station 7 was situated inshore off a City of Portland storm drain. Sediment cores were collected from stations 1 through 4 and split into surface ("S" sample ID suffix, 0-20 cm) and bottom ("B" sample ID suffix, 20-40 cm) samples. Surface (0-20 cm) samples were collected from the remaining stations. A gravity core was used to collect both surface and subsurface sediment samples.

Sediments were composited into six samples: 1S/2S, 1B/2B, 3S/4S, 3B/4B, 5S/6S, and 7S. Sediment samples were analyzed for grain-size distribution, volatile organics, metals, SVOCs, VOCs, pesticides and PCBs, and TBT (samples 1B/2B and 5S/6S only). Sediments were fine-grained silt. This project was canceled in 1991, and no dredging permit application was ever completed.

On April 8, 1992, the site was revisited and sediment cores were recollected from four locations (stations 3 through 6) located within a revised dredge prism boundary. The revised dredge plan excluded sediments near the storm drain. Cores were collected with a gravity corer. Again, cores 40 cm in length were collected from each location and split into surface ("S", 0-20 cm) and bottom ("B", 20-40 cm) samples. Sediments were composited into four samples: 3S/4S, 5S/6S, 3B/4B, and 5B/6B.

Sediment samples were analyzed for grain-size distribution, volatile solids, metals, SVOCs, VOCs, pesticides and PCBs, and TBT. Sediment samples were fine-grained silt and clay. Results for surface sediment samples and subsurface samples are provided below in separate tables. Results are reported in dry weight.

The Corps determined that sediments from the upstream portion of the project were suitable for unconfined, open-water disposal, but the downstream portion of the project would need to be disposed of at an upland or confined in-water disposal site.

Summary Data for Surface Samples.

Parameter	Minimum	Maximum
Arsenic (mg/kg)	1.3	640
Cadmium (mg/kg)	0.4	8
Copper (mg/kg)	21	1,200
Lead (mg/kg)	11	670
Mercury (mg/kg)	0.02	0.12
Zinc (mg/kg)	61	7,000
Tributyltin (µg/kg)	8.91	16.2

Parameter	Minimum	Maximum
LPAH (µg/kg)	180 A	750 A
HPAH (µg/kg)	300 UA	4780 A
Total PCBs (µg/kg)	90	160
Total DDTs (µg/kg)	5 UA	100 UA
Bis(2-ethylhexyl)phthalate (µg/kg)	1,500 U	10,000
Dibenzofuran (µg/kg)	300 U	300 U
4-Methylphenol (µg/kg)	84	370
Xylene (µg/kg)	5 U	20 U
Diesel Fuel (mg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na

na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Not detected at detection limit shown.

Summary Data for Subsurface Samples.

Parameter	Minimum	Maximum
Arsenic (mg/kg)	1.5	1.7
Cadmium (mg/kg)	0.6	0.6
Copper (mg/kg)	23	26
Lead (mg/kg)	13	13
Mercury (mg/kg)	0.06	0.08
Zinc (mg/kg)	68	74
Tributyltin	4.37*	
LPAH (µg/kg)	140 A	140 A
HPAH (µg/kg)	300 UA	1,072 A
Total PCBs (µg/kg)	17 A	17 A
Total DDTs (µg/kg)	5 UA	100 UA
Bis(2-ethylhexyl)phthalate (µg/kg)	1,500 U	1,500 U
Dibenzofuran (µg/kg)	300 U	300 U
4-Methylphenol (µg/kg)	140	340
Xylene (µg/kg)	5 U	10 U
Diesel Fuel (mg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na

*Only one sample analyzed for this analyte.
na – Not analyzed.
A - Detected quantities of analytes added together as defined in WAC 173-204-320 for LPAH and HPAH, as in DMMO (2000) for DDT, and for all Aroclors or congeners for PCB.
U - Not detected at detection limit shown.

COLWIL90. Sediment Quality (Dioxin/Furan) Evaluation, Lower Columbia and Willamette Rivers. ***(Prepared by U.S. Army Corps of Engineers, Portland District, 1990).***

Between May 3, 1990 and May 18, 1990, the U.S. Army Corps of Engineers, Portland District, collected subsurface sediment samples using a benthos gravity corer from the lower Columbia River and the lower Willamette River. The purpose of the survey was to determine the extent of dioxins and furans within the proposed channel alignment.

Sample locations in the lower Willamette River were chosen from general shoal areas or where hydrophobic organic compounds were detected in previous sampling events either by the Portland District or DEQ. Cores were collected from 10 locations: WR-GC-2 (RM 4.2 west side of channel), WR-GC-1 (RM 6 U.S. Moorings), WR-GC-3 (RM 6.8 Willamette Cove), WR-GC-4 (RM 7.3 west side of channel), WR-GC-5 (RM 9 west side of channel), WR-GC-6 (RM 9 mid-channel), WR-GC-7 (RM 10 east side of channel), WR-GC-8 (RM 10 mid-channel), WR-GC-9 (RM 10 west side of channel), and WR-GC-10 (RM 11 west side of channel). Two cores were collected from WR-GC-3 and combined (WR-GC-3A+B). With the exception of WR-GC-01, the entire length of each core was used as a single sample. Core lengths ranged from 44 to 129 cm. WR-GC-01 was divided into two separate samples, top (0-70 cm) and bottom (70-142 cm).

Samples were generally analyzed for grain-size distribution, TOC, volatile solids, and dioxins/furans. Samples from WR-GC-01 were only analyzed for conventionals. Sediments were largely silt (medium to coarse) with the exception of WR-GC-8, which consisted of fine sand. TOC ranged from 0.90 to 4.0% (WR-GC-3A+B), and volatile solids ranged from 3.5 to 10% (WR-GC-3B). 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) was detected in two lower Willamette core samples: WR-GC-4 (0.63 parts per trillion [pptr]) and WR-GC7Rep (0.62 pptr). 2,3,7,8-TCDF ranged in concentration from 0.73 pptr (WR-GC-7) to 110 pptr (WR-GC-4).

CLBC8494. Columbia River Basin Contaminant Aquatic Biota and Sediment Data. ***(Compiled by U.S. EPA Region 10: http://www.epa.gov/r10earth/data/crbdata.html).***

Sediment chemistry data from two lower Willamette River studies were available in EPA's online database download. Studies include:

1) Curtis, L.R., H.M. Carpenter, R.M. Donohoe, D.E. Williams, O.R. Hedstrom, M.L. Deinzer, M.A. Beilstein, E. Foster, and R. Gates. 1993. Sensitivity of cytochrome P450-1A1 induction in fish as a biomarker for distribution of TCDD and TCDF in the Willamette River, Oregon. *Environ. Sci. Technol.* 27:2149-2157.

This study was performed to determine the extent of 2,3,7,8-TCDD and 2,3,7,8-tetrachlorodibenzo-furan (TCDF) contamination in the Willamette River due to industrial discharges. Sediment samples were collected from six stations from RMs 6.8 to 195. Only one station (RM 6.8) was sampled below Willamette Falls. Three surface sediment samples (top 15 cm) were collected from each station using a stainless-steel Eckman dredge (0.23 m^2). Each sample represented a composite of three to five grabs. Samples were analyzed for TCDD, TCDF, PAHs, and organic carbon content.

The sediment samples collected from RM 6.8 consisted of clay, sand, and gravel with an average organic carbon content of 2.38%. TCDD and TCDF were detected in all three samples collected. The average TCDD concentration was 1.62 pg/g, dry weight, and the average TCDF concentration was 10.11 pg/g, dry weight. PAH concentrations (µg/kg, dry weight) summarized in Curtis et al. (1993) are as follows:

Parameter	Minimum	Maximum
Naphthalene	220	30,200
Acenaphthene	30 U	14,900
Dibenzofuran	70	11,400
Fluorene	70	16,100
Phenanthrene	250	27,600
Anthracene	70	8,300
Fluoranthene	340	17,400
Pyrene	370	15,500
Benz(a)anthracene	90	2,950
Benzo(b)fluoranthene	110	2,060
Benzo(k)fluoranthene	400	1,320
Benzo(a)pyrene	30 U	340
Indeno(1,2,3-c,d)pyrene	30 U	440
Dibenzo(a,h)anthracene	30 U	160
Benzo(g,h,i)perylene	90 U	410

U - Undetected at concentration shown.

2) DEQ. 1994. Willamette River Toxics Study – 1988/1991. Oregon Department of Environmental Quality, Water Quality Division, Portland, OR.

Approximately 26 locations in the Willamette River and its tributaries were sampled by DEQ between 1988 and 1990. Six sediment samples were collected below Willamette Falls at RMs 6 (1988), 7 (1988-1990), 8 (1988-1989), 14 (1989), 16 (1988), and 18 (1989). Surface sediment samples (top 15 cm) were collected using a stainless-steel Eckman dredge (0.23 m^2). Each sample represented a composite of three to five grabs. Samples were generally analyzed for metals, PAHs, and pesticides and PCBs (Aroclors). Exceptions included Station 8 in 1988 (PAHs were not analyzed) and Station 7 in 1990 (metals were not analyzed but PCB congeners were analyzed). Sediments from stations 7 (1988-1989), 8 (1988), 16, and 18 were also tested using bioassays.

Results for indicator chemicals in LWR samples are presented in the following table. All results were reported in wet weight. PCB congeners were not detected at 0.005-mg/kg, wet weight. Because all sample results are reported on a wet-weight basis, comparability with other data sets is limited.

Parameter	Minimum	Maximum (Location)
Arsenic (mg/kg)	2.33	45.5 (RM 6)
Cadmium (mg/kg)	0.07 J	0.9 (RM 6)
Copper (mg/kg)	14.6	320 (RM 8)
Lead (mg/kg)	12.4	151 (RM 8)
Mercury (mg/kg)	0.03	1.74 (RM 8)
Zinc (mg/kg)	72.3	703 (RM 8)
Tributyltin (µg/kg)	na	na
Total DDT (µg/kg)	3 U	1,690 (RM 7)
Total PCBs (µg/kg)	15 U	4,200 (RM 8)
LPAH (µg/kg)	60 J	1,000,000 (RM 7)
HPAH (µg/kg)	16.1 J	36,000,000 (RM 7)
Bis(2-ethylhexyl)phthalate (µg/kg)	na	Na
Dibenzofuran (µg/kg)	24.6 J	11,400 (RM 7)
4-Methylphenol (µg/kg)	na	na
Xylene (µg/kg)	na	na
Diesel Fuel (mg/kg)	na	na
2,3,7,8-TCDD (ng/kg)	na	na

na – Not analyzed.
U - Undetected at concentration shown.
J - Estimated value.

Appendix G

LWG
LOWER WILLAMETTE GROUP

PORTLAND HARBOR RI/FS PROGRAMMATIC WORK PLAN

APPENDIX G: DATA MANAGEMENT PLAN

REVISED DRAFT FINAL
November 13, 2003

Prepared for:
The Lower Willamette Group

Prepared by:
Striplin Environmental Associates, Inc.

TABLE OF CONTENTS

1.0 INTRODUCTION 1

2.0 FIELD DATA MANAGEMENT ACTIVITIES 2
2.1 Field Data Records 2
2.1.1 Field Records 2

3.0 CREATION AND MAINTENANCE OF PROJECT DATA 4
3.1 Data Record 5
3.1.1 Sample Code System 5
3.2 Sample and Field Measurement Locations 7
3.3 Chain-of-Custody Procedures 7
3.4 Data Review and Validation Records 8

4.0 PROJECT FILE REQUIREMENTS AND ELECTRONIC DATA MANAGEMENT 9
4.1 Hard Copy Files 9
4.1.1 Document Control 9
4.2 Electronic Files 10
4.3 Data Tracking 10
4.4 Electronic File Deliverables 11
4.5 Data Access 11
4.6 Data maintenance 11

5.0 DATA PRESENTATION 13
5.1 Graphical Data Display 13

6.0 TRANSFER OF INFORMATION TO EPA REGION X 15

7.0 REFERENCES 16

1.0 INTRODUCTION

The purpose of this Data Management Plan (DMP) is to create standardized procedures and formats for all non-privileged documents and environmental data (field and laboratory) generated during the Portland Harbor Remedial Investigation/Feasibility Study (RI/FS). The following guidance is included in this DMP:

- Field data management activities
- Creation and maintenance of project data
- Project file requirements
- Procedures for presenting project results and data
- Procedures for transferring electronic files to other parties

The plan is also designed to maintain the organization of complex environmental information using a relational structure of data tables. This structure enables the environmental data from both the historical review and upcoming investigations, including sediment characterization and ancillary technical information, to be effectively stored so that specific descriptive facts (field sampling) about different subjects (e.g., survey, analytical data, tissue burdens, etc.) are contained in separate tables but remain related to one another by a composite key. Consequently, queries for tracking and securing technical facts about a facility, survey, or station, from sample collection through laboratory analyses and the review/validation process, can be completed effectively and can draw together meaningful information for addressing project objectives.

2.0 FIELD DATA MANAGEMENT ACTIVITIES

During field operations, effective data management is essential to provide consistent, accurate, and defensible documentation of data quality. Field data will include identifying information and descriptive and geographical information associated with sediment, water, and biota sample collection.

2.1 FIELD DATA RECORDS

To avoid alteration, damage, or loss of field data during the Portland Harbor RI/FS, it will be the responsibility of the field task leader to ensure that at the conclusion of the field survey all field data (i.e., logs, notebooks, field sheets, etc.) will remain in their possession until documents are placed in the project file. The field task leader is also responsible for training junior staff in the specifics of documentation and chain-of-custody (COC) requirements (see Field Sampling Plan for details). Standardized field records and COC documentation minimizes the chance of loss or damage of project data. This section provides guidance and data requirement checks of field data records and defines corrective actions if errors are detected in field records.

2.1.1 Field Records

Daily field records (a combination of field logbooks and field data sheets) and navigational records will make up the main documentation for field activities.

Field Logbooks

All field activities and observations will be noted in a field logbook during fieldwork. The descriptions will be clearly written with enough detail so that participants can reconstruct events later if necessary. Field logbooks will contain any changes in personnel and responsibilities or deviations from the Portland Harbor RI/FS Work Plan or Field Sampling Plan (FSP), as well as the reasons for the changes. Requirements for logbook entries include the following:

- Separate field activity logbooks will be kept for each task, in addition to the master site logbook
- Logbooks will be bound, with consecutively numbered pages
- Removal of any pages, even if illegible, is prohibited
- Entries will be made legibly with black (or dark) waterproof ink
- Unbiased, accurate language will be used
- Entries will be made while activities are in progress or as soon afterward as possible (the date and time that the notation is made will be noted as well as the time of the observation itself)

- Each consecutive day's first entry will be begun on a new, blank page
- The date and time, based on a 24-hour clock (e.g., 0900 a.m. for 9 a.m. and 2100 for 9 p.m.), will be recorded on each page
- When field activity is complete, the logbook will be entered into the permanent Portland Harbor project file.

In addition to the preceding requirements, the person recording the information will initial and date each page of the field logbook. If more than one individual makes entries on the same page, each recorder will initial and date each entry.

Separate logbooks for each activity may be needed because several field activities may occur at once. In addition to each task or activity logbook, a master field logbook will be used. A description of impending operations and general field activities, including personnel on site, will be noted in the master logbook. The master logbook also will include a list of the activity logbooks.

Logbook corrections will be made by drawing a single line through the original entry, allowing the original entry to be read. The corrected entry will be written alongside the original. Corrections will be initialed and dated and may require a footnote for explanation.

Field Data Sheets

Information such as habitat descriptions, sediment characteristics (i.e., color, texture, etc.), surface water properties (i.e., temperature) and biota sampling data (i.e., sampling gear, coordinates, etc.) will be noted on the field data sheets. Depending on the activity, the type of field data sheet and the information recorded on it may vary. A reference date and activity will be entered into the logbook to refer to the field data sheets being generated. The field data sheets will be kept in the project file as a permanent record of the sampling or field measurement activities. If field data sheet entries are entered in an electronic format, each sheet will be annotated to indicate who completed the data entry and when. The field task leader is responsible for ensuring that all requested information on field data sheets answered before datum become part of the permanent file.

Field Data Management

As soon after collection as possible, field notes and data sheets will be scanned to create an electronic record for use in creating the cruise report. Twenty percent of the scan-transferred data will be verified against the hard copy records. However, for cases when field data is hand-entered into the database all data will be verified against source documents. Electronic quality assurance (QA) checks to identify anomalous values will also be conducted following entry.

3.0 CREATION AND MAINTENANCE OF PROJECT DATA

A relational database will be used to organize, analyze, and store project information and data. EQuIS, a system based on Microsoft Access, will be used specifically to:

- Provide a single centralized repository for chemistry (sediment, tissue, and water properties), bioassay, and benthic data via joining chemical and biological specific attributes in data tables across field data tables
- Provide a user-friendly interface for database queries and generation of reports
- Allow the data to be viewed and displayed in a GIS-compatible format, along with other GIS data layers
- Conduct data manipulations, such as total organic carbon (TOC) and lipid normalization, comparison to sediment and tissue guidelines, summation of analytes, etc. using normalization concepts and modifying the system's basic structure query language to define specific analytical groups from the data warehouse
- Support calculation of sediment and tissue guidelines, including exceedance calculations, development of data distributions, statistical comparison, calculation of area-weighted averages, and error rate calculations.

The EQuIS system structures data into relational tables and provides the platform from which data can be transferred onto the file server as Access or NOAA Query Manager files. Authorized EQuIS users are able to create queries based on specific criteria, such as location, date/time, matrix type, and a range of values contained within the data set. Maps from which a user can select a location and receive data at or in the vicinity of that location, will also be integrated into the system.

EQuIS can provide detailed or characterized information about sampling locations, sample types, sampling and analytical methods, results, and QA information. Simple comparisons to regulatory standards or risk-based screening levels can be made, along with calculations of descriptive statistics (e.g., Compliance Assessment Remediation Statistics ™). Data can also be exported to spreadsheets, data analysis software, or other databases according to their requirements.

Analytical data will be added to the database using standardized formats and a QA program. The QA program checks the format and completeness of chemical data. Most data will be transferred directly from the laboratories via electronic

files to eliminate the potential for error during keyboard data entry. All data that requires manual input will be printed, verified against the original source documents, and corrected if necessary within the EQuIS system. The hard copies will be initialed as they are checked during verification of electronic versions of the original source documents.

3.1 DATA RECORD

The data record will be the main tracking mechanism for Portland Harbor RI/FS activities. The data record will ensure that analytical data are traceable to specific samples. The data record will also document sample shipments, data receipt, and data validation.

3.1.1 Sample Code System

A unique code will be assigned to each sample as part of the data record. This code will indicate the project phase, sampling location, sample matrix, sample compositing, level of replication/duplication, and matrix specific sample information (i.e., sample depth interval for sediment, water, or benthos samples and organism and tissue type for tissue samples).

Project Phase	Sampling Location	Sample Matrix	Sample Interval or Organism/Tissue	Composite, Replication, Duplication
LWG*aa*	*rrixxx*	*bb*	*dzzz* or *SStt*	*CRD*

Project Phase – All samples for LWG will be prefixed with "LWG". The following two characters will indicate the Phase or Round of sampling under which the sample was collected. For example, the Round 1 samples will start with "LWG01". If the round has multiple events, then the prefix will show those. For example, Round 1A samples will start with "LWG1A".

Sampling Location – (also called Station Name) Sampling locations will consist of three parts. The first two characters, "rr", indicate the river mile (rounded down to the nearest whole mile) of the location. The next character will be either "B" for beach locations or "R" for on-water river locations. All sampling locations within each river mile will be numbered sequentially from 001 to 999, represented by the final three characters. It is recognized that tissue sampling is often conducted along a transect or trawl track and thus the location is not a single point. For the transects that are not contained entirely within one river mile, the river mile of the midpoints will be used in the name of those line sampling locations.

The exception to this sampling location naming convention will be for sampling of whole segments of river for fish tissue. In those cases, the six character sampling location name will be "FZ", for Fishing Zone, followed by two digits

for the lower river mile and another two digits for the upper river mile. For example, a sampling area for fish tissue from river mile 3 to river mile 6 would be named FZ0306. Note that "Fishing Zones" can be designated for collection of any organisms, not exclusively vertebrate fishes.

Sample Matrix – The matrix component is a two-character code that defines the type of material sampled. The following codes will be used to indicate the various matrices being sampled:

- SD = sediment
- SW = surface water
- BN = benthic invertebrate community structure
- TS = tissue

Sample Interval or Organism Tissue – For sediment, surface water, and benthos samples, this four-character section of the sample code will represent the depth interval of the sample within the sediment or water column. The first character will be "S" for samples taken at the sediment or water surface that have no associated subsurface samples. Samples taken at multiple depth intervals, as defined in the field sampling plan, will be represented in the first character with letters ranging from "A" to "M". "A" will be used to indicate the top interval (i.e. at or closest to the surface). All subsequent (deeper) sample intervals will be indicated in alphabetical order.

The final three characters, for both single interval "S" samples and multiple interval "A" to "M" samples, will be three digits indicating the distance to the bottom of the sample from the sediment or water surface (in centimeters). For example, two samples defined in the field sampling plan to be taken from a sediment core at the sediment surface to 10 cm and from 10 cm to 20 cm would be indicated with "A010" for the upper sample and "B020" for the lower sample.

For tissue samples, this four-character section of the sample code will represent, with the first two characters, the organism that will be collected and, with the last two characters, the specific tissue that will be tested. For example, "CRWB" represents a crayfish (CR) whole body (WB) tissue sample. Codes for the organisms collected and tissues tested will be defined in the field sampling plan. All subsequent sampling plans will have matching codes with all previous plans.

Composite, Replication, Duplication – The last three characters in the sample code are used to indicate the level of compositing, replication, and/or duplication represented by the sample. The first character will either be an "S" for a single sample or a "C" to indicate that the sample is some type of composite (e.g., spatial or across organisms). The second character will range from 0 (for a unique sample with no replication) to a maximum of "9" (to indicate which replicate a sample is in a series of replicates). The last character is used to indicate whether

or not a sample represents a split or duplicate analysis. Use of a "0" indicates no duplication; a "1" or a "2" indicates which duplicate in the series a sample represents.

Replication and duplication of samples will not be apparent to the analytical laboratories because the sample identification code will not be explained to lab personnel. In addition, all of the chemistry laboratories performing analysis for LWG have Laboratory Information Management Systems (LIMS) and will independently lab code all samples when they arrive. The project manager and sample receiving agent will be the only people with copies of the chains-of-custody and the ability to reference back to LWG field codes. Thus requiring an extra coding in the field for security purposes is redundant.

3.2 SAMPLE AND FIELD MEASUREMENT LOCATIONS

Latitude and longitude coordinates will be obtained for all sampling and field measurement locations (accuracy ± 1 meter) using a differential global positioning system (DGPS) unit (details provided in field sampling section of work plan). A station number or location, which will correlate with the sample code, will be given to each site where DGPS data are collected. These points will be identified later on site maps. The standard projection method to be used during field activities is Horizontal Datum: North American Datum of 1983 (NAD83), State Plane Coordinate System, Oregon North Zone (International Feet). In addition, all hydrographic surveys, will be referenced to National American Vertical Datum of 1988 (NAVD88).

3.3 CHAIN-OF-CUSTODY PROCEDURES

The COC record will ensure that precise documentation of sample possession and handling is maintained from the time of collection until final site decisions are approved. The COC record will include:

- Sample labels and custody seals
- Sample logbooks and field data sheets
- COC sheets
- Laboratory-generated sample logs produced upon receipt of the samples at the laboratory.

The COC form will be a critical aspect of the COC record. A designated field team member will be responsible for completing this form, which will be signed when received by the laboratory. The following information will be included on the COC form:

- Site name

- Field task leader's name and team members responsible for collection of the listed samples
- Collection date and time of each sample
- Sampling type (e.g., composite, grab, trawl)
- Sampling station location
- Number of sample containers shipped
- Requested analysis
- Sample preservation information
- Name of the carrier relinquishing the samples to the transporter, noting date and time of transfer and the designated sample custodian at the receiving facility.

In cases of project time constraints or analytical concerns, the person responsible for completing the COC form also will note whether samples require rapid laboratory turnaround. These notes will be made in the remarks section of the form. The original COC form will be transported with the samples to the laboratory and will remain in the laboratory's file until the laboratory turns around the reviewed and verified analytical data associated with the samples listed on the form. At that time the original COCs will be provided with the hard copy of the analytical results so that they are stored together in the LWG project files. This form will note all shipping data (e.g., shipper's tracking number, organization, time, and date). A complete custody record will consist of the original and any duplicate COC records along with the shipper's label or delivery note. The field task leader is responsible for ensuring that all records are correct and that they become part of the permanent project file (see details in Field Sampling Plan).

3.4 DATA REVIEW AND VALIDATION RECORDS

The accuracy and precision of the data values will be compared to QC criteria as described in detail in the chemistry quality assurance project plan (QAPP) of the work plan during the review process. Level 2 data validation (EPA 1988a, b) requirements will be used when validating sample data and laboratory quality control samples. Documenting and tracking changes to analyses results (e.g., re-extractions, averaging duplicated analytical facts, etc.) made by the data validator (to be named) will be recorded electronically using attributes such as, validator qualifier, reportable result, and result value type. Electronic corrections will be initialed and dated and this information along with any footnotes for explaining corrections will be reported in validator comment element. LWG team consultants will be responsible for completing all data reviews, validations and for ensuring that all records become part of the permanent project file.

4.0 PROJECT FILE REQUIREMENTS AND ELECTRONIC DATA MANAGEMENT

The LWG will maintain project documentation files in the LWG's repository in Portland, OR. These files will contain an accurate record of all activities conducted and information generated during the RI/FS project. LWG team consultants will maintain copies of unique work products and provide copies to the LWG repository for the final project documentation. Documents that are privileged (e.g., attorney work product or attorney-client privileged), will be maintained separately and are not addressed under this Plan or by the following procedures.

4.1 HARD COPY FILES

Hard copy files will be generated for all project plans, activities, and results for the Portland Harbor RI/FS.

4.1.1 Document Control

Document controls will be set to ensure that documents are accurate and current. These controls will also verify that the documents represent ongoing project operations and are in the possession of those individuals responsible for implementing, reviewing, and approving the prescribed procedure and work results. Documents that specify results of work to be accomplished under prescribed QA protocol will be identified in the LWG library data table by date, point of contact, availability (e.g., electronically) and links to other user-defined media.

Document Control Numbers

Documents can be traced and maintained with document control numbers from initiation through revision and archiving. Document control numbers will be assigned to each deliverable document produced during the Portland Harbor RI/FS. Document control numbers and date will appear on each page of the document so that draft and final versions will be distinguishable.

Document Distribution

Draft and final documents will be distributed as hard copies to the EPA team personnel listed in the AOC. Documents will also be posted to the project server (as described in more detail in the project workplan) and can be accessed by anyone who is an approved user.

Review and Approval

A formal review and approval process will be conducted by the LWG before any project document is released to EPA. The LWG's review process will ensure that the submittal is complete in accordance with the Scope of Work (SOW). The

review will ensure that appropriate scientific assumptions and calculations were used and that information is provided in a logical and organized manner.

Documents will be reviewed by the EPA project team. Following receipt of EPA comments, draft documents will be revised, internally reviewed, and submitted to EPA as final documents. Following final review by EPA, EPA will transmit a letter approving the document to the LWG.

Storage Procedures

All files will be inventoried and archived in accordance with the LWG and team consultants' standard operating procedure (SOP) for maintaining project files. Copies of all documents will be stored in the LWG repository in Portland, OR.

4.2 ELECTRONIC FILES

All laboratory's chemical, biological, and physical analytical data associated with the samples will be requested from the laboratories in an electronic format that is compatible with SEA's EQuIS database. Data files will also be provided as hard copy files. Data are loaded into EQuIS using a comma-delimited, ASCII protocol, variable-length text file for each system data type (e.g., survey, station, sediment sample, analytical results). Data validation qualifiers will be entered directly into the electronic database where 20 percent of the Laboratory Information Management Systems (LIMS) and biological data will be verified against hard documents. A record that fails to pass any of numerous data validation and integrity tests is written to a user-specified exception file along with the rejection error. In this manner, large volumes of data can be processed without interruption while problem data are identified and saved for further processing.

Data available only in hard copy, along with all field observations or measurements, will be hand-entered into the database and reviewed for corrections before use. All hand-entered data will be subjected to 100% percent verification against the source document.

All electronic files will be maintained in formats that will facilitate transfer of data into EQuIS and the associated Portland Harbor ArcView GIS. Details on the structure of EQuIS and information on the mechanism for data input are available from the EQuIS User Documentation and described in (SEA 2001).

4.3 DATA TRACKING

All incoming data, hard copy or electronic, will be tracked by SEA's Data Manager. The sample numbers and date received will be noted, and records of these will be kept in the project's database. Data entry, validation, and GPS downloads also will be tracked in the same manner. The data manager will keep

copies of the original data on disk. The tracking information will be kept in hard copy format and made available weekly to the project manager.

4.4 ELECTRONIC FILE DELIVERABLES

Reports, management plans, and other documents will be submitted to EPA in Adobe portable file document (.pdf) electronic files, in addition to hard copy, for distribution to interested parties electronically and via the Portland Harbor RI/FS shared server. Data will be submitted electronically in a format compatible with EPA's database system (NOAA's Query Manager). The database administrator of the NOAA Query Manager has provided to SEA's data administrator format specifications for transferring data between SEA's LWG project database and Query Manager. Transferring SEA's Willamette Historical database to Query Manager database format has been completed (and provided to EPA).

4.5 DATA ACCESS

Files containing validated physical, chemical, and biological data will be stored on the EPA/LWG shared server and distributed on CD-ROM upon request by EPA. The various types of environmental data collected by the LWG will be placed into Access tables or Excel spreadsheet files. Information within those tables will be cross-referenced based on key fields such as location, date/time, matrix type, or other fields.

4.6 DATA MAINTENANCE

The backup and restore procedure is separated into two processes in SEA's database. The first process involves extracting and restoring the data to and from the EQuIS data table maintenance system using the backup and restore utility of the system. The second process involves extracting data from the storage media using a storage manager for retrieving data that will be placed on web server. A point-in-time extracting/retrieving feature allows the database administrator to simply provide a date or time in which the network will be refreshed with updated datum. After 60-days of receiving the final analytical results from laboratories the database administrator will refresh the web server with updated datum to comply with EPA requirements.

Network server data is stored on redundant, mirrored hard drives to protect against data loss due to hard drive failure. These drives are mounted in a custom Linux fileserver protected by an uninterruptible power supply. The data from these drives, as well as any other data stored elsewhere on the network, is backed up every hour to another PC, where two previous versions of all files are stored to protect against data loss due to user error. An off-site backup copy of this drive is made weekly to protect against loss due to fire and theft.

Overall, maintenance of components that make up the data infrastructure (systems that store, backup, archive, etc.) and network systems will be monitored on a monthly basis to ensure that ongoing data storage and access needs are efficiently managed. Data will be protected from system failure, accidental damage, catastrophic failures and intrusion. All state and federal guidelines for data management will be observed to ensure data remains retrievable in the future.

5.0 DATA PRESENTATION

Data from Portland Harbor will be presented clearly using GIS tools, tables, and figures. At the conclusion of the RI/FS, all presentation materials will be archived along with field and laboratory data. Illustrations, charts, tables, and other visual displays will be used to organize, evaluate, and present data.

5.1 GRAPHICAL DATA DISPLAY

Graphical methods of data presentation may be used to supplement information presented in the data tables to depict data trends and patterns. For example, maps may be used to delineate sample area boundaries, Portland Harbor topographic and bathymetric features, and chemical concentrations at discrete points. Isopleth maps may be used to estimate concentrations of chemicals between sample locations. Other types of maps and logs, such as those generated by the sediment profile image (SPI) survey and acoustic bathymetric survey, can be provided as necessary to present data and information collected during field efforts.

The LWG data management system will provide spatial referencing that can be used by GIS programs such as ArcInfo and ArcView so that data can be used as effectively as possible.

The ArcView system's standards, protocols and formats will be used to automate, store, update, manipulate, analyze and display geographically referenced information. Such information consists of two linked components. The spatial component indicates the location, shape of and relationship among features. The tabular component describes the feature's attributes. Examples are sample type, sediment volume, and concentrations of chemicals of concern.

Most Portland Harbor RI/FS activities will use GIS for decision support, analysis, and display. A common spatial reference framework and standardized attribute schematic will be developed to facilitate use by the various stakeholders. The following standards will be included:

- Spatial Framework
  - Horizontal and vertical reference datum
  - Map projection
  - Units of measure
- Data Format
  - ArcInfo coverage
  - ArcView shape file
  - AutoCAD file

A GIS process has been developed to address objectives, data and application needs of the project. Specific activities associated with this effort are early

establishment of controlled vocabulary, establishment of NAVD88, marks on key structures, and a process to bring key historical data sets into the common spatial framework.

Other components of the common spatial data framework are:

- Horizontal Datum: North American Datum of 1983 (NAD83)
- Projection: State Plane Coordinate System, Oregon North Zone, northings and eastings
- Units: U.S. international feet
- Columbia River Datum: Hydrographic surveys.

All new data collection will utilize the vertical and horizontal datum stated above, with sufficient ties to previously used datum (NAD27 and National Geodetic Vertical Datum of 1929; NGVD 1929) to allow for comparisons with older data.

6.0 TRANSFER OF INFORMATION TO EPA REGION X

All electronic files will be maintained in formats that will facilitate transferal of data into NOAA's Query Manager. Data will be provided to EPA at specific points in the RI/FS, including following the compilation of historical data (data were transmitted April 26, 2002), following each field event, and at the completion of the project. Each data transmittal will be composed of existing data and recently collected data, including data collected by the LWG as well as other parties. As part of the database deliverable, tables that clearly show the new data and any other changes will also be provided. Updates of the LWG's database will be made available to EPA and LWG members on a quarterly basis.

7.0 REFERENCES

EPA. 1988a. Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA. Interim Final Report. Office of Emergency and Remedial Response, Environmental Protection Agency, Washington, DC.

EPA. 1988b. Laboratory Data Validation: Functional Guidelines for Evaluating Inorganic Analyses. Prepared for the Office of Emergency and Remedial Response, Environmental Protection Agency, Washington, DC. 73 pp.

SEA. 2001. Portland Harbor Superfund Site Technical Memorandum: Proposed Database Approach. Striplin Environmental Associates, Inc., Olympia, WA.